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## **Improving the Cable Car Experience with VR**

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Submitted in partial fulfilment of the requirements for  
Bachelor of Engineering with Honours



## **Abstract**

Since the COVID-19 pandemic began, borders have been closed to most overseas visitors and the tourism industry in New Zealand has suffered. Wellington Cable Car (WCCL), a popular spot for tourists before the pandemic, has seen a large reduction in traffic through its one-of-a-kind funicular railway. However, as restrictions ease in New Zealand and borders reopened this year, WCCL anticipates the return of what used to be their main consumer group. With Wellington's many tourist attractions, there is sure to be some competition for the attention of these overseas travellers. To stand out and draw tourists in, WCCL needs something new and exciting, to contrast its rich history. Although many things had to take a standstill during the pandemic, technology was not one of these things. More and more people are becoming interested in participating in Virtual Reality (VR) experiences, and VR has even become an option for commuters. The goal of this project is to develop a prototype for an application that will enhance the experience of the cable car and can be a fond reminder of tourists' visits when they return home.

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# 1. Introduction

The aim of this project is to design and develop a prototype for a virtual reality (VR) app that will enhance the cable car experience for tourists and can be kept as a souvenir.

## 1.1. The Problem

The worldwide pandemic of Covid-19 has had quite an impact on the tourism industry. Since international borders have been closed, tourist attractions across Aotearoa have seen a drastic change in the number of visitors they see annually. In the year long period ending August 2022, New Zealand hosted only 541,000 overseas visitors, as opposed to the 3.90 million that visited in the August 2019 year [1] [2]. In a graph taken from Stats NZ Tauranga Aotearoa, Figure 1 shows the number of overseas visitors in New Zealand over a 10 year period from August 2012 to August 2022 [1]. The Wellington Cable Car is no exception to this, seeing less than 50% of its usual ~1.2 million passengers enjoying its scenic view in the first year of the pandemic [3]. This forced WCCL to adapt its business model to engage domestic customers more. With borders set to reopen to some tourists this year and WCCL hoping to welcome them once again, WCCL have been working on initiatives to engage tourists, with the expectation that they will come swarming back in. However, it is not the only major tourist attraction in the city, so how will it compete with other attractions that are also preparing for the coming wave of tourists, and secure their spot as the second most visited attraction in Wellington [3]? To captivate tourists, WCCL asked me to develop an AR or VR application that is easy for visitors of the cable car to use, to enhance the experience and get tourists excited about the cable car again. The usability and user experience of this solution was then assessed by conducting user evaluations.

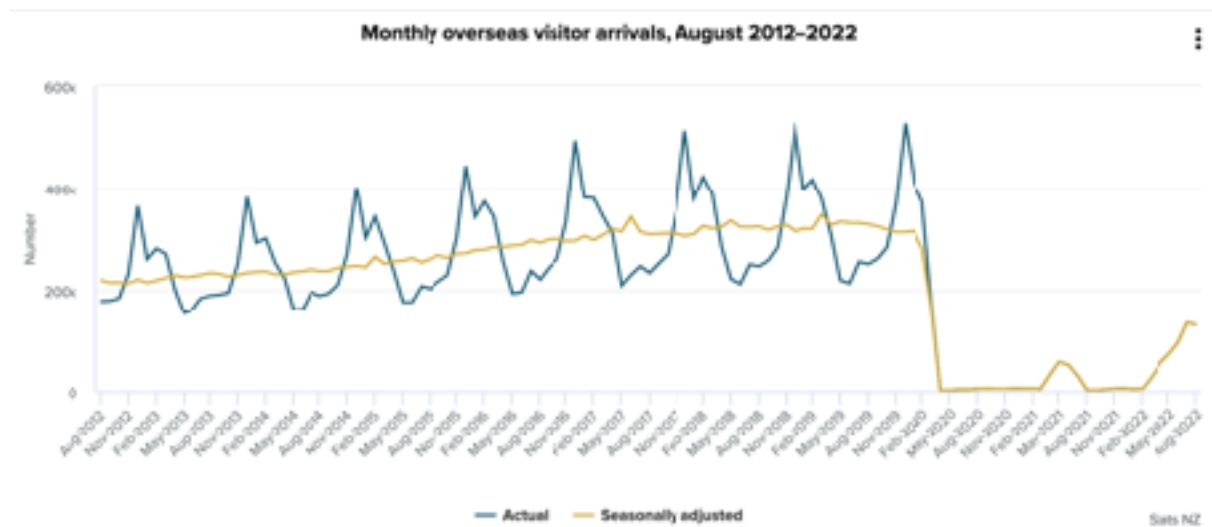


Figure 1: Graph showing number of overseas visitors to NZ

## 1.2. Outcome

During the course of this project I designed and developed a prototype for a unique VR experience using portable cardboard virtual reality headsets, similar to the Google Cardboard. Screenshots of the app can be seen in Figures 2 and 3. Additionally, I evaluated the app through user trials and selected participants from the target demographic. Although user trials took place at the cable car terminal, the application can be used anywhere. The cardboard headset is easy to assemble and cheap enough for WCCL to let users take them home with them. The experience showcases a virtual gallery of some of the photos and other media showing the history of the cable car. Users are able to navigate the gallery

and look at these images and read about its history. This also includes 360 degree video of the old winding room and images from the inside of the historic cable car, currently located in the cable car museum. This app is intended as a prototype for further development and therefore includes only a few of these items in order to get a sense of what the experience could be and get feedback from potential users through user trials, before investing time and money into further development. In the future, the client may wish to add more content or extend some of the explanations/details of each item in the virtual world.

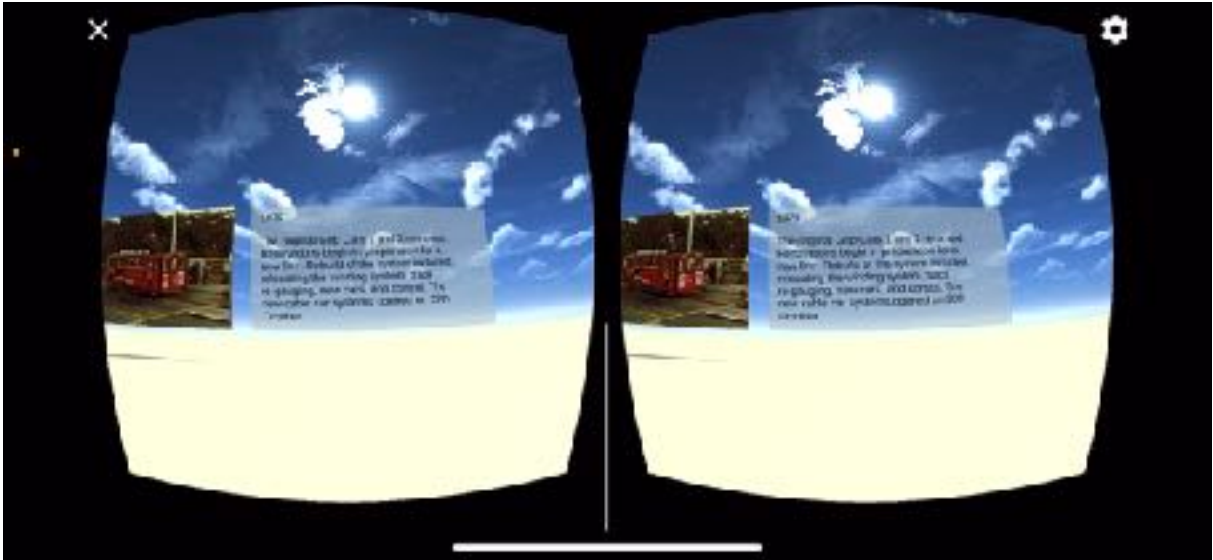


Figure 2: Screenshot of the VR app

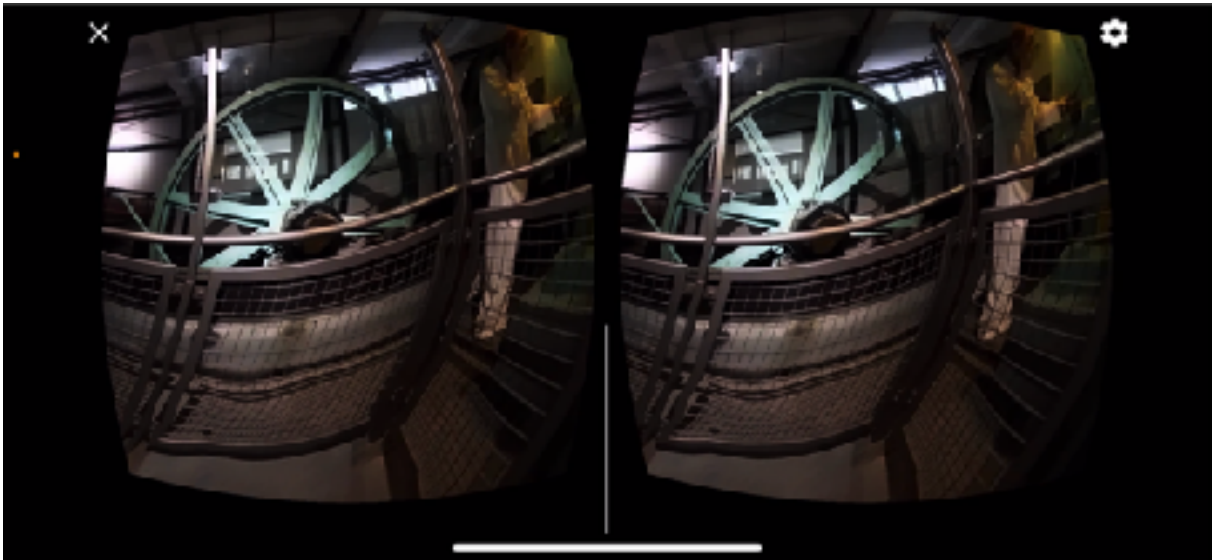


Figure 3: Screenshot of the winding room video

### **1.3. Contributions**

During this project, I have made the following contributions:

- The conceptualisation of a VR app that engages tourists and enhances the cable car experience
- The design of the virtual world within the VR app
- A functional prototype of a VR app that implements this design
- An evaluation of both the usability of this app and user enjoyment of the app

## 2. Background and Related Work

Extended Reality (XR) or Mixed Reality (MR) refers to the group of technologies encapsulating Augmented and Virtual Reality (AR and VR). These technologies use 3D worlds and models to augment or create virtual realities and extend experiences beyond what is real [4]. Augmented and virtual reality can be used to create immersive experiences for entertainment, learning, and productivity. The key difference between AR and VR, is that AR incorporates the real world environment and simply alters it or adds to it, while virtual reality completely occludes users from their environment and transports them to an entirely different world. This literature review will be focusing on VR, as opposed to AR, as this was what the client and I decided to implement.

### 2.1. VR Experiences in Transit

The original concept for the app was for it to be used in transit on the cable car. The use of VR in transit is a broadly researched concept. In big cities it is common for workers to have long commutes to work and these are often considered as working time [5]. These commutes can be utilised by workers to be productive, however most feel that the environment is a limitation to their productivity [6]. The use of smartphones present the issue of screen size as a limitation, while laptops can be problematic ergonomically [6]. Many studies have looked into whether VR is an appropriate solution for this. One study found that generally participants were willing to engage in productivity activities using VR [6]. It also found that the productivity tasks participants usually completed in transit, did not match the tasks which they preferred to engage with using VR. One of the preferred tasks that many participants were interested in using VR for was watching videos [6]. This could suggest that users are more interested in using VR for entertainment purposes rather than productivity. The use of VR for entertainment has also been studied in a variety of contexts, with one study looking specifically at the use of VR to improve the transit experience on Finnish metro services [7]. The study found that participants reported feeling less bored and that the commute was a more positive experience. The study also noted that the use of VR on the metro did not noticeably bother other passengers and that the use of VR headsets did not draw in extra attention from other passengers [7]. This is most likely due to the fact that the VR experiences participants were engaged in did not involve a lot of movement, and so participants were able to sit mostly still while in transit. If the VR experience was a more interactive movement based one, this could cause problems and disrupt other passengers [7]. It was also noted that the cabin was not very full during these studies, and the effects on other passengers may be more disruptive during busier hours.

Another suggested use of VR in transit was relaxation and mindfulness. As opposed to productivity, this study proposes that transport is an ideal setting for VR use for mindfulness [8]. The study found that VR use for mindfulness resulted in participants feeling calmer and more relaxed after the experience. They found that the experience was more effective in producing these results when the movement of the VR setting was matched to the movement of the car [8]. This reduced the side effects of motion sickness and actually yielded better results than when participants used the VR in a stationary car.

However, the use of VR on public transport may not be recommended, as it occludes users from the real world, making them less aware of their surroundings, which may cause motion sickness side-effects [9], as well as discomfort for the user, as they may not feel safe being fully distracted while surrounded by other passengers. A study from 2021 found that people were hesitant to use VR on shorter journeys on public transport largely due to the lack of awareness of their surroundings [10]. Things they worried about included disrupting other passengers, missing a stop, and experiencing motion sickness. A study conducted at Georgia Institute of Technology found that out of three XR experiences, participants felt safest using AR, and least safe using VR [11]. Participants using VR reported feeling safest in a room, or non-automated car, and least safe in fully-automated vehicles, public transport, and taxis [11]. This is further evidence to show that users may not want to use VR in transit on public transport. In this project, the proposed use of VR was in a frequently crowded cable car. These



studies suggest that this would not be desirable for users, due to the concerns of disrupting the public, and the lack of safety. The use of VR would also mean that passengers miss out on the fantastic views and scenery that the cable car is famous for. Because of this, it was decided that the application will not be made for use in transit, but separately to the cable car ride instead.

## **2.2. VR Museum Experiences**

The reviewed proposal for the project suggests a virtual gallery experience, containing images and video of the cable car from history. The onset of COVID-19 has encouraged the development of immersive virtual experiences in many fields all over the world, such as medicine, education, and entertainment [12]. Virtual galleries have become increasingly popular since lockdowns and capacity limits have forced museums and galleries to close [12]. Before Virtual Reality, online galleries of work were limited to 2-dimensional spaces, such as websites, or videos. These formats create a passive experience for the viewer and are often not very engaging. What has made VR galleries so successful, is the ability that users have to interact with and be fully immersed in the experience [13]. A study conducted at the University of Warwick found that VR can improve knowledge retention and understanding when compared to traditional or video learning formats [14]. It even found that the VR learning experience led to an increase in positive emotions, as opposed to the decrease in positive emotions that was reported for the traditional and video experiences. This all goes to show that VR is a more fulfilling experience for most viewers.

VR can be used in museums and galleries, not only to create a more interactive and engaging experience, but also to provide virtual reconstructions of artefacts and improving historical realism [15]. The Herbert Virtual Museum was developed in collaboration with the Herbert Art Gallery in Coventry, England [15]. This virtual museum made the galleries collections available virtually. This was found to engage and enhance the museum experience for both visitors and remote users [15]. The Herbert Virtual Museum preserves historical content and engages users to interact with the content in a more engaging way than is possible in the real world [15]. An example of a fully virtual gallery that was created during the pandemic and has been highly successful, is the Virtual Online Museum of Art (VOMA), created by Stuart Semple. This virtual gallery was the world's first museum that is entirely online and was opened in 2020 [16]. VOMA is an example of the barriers virtual museums can overcome. In 2021, the museum showcased an exhibition titled "Why We Shout: Art and Protest", which featured a Diego Riviera mural painting from the Rockefeller Centre in New York in the same room as an iconic Banksy piece, currently located on a wall in Palestine [17]. This was a striking choice that would not have been physically possible in the real world. Through the use of a virtual world, VOMA expands the possibilities of the art world and creates a truly unique experience.

Wellington's own Te Papa museum also utilises VR to give access to a wider audience. Te Papa gives the option of virtual tours through their Virtual Explorer programme [18]. This allows children anywhere in the world to engage with the exhibits in the museum without having physical access to them. They also offer an education resource for children that allows them to create their own Virtual worlds and view them using Google Cardboard VR headsets [19]. Through utilising these technologies, Te Papa manages to engage children and families all over the world and keep up with new developments in entertainment technology. Just like the cable car, Te Papa also relies largely on tourist traffic, and it is these kinds of experiences that draw them in.

## 3. Design

Before development could begin, three main steps were essential to the design of the application. These were gathering requirements, designing a user interface, and case study.

### 3.1. Requirements

It took many meetings and discussions to gather requirements and clarify the ideas for the project. The initial concept was quite vague, so I had a lot of freedom to suggest potential solutions. WCCL wanted a product that would draw in tourists as the borders reopened and celebrate the 120th anniversary of the Cable Car, which they celebrated this year. The product needed to be portable and easy for many people to use at once, as the cable car gets very busy during peak tourism periods. The success of the application can be measured by whether the users felt the app was easy to use and whether they felt it enhanced the experience for them.

Before I could begin developing a demo app of any kind, I had to decide on a platform to use for the app. I chose to develop the app for an iPhone and this decision is explained further in section 3.4. I have never created any augmented or virtual reality apps before so I had to do a lot of learning before I could get started. I used Youtube tutorials and various articles, including articles on Apple's developer site.

Initially, we discussed the potential for both AR and VR apps that could be used during transit. After doing some background research I concluded that using VR during transit on the cable car would be hazardous as it could cause motion sickness and occlude users from their physical environment, and would not fulfil the requirements, as it would not enhance the experience so much as distract from it. Due to this, we discussed possibilities of an AR app instead. The concept that we were beginning to clarify was one of an AR app that allowed users to view the environment outside through the app on their smartphone, which would use the camera to overlay information about landmarks on the screen. To help illustrate how an AR app might work, and as a first attempt at developing for AR, I created a demo app for an AR experience.

The app I created had a 3D object (a pyramid) that could be placed anywhere in the space the user is in by tapping the screen. The object would then hold its position in relation to the real world as the user moves around and views the space through the camera. A screenshot of the AR demo app can be seen in Figure 4 below. I had some difficulty with making the object placement match the intended placement of the user. This resulted in the pyramid being placed in somewhat random areas, and not the area that the user tapped. Despite this, it was a good demo to show the client what the app might look like. This was useful in illustrating the type of app I was talking about to the client, who did not have experience with virtual or augmented reality.



Figure 4: Augmented Reality demo application

After showing the client the demo app I had created, we decided that the original proposal was not the best possible solution. In discussing the demo, the concern arose that the use of an AR app in transit may not enhance the cable car experience, but would distract passengers from the beautiful views which they are so famous for. Additionally, since many passengers may not have used such an app before, they would need more time to become acquainted with it before they could fully enjoy it, and the short journey from the Lambton Quay terminal to Kelburn would not allow for this. Another requirement put forth by the client was that the app could act as a souvenir, so that visitors could show friends and family when returning home. Creating an AR app would then be location dependant and wouldn't allow the users to experience it when returning home. Thus, I decided it would better satisfy the goal of the project to develop an app that could be used separately from the cable car, rather than relying on the short journey. This addressed the issue of distracting the users from the in transit experience of the cable car as well as some of the health and safety concerns relating to the use of VR in transit. I chose to make it a VR app to ensure tourists can enjoy it just as much when they return home as they did in Wellington.

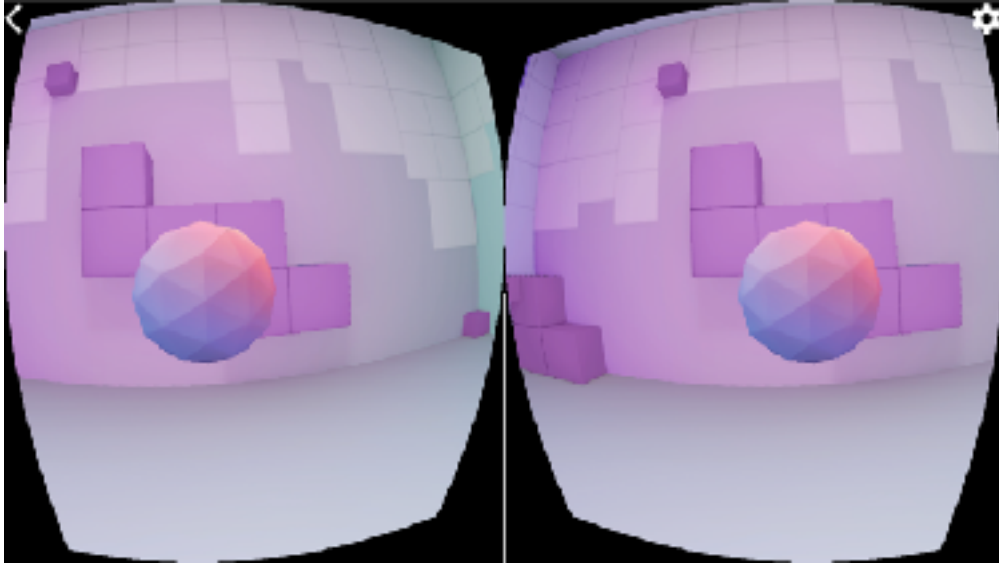


Figure 5: Virtual reality demo application

After reviewing the original concept, I decided to create a demo app for VR to show the client and to learn how to set the app up. I used a Google Cardboard Quickstart guide to help me create the app. The demo app is interactive with the user having the ability to select items in the VR. The cardboard VR headsets available at the university are slightly different from Google Cardboard headsets, and I realised from creating this demo app that there was no button on the headsets we had available, and users would therefore not be able to interact with the app other than moving around in the world. After doing some research on the potential solutions to this problem, I decided that the simplest and most sustainable solution to this was to use head movements to allow the user to move in the world and interact with the environment. Tilting the headset slightly forward (looking down slightly) moves the user forwards in the world. The reason I did not decide to use real world movement (where users simply walk forwards in real life) was because the app was likely going to be used before or after users ride the cable car and they will not necessarily have a clear space set aside to walk around in. This could lead to people bumping into each other and getting injured. I raised this issue and my proposed solution in the next meeting with the client, and they were happy with the design choice. The clients were also happy with the demo and satisfied with the new direction of the project. A screenshot of the VR demo app is shown in Figure 5.

I decided to write up a brief document as an update to the proposal so that we would have something to reference that represented the updated vision for the project. This document was then sent to the client and I made sure to get their approval to confirm we were all on the same page. This updated proposal can be found in the appendix.

### 3.2. Case Study

After clarifying the requirements and concept for the project, I conducted a case study using a persona which I named John Smith, representing a member of the target demographic. The purpose of a persona is to better understand the target user and design a product that is tailored to this type of user [20]. To create these case studies I talked to the client about what their typical tourist demographics are and applied these characteristics to create an example persona to conduct a case study. I then ran through possible scenarios and noted step by step what John was doing and what is shown in the app.

## **John Smith - Persona**

John Smith is a 60 year old man from London, working in finance. He is visiting Wellington on holiday with his family. John has experience using computers in his work and home life, and enjoys watching movies and videos online with his family. He has heard of the concept of VR, but generally doesn't stay up to date with developments in tech and has never used a VR headset before. John finds new technology to be confusing at times, but has a positive attitude towards it.

### **Scenario One: John wants to read about the old cable car**

John opens the Cable Car VR app that he has downloaded on his phone. He places the phone into the cardboard headset he has been given. He then raises the headset to his eyes and sees the introductory pop up. He reads the introduction and closes the pop up by tilting the headset forward as explained in the instructions. John then moves the headset back up to a neutral position to look at what is in front of him in the virtual world. He can see an image of the old cable car and a short paragraph describing the image to the right. John takes a moment to read the description and look at the image. He then turns to see what other images are near by. He finds a different image with a similar description and reads this.

### **Scenario Two: John wants to see the 360 video of the winding room**

After viewing the images of the old cable car, John wants to try and find the 360 video of the winding room. He turns around slowly to find the 360 video of the winding room. John sees a sphere with a sign in front of it saying winding room. He recalls the instructions in the pop up he just closed telling him to tilt the headset forwards to move. John moves towards the sphere until he is inside it, as explained in the pop up. Now that John is inside the sphere, he can see the winding room around him and a big wheel turning. John looks around for a while and then decides to leave the winding room. He tilts the headset forward to move forwards in the direction he came from.

### **Scenario Three: John wants to see a different 360 video**

Once John has left the winding room, he can see other spheres next the winding room sphere. He moves toward one that has a sign on it saying "The Old Cable Car". He continues moving towards the sphere until he is inside it. John can see the inside of the old cable car around him. John looks around to view the scene. John is satisfied with what he has seen in the app and removes the headset from his face. He then removes his phone from the headset and closes the app.

## **3.3. User Interface**

Once I had gathered requirements and run through a case study, I created some rough sketches of the user interface. These sketches are shown in Figures 6 and 7 below. After further discussion with the client and approval of these early sketches, I went on to create a digital diagram of the interface, shown in Figure 8.

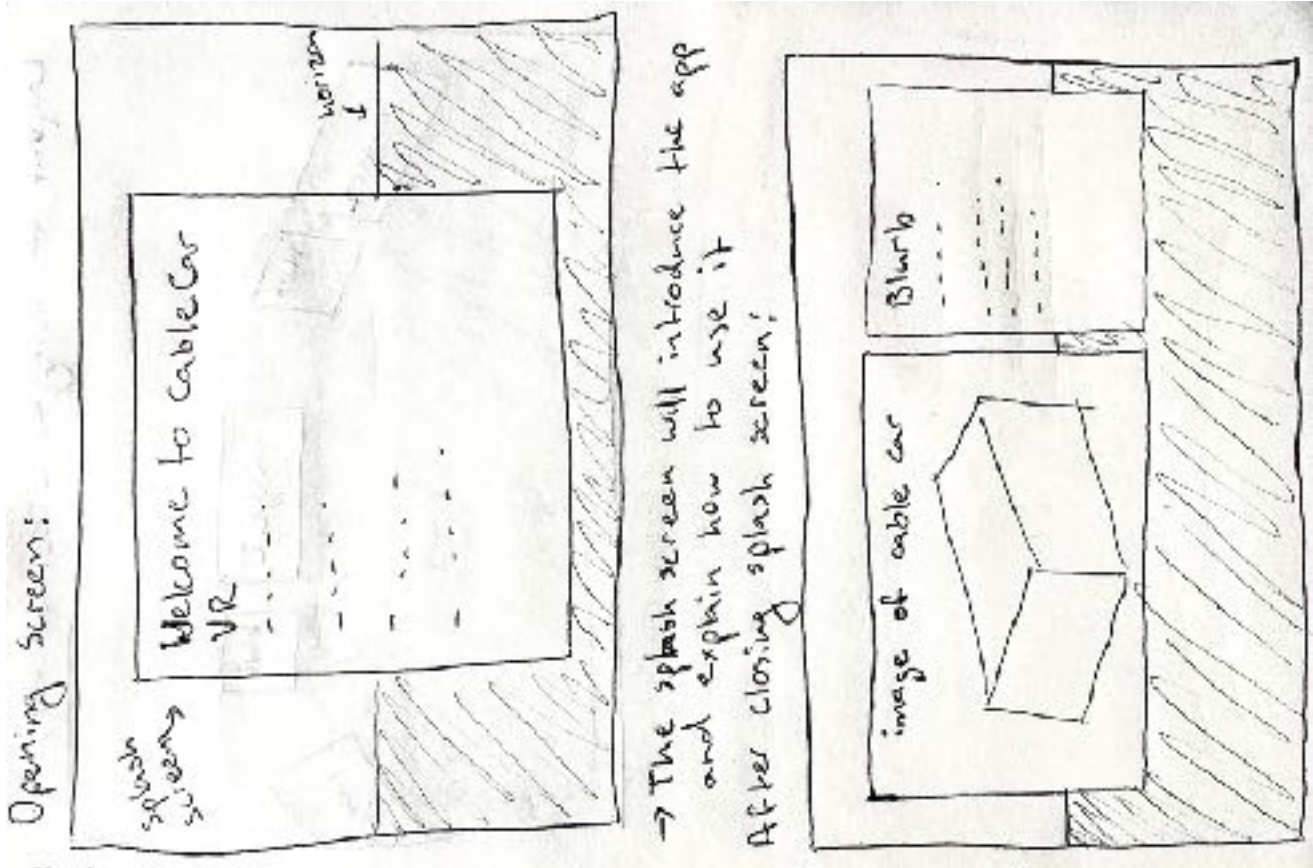


Figure 6: Sketch of UI

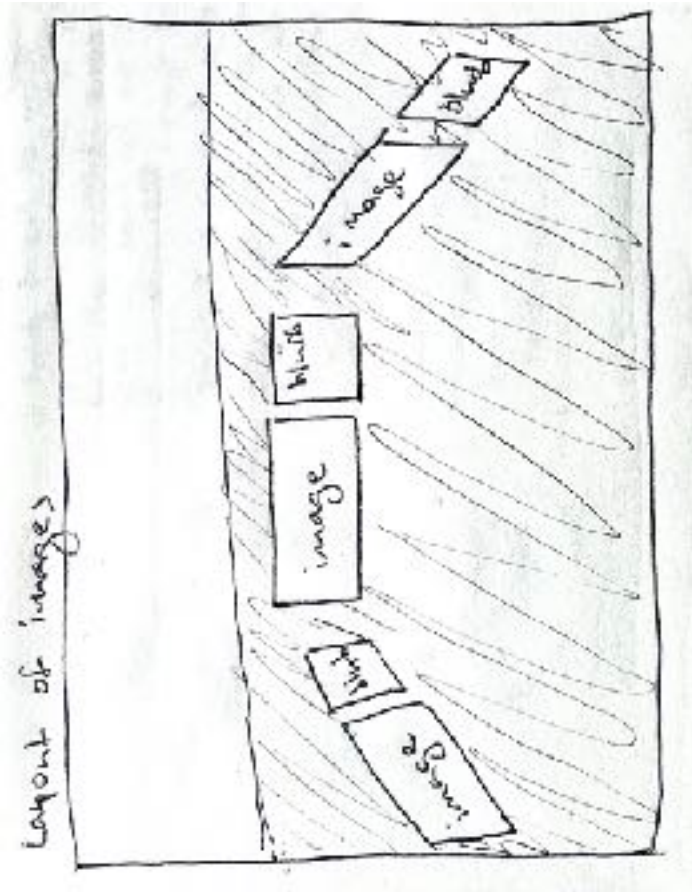


Figure 7: Sketch of UI

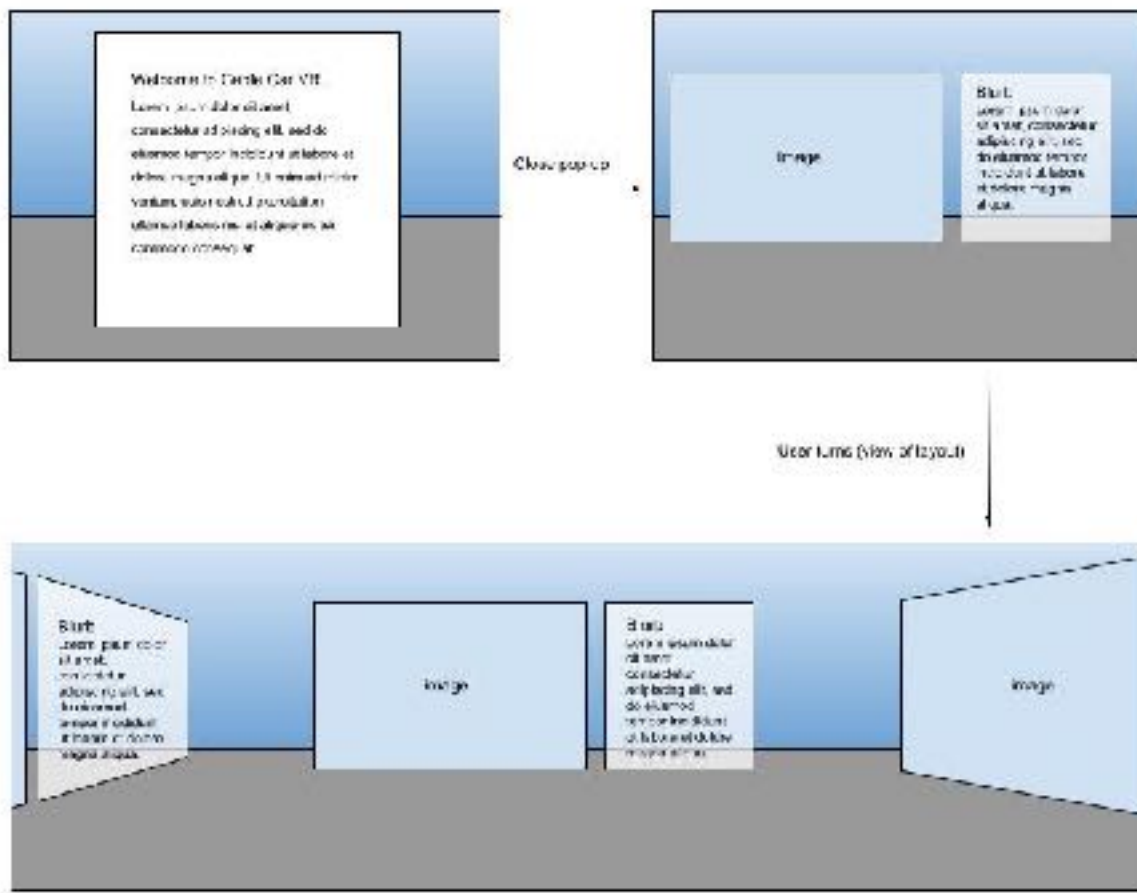


Figure 8: Diagram of user interface

Figure 8 shows multiple views of the app. In the top left you can see the opening scene of the app, with a pop up that will have a short introduction and instructions on how to use the app. Once the user has closed this pop up, the next scene can be seen on the right. This shows an image accompanied by a short description for the user to read. I chose here to display the images similarly to how it would typically be seen in a museum or gallery, with the image at eye height and the short image description sitting beside it. Below this we see the view of a user looking around, this illustrates the layout of the images. The images are rotated slightly to face the user so that when they look around they can easily see each image front-on without moving too much.

### 3.4. Hardware

I chose to develop the app for iOS as opposed to Android, because although both are popular mobile operating systems, there are currently a lot more VR apps available to Android users than iOS users [21]. I wanted to create an app that gave iOS users the unique opportunity to experience VR as well. I also note that it would be relatively simple to switch mobile platforms on Unity, and so this decision is not one that will affect opportunities for future development.

I decided to develop for mobile VR with cardboard headsets as opposed to bulkier more expensive headsets such as Oculus Quest, because the client wanted the experience to be something that users could take home with them. If the application was built for a dedicated VR device, most visitors would not be able to use it when returning home because they may not have their own VR headset. The advantage of the cardboard headsets is that they are cheap and easy to set up and can even be customised to have the cable car logo on them. WCCL could either give them away for free or charge a few dol-

lars per headset. Most tourists will have a phone on them and will easily be able to download the app and use the headset themselves. This means when they return home they can share the experience with family and friends as a souvenir of their visit to the cable car. This was what the client had requested. I chose to use the 360 cardboard headsets because the university had a large supply of these that were not being used, and for the sake of sustainability and cost it was better to use these than for the client to buy new cardboard headsets. An image of the cardboard headset that has been designed with the Victoria University of Wellington Faculty of Engineering logo and text can be seen in Figure 9 below.



Figure 9: Cardboard VR headset



## 4. Implementation

The implementation of the app consisted of four key aspects: Gathering content, project setup, implementing the 360 video and images, and implementing interaction functionality.

### 4.1. Gathering Content

Some of the content for the app (images and text) was provided by the client. I had to organise this with them in order to get the right number of images and corresponding descriptions by the time I needed them. The client used images they had on hand from the recent promotion of the 120th anniversary of the cable car. They sent these through to me along with the appropriate descriptions for the images. Examples of some of these images are shown in Figures 10 and 11 below.



Figure 10: The construction of the Kelburn terminal



Figure 11: The Kelburn terminal in 1974

In addition to this, I collected footage of the old cable cars and winding room from the Cable Car Museum. To get the footage, my supervisor put me in contact with someone who was able to lend me a 360 camera. The camera I used was the Ricoh Theta 360 camera. I also had to get in contact with the Cable Car Museum in order to ask for permission to collect footage. I wrote up a brief explanation of the project and described the footage I was hoping to get and sent this to the client, who contacted the museum directly. The museum staff then set up a meeting for us to discuss the project a little more and talk about what was possible for me to record. After this, we arranged a time when I could visit the museum to get the footage. I made sure to arrange to have access to the 360 camera at the same time.

I visited the museum during open hours to collect the footage, which meant there may be other people around in the background of the videos. I wrote up a media consent form (found in the appendix), which I asked visitors of the cable car to sign, in case they were in the background of any of the videos or images. I collected footage from multiple positions in the winding room and both of the old cable cars, one of which is not meant to be touched by the public. This made the footage unique in that no one could normally see that inside view of the cable car.

Once I had collected the footage, transferred the footage onto my computer and returned the camera. The video files were saved as MOV files, and I used the Ricoh Theta app to convert these to MP4 files in the correct format. Screenshots of some of these videos can be seen in Figures 12 and 13 below.



Figure 12: Inside view of the old grip car



Figure 13: Inside view of the old cable car

## 4.2. Project Setup

To implement the app, I used Unity, Visual Studio Code with C#, Xcode and the GoogleVR Cardboard plugin to develop the 3D environment and make it compatible with the cardboard headset. I began by creating a 3D project in Unity and downloading and importing the GoogleVR Cardboard plugin. Some unexpected challenges arose here, as I discovered the version of the plugin that I had been researching was deprecated and so I had to switch to the updated version. This was challenging because the tutorials and guides I had researched did not apply in the same way to the updated plugin. This meant that during development I had to do a lot of trial and error to figure things out that differed to the tutorials and documentation I had looked at previously. However, the GoogleVR Cardboard headset has been a very popular starting point for developers creating mobile VR apps, and so I found a lot of resources online from other developers asking similar questions to me. To set up the project I had to configure project settings to be compatible with the VR headset and Cardboard plugin, and switch to the iOS platform in build settings.

The virtual world is encapsulated by a scene in the Unity project. The scene contains game objects, representing the objects in the world. The scene hierarchy can be seen in Figure 14. There are three image objects, each containing a panel and text, making up the image and image description. I positioned and transformed these objects in the world to create the VR environment. A screenshot of the editor is shown in Figure 15.

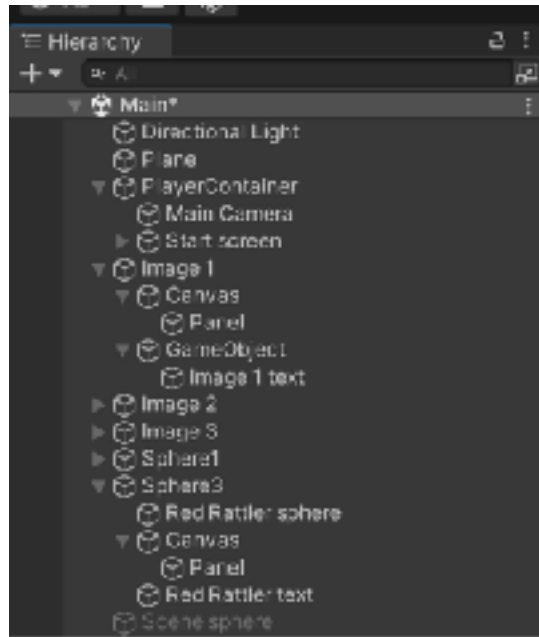


Figure 14: Screenshot of objects in the project hierarchy

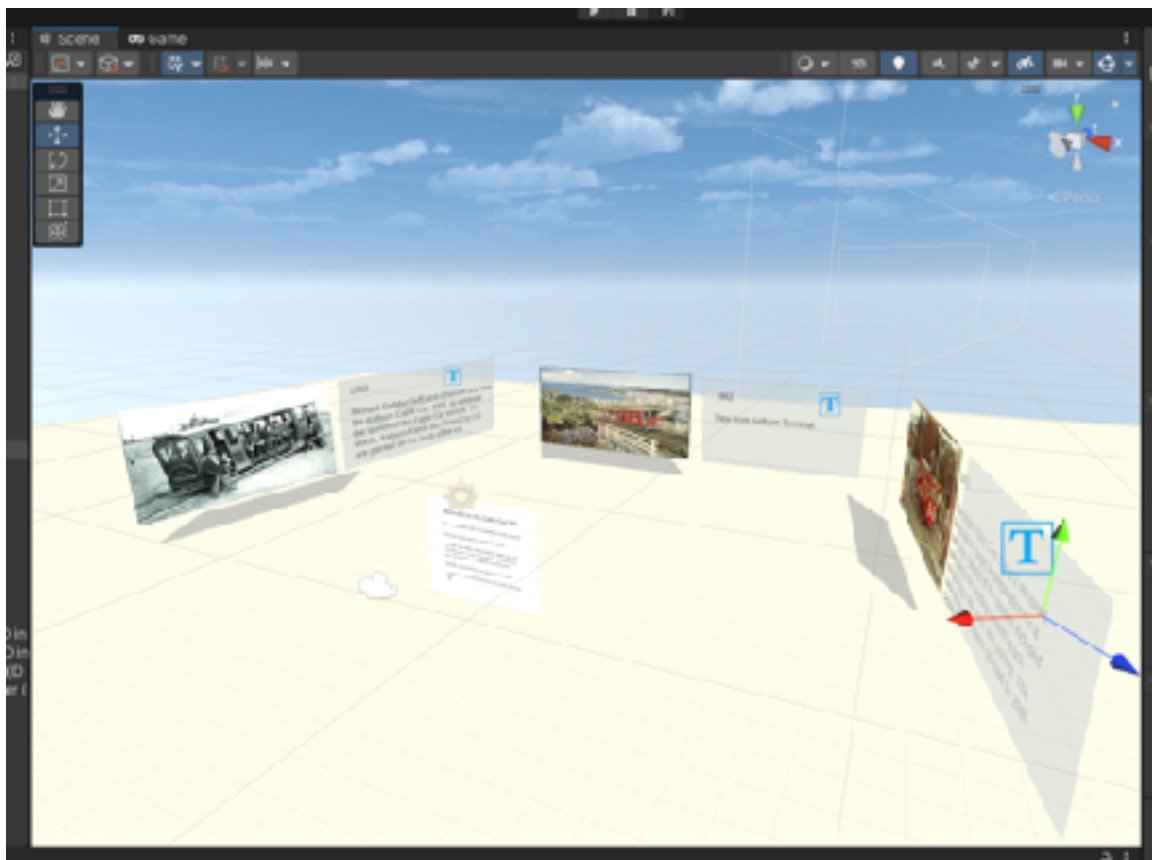


Figure 15: Screenshot of the scene editor

### 4.3. 360 Video and Images

To make the 360 images and videos visible, I first had to import the videos and images and ensure they were correctly formatted. I then created a spherical game object and for the videos, I added a video player component to the sphere so that the video would play. I then created a render texture using the video and a new material. After setting the render texture of the material to the one I had just created, I could now set the material of the sphere to this material. This creates a sphere with the video wrapped around the surface of the sphere. The problem here is that the video is playing on the outside of the sphere, but to view it as a 360 video, it needs to be seen from inside the sphere. To do this I created a script in Visual Studio Code that inverts the material of the sphere to point inwards rather than outwards. I then applied this script to the sphere object. Figure 16 shows the view from inside one of the spheres.

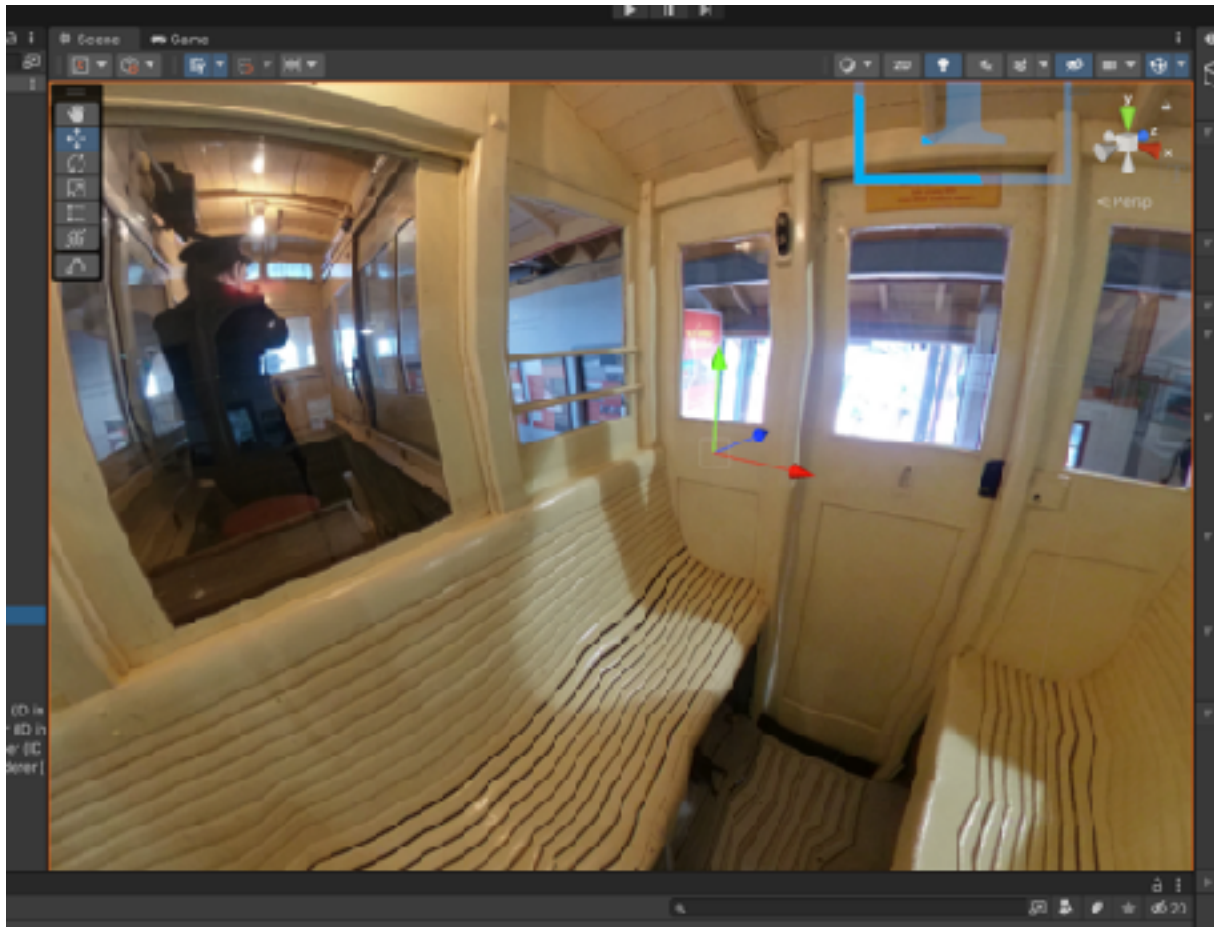


Figure 16: View from inside the red rattler sphere

### 4.4. Functionality

A challenging aspect of using the cardboard headsets available at the university, was that they did not have a button on them for users to interact with the app. The only way for users to navigate the app is with movement. A possibility for users to move in the virtual world, was for the app to simply track their movement in real life. This would mean that in order for users to move in the app they would have to walk around in the real world. When users are using the app they are completely focused on the virtual environment and have little to no awareness of the real world environment they are in. This means they could easily walk around and bump into things or people without noticing. The app will

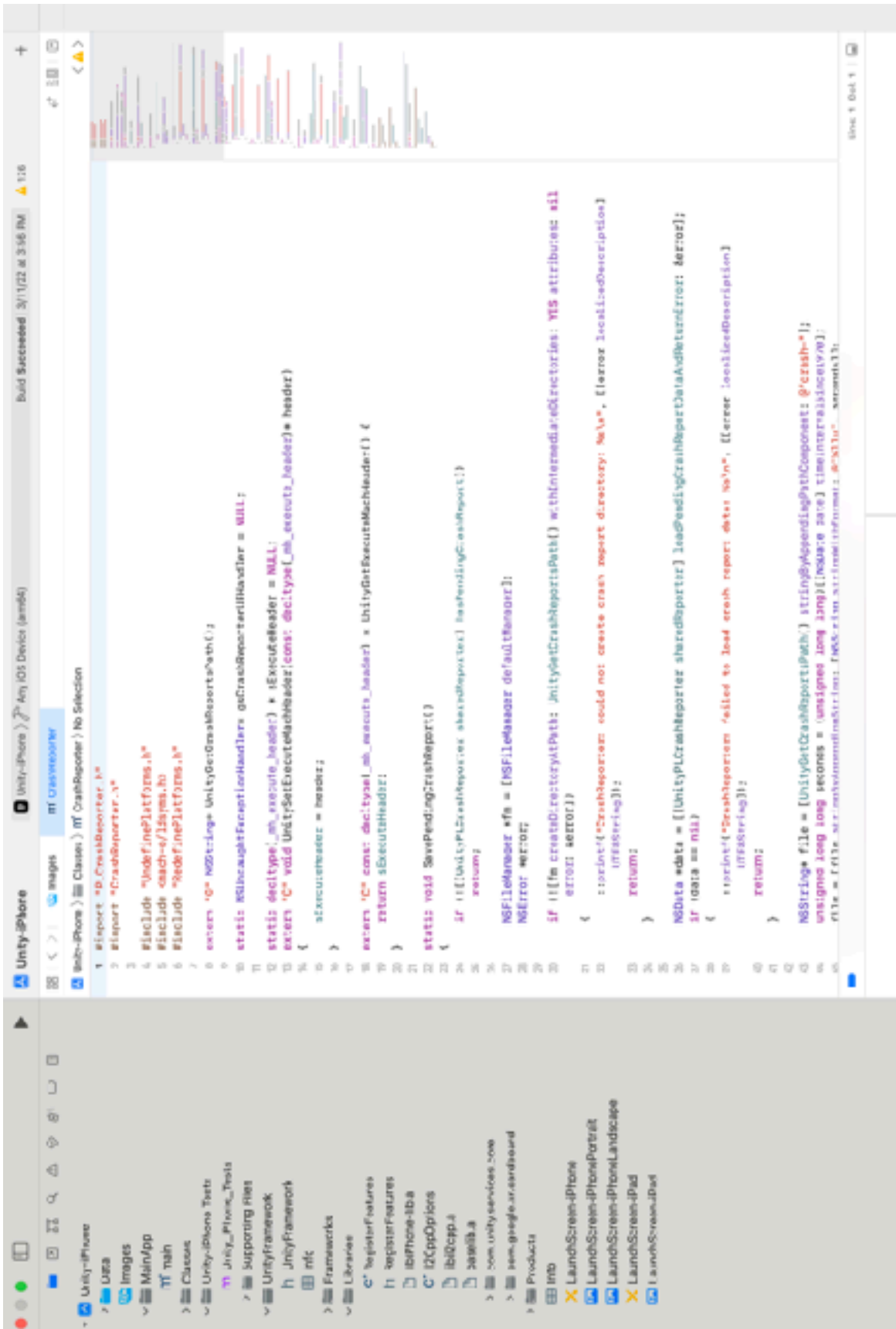


Figure 18: Xcode editor

likely be used by tourists in the cable car terminal, which is a space that is often crowded and features a platform next to the cable car tracks, so I chose not to go with this approach as it posed too great a risk to users health and safety. Instead, I chose to use the angle the user is looking forward at as a trigger to allow movement. I created a script that tracks where the user is looking and moves the user forward in the world when they are looking down at 25 degrees or greater. I felt this was an appropriate solution, as it is unlikely users will need to look down for any other reason. This ensures that the user can move around freely in the virtual world, while remaining stationary in the real world.

A similar challenge with interaction arose when the user tries to close the introductory pop up. Since there is no button, I had to find another way for the user to trigger the pop up closure. I decided to keep it simple and use the same trigger for movement to close the pop up. I created a script similar to the player movement script that would close the pop up when the player tilts the headset forwards at 25 degrees. A screenshot of the opening screen with the pop up can be seen in Figure 17.



Figure 17: Opening screen of the app

## 4.5. Running the App

I used Xcode to build and install the app onto my phone and then run it. This allowed me to debug the app while I used it in the actual VR headset. To install an app onto an iPhone I had to create a developer profile and configure the iPhone to allow developer tools. This was easy to do as there are many resources available online explaining the process [22]. A screenshot of the Xcode setup is shown in Figure 18.

## 5. Evaluation

The evaluation of the VR app has two main goals:

- To identify any issues that users may have in interacting with and navigating the application.
- To understand whether the application satisfies the goal of enhancing the cable car experience.

### 5.1. Design of Study

To run user trials for the project, I had to first get approval from the ethics committee. To do this, I completed an ethics application on Research Master detailing the context of the project, when and where testing would take place, and any potential risks to the participants or me during the evaluation. Additionally, I had to supply supporting documents such as an interview schedule, information sheet, and consent form for the participants. The application was submitted on the 8th June 2022 and I received feedback on the 29th of June. I then resubmitted after making the appropriate amendments on the 15th of August and the application was approved on the 26th of August. The full application and supporting documents can be found in the appendix.

To evaluate the VR app, I first ran a pilot study. The purpose of the pilot study was to test the app with a small sample of people, and find any problems with the study procedure and/or the app that could be fixed before a larger scale trial was implemented. I ended up going through the study with two participants prior to the final study. I then made some adjustments to the study procedure and the app before continuing to the final study.

Each trial was conducted individually. The study consisted of 7 tasks for the users to complete. These encapsulate the main functions of the app in order to provide an accurate evaluation of the usability of the app. To record responses, I took notes of any difficulties the participants were having or comments they made while they ran through these tasks. I also created a survey for users to fill out once they had completed the tasks and ensured they had ample opportunity to provide feedback. As compensation for the study, WCCL provided me with some badges and free return tickets on the cable car, which I gave to participants upon their completion of the study. The results were then collated and handed on to the client.

### 5.2. Pilot Study

The pilot study involved two participants, one aged 20 and the other aged 45. This study was intended to identify any major issues that would be problematic to the user trials and threaten the quality of the evaluation. The study consisted of the same tasks, instructions, and survey as the final user trial. There were two issues identified in these trials. The first issue was that users were not seeing the introductory pop up as it disappeared after opening the app, when they were putting the headset on. This was because the trigger to close the pop up was to tilt the headset forwards, and this movement was also happening when users were handed the headset. To fix this for the final trial, I implemented a timer that stopped the pop up from closing for 10 seconds after the app was opened. This allowed users to hold the headset at an angle after starting the app. The second issue that was identified was that the instructions in the introductory pop up appeared blurry and out of focus because the text was too small. I addressed this by increasing the font size on the pop up so it was clearer and easier to read.

### 5.3. Participants

The demographic that the app is targeted at is tourists riding the cable car. Because of this, I decided to select participants of this demographic by conducting the trial at the cable car terminal and asking visi-



tors to participate. This ensured that the sample of participants accurately represented the intended users. This was an important step because many of these participants had never used VR headsets before or understand the concept. If I had selected participants from my cohorts who have a lot more experience with technology, they would not have had some of the same issues and given very different feedback. There were 10 participants for the final study selected at the cable car terminal.

The set up at the terminal allowed for a table and some chairs to be arranged next to a VUW banner to draw tourists in. Though participants had to stand when trialing the app, they were able to sit down to read the information sheet and consent form as well as filling in the survey. The set up is shown in Figure 19 below.



Figure 19: Set up at Kelburn terminal for the user trials

## **5.4. Procedure**

The study was designed to expose problems in the usability of the app, by assessing the ease of which users completed tasks while using it. Before beginning the study, the participant first read the information sheet and consent form. Once they had read the sheet I asked if they had any questions and answered these if needed. If the participant decided to do the trial, they then signed the consent form. This process ensured that the participant was well informed and able to give consent. Next, I introduced the user to the headset and explained to them that they did not have to walk around while using the headset, to ensure that they would not start bumping into things around them. I did however make sure that there was some clear space around them in case they did try to walk around. I then asked the participant to run through the 7 tasks I had planned, and recorded their responses to these tasks. I used my own phone for these trials with the app loaded on it, and recorded the screen so that I was able to go back and see what the users were looking at during the trial when reviewing the feedback. This was useful, as I could not see what was on the screen while they used it, due to the headset. Once the participant completed the tasks, I gave them some time to look around some more in the virtual world if they wanted to and I found that 6 out of the 10 participants were curious to continue using the app for a few minutes. I then asked the participant to complete the survey on my laptop and gave them some time to do this. Once they had completed the survey I offered them a badge and free return ticket as compensation and they were free to go.

## **5.5. Study Tasks**

The tasks I asked the users to complete are as follows:

1. Read the pop up introduction to the app and close the pop up when you are ready.
2. Locate the black and white image of the old cable car, what year is this cable car from?
3. Locate the image from the year 1962.
4. Locate the 360 video of the winding room and enter it.
5. Exit the winding room.
6. Find the 360 image of the “Relentless Red Rattler” and enter it.
7. Return to the first black and white image.

These tasks prompted the user to interact with all aspects of the app. I gave participants further guidance where necessary and noted the occurrences of this.

## **5.6. Data Collection and Analysis**

During trials I collected data on the success of tasks in the form of written notes and later processed these to create graphs. I also collected data via the survey I created on Google Forms, which participants filled out after using the app.

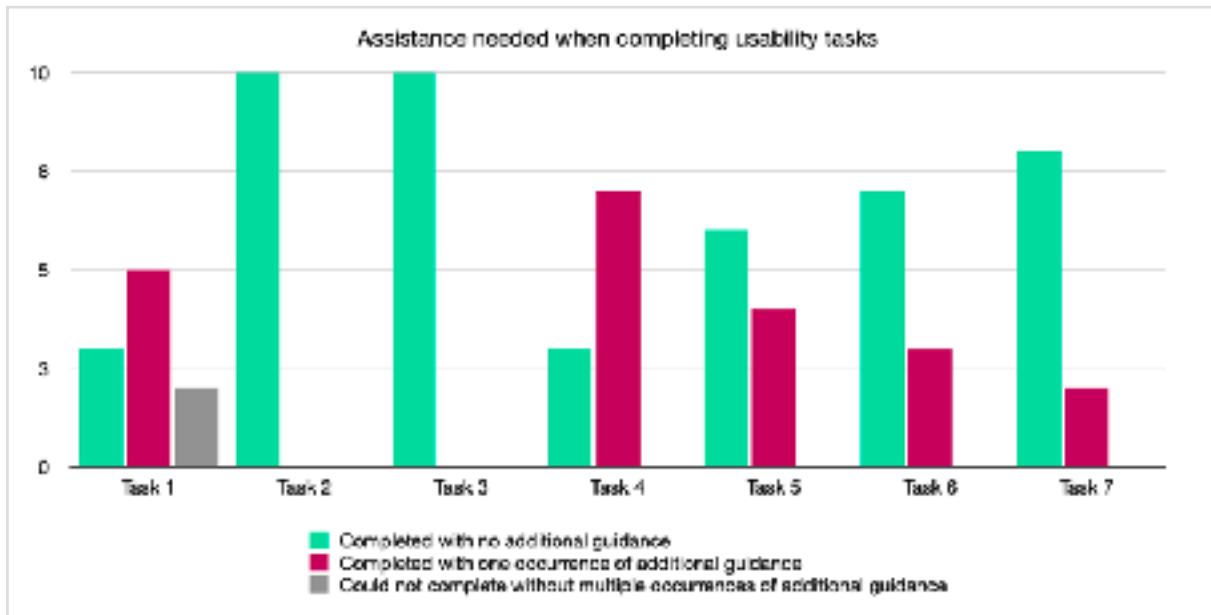


Figure 20: Graph showing number of participants needing guidance for each usability task

The graph in Figure 20 above, illustrates the difficulty of each task. This was measured by the guidance participants required during completion of these tasks. I have categorised the results into 3 groups: Completed with no additional guidance, Completed with one occurrence of additional guidance, and Could not complete without multiple occurrences of additional guidance. This guidance was given when users got stuck or asked me for clarifications on how to use the app. In the graph we can see that the task participants needed the most guidance in was task 1. This task required the user to read the introductory pop up and close it by moving forward. I noted during the trial that many participants could not find the pop up or mistook the descriptions next to images as the introductory pop up. This revealed a bug in the system where the pop up was not fixed to the character, and therefore did not stay in the line of sight of the user as it should have. Examples of this are illustrated in Figures 21 and 22 below. All users completed tasks 2 and 3 with no additional guidance. These tasks require the user simply to look around in the virtual world and find the images. The later tasks where people did need guidance were all involving navigation and movement around the world. However, no participants required multiple occurrences of additional guidance in the last 4 tasks. The graph in Figure 20 also shows that the number of participants needing additional guidance decreases for each task. This shows that users may have had some difficulties in navigating the app in the earlier tasks, but over time and after completing more tasks, they were more successful. This is expected when users are navigating a new experience, as it does take some time to become acquainted with the device and virtual world.

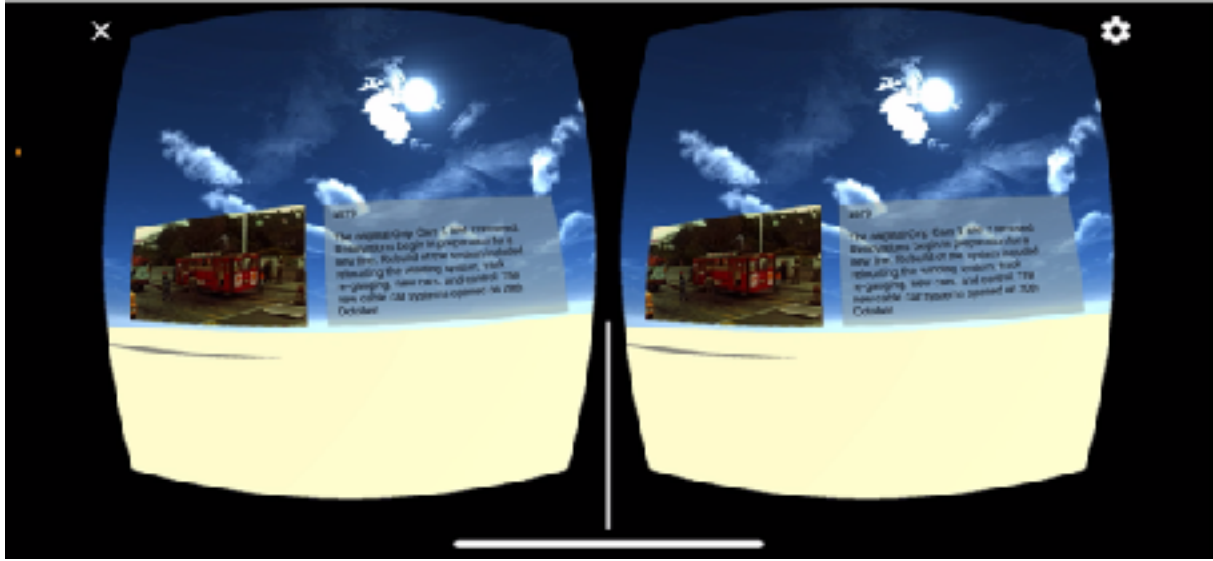


Figure 21: Opening view of the app where pop up is out of view

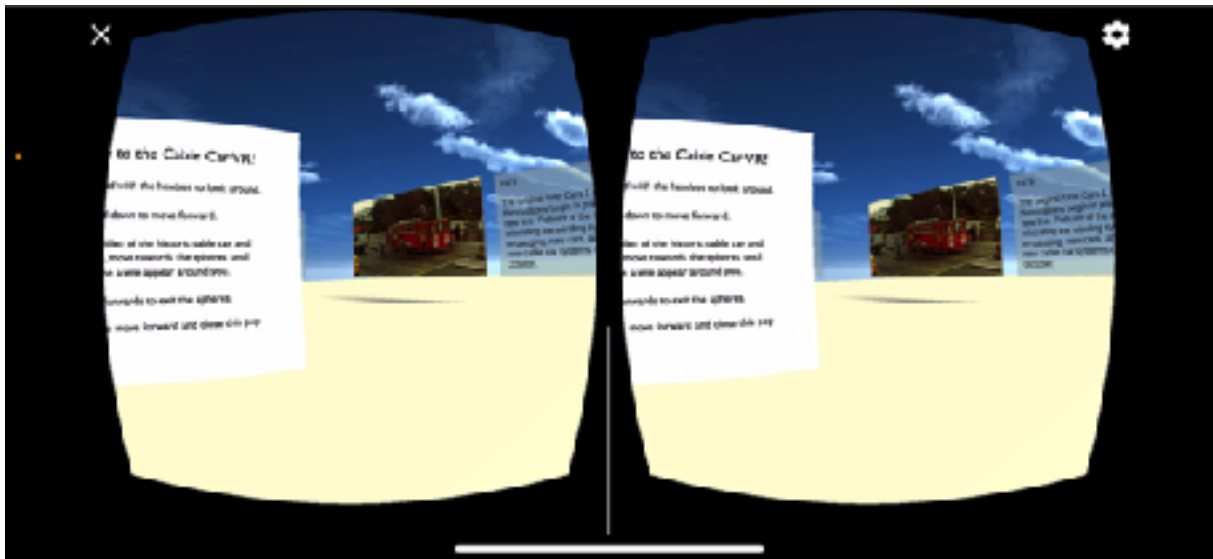


Figure 22: Opening view of app where pop up is partially in view

The survey used to collect feedback on the app was based on the System Usability Scale (SUS) developed by John Brooke [23]. I chose to base my survey on this scale because it is simple to implement and reliable for small sample sizes. Additionally, I added some questions that were more specific to the app, such as “Did you experience any discomfort due to the use of the application during the trial?” and “Would you say that the application enhanced your experience of the Cable Car as a whole?”. I also included follow up questions asking for an explanation of the answers participants provided to these questions so that they had an opportunity to make comments and suggestions that they did not feel comfortable sharing directly with me or had not thought of during the trial.

The SUS is a Likert scale, meaning participants record their agreement to statements on a 5 point scale [23]. The choices range from Strongly Disagree, to Strongly Agree.

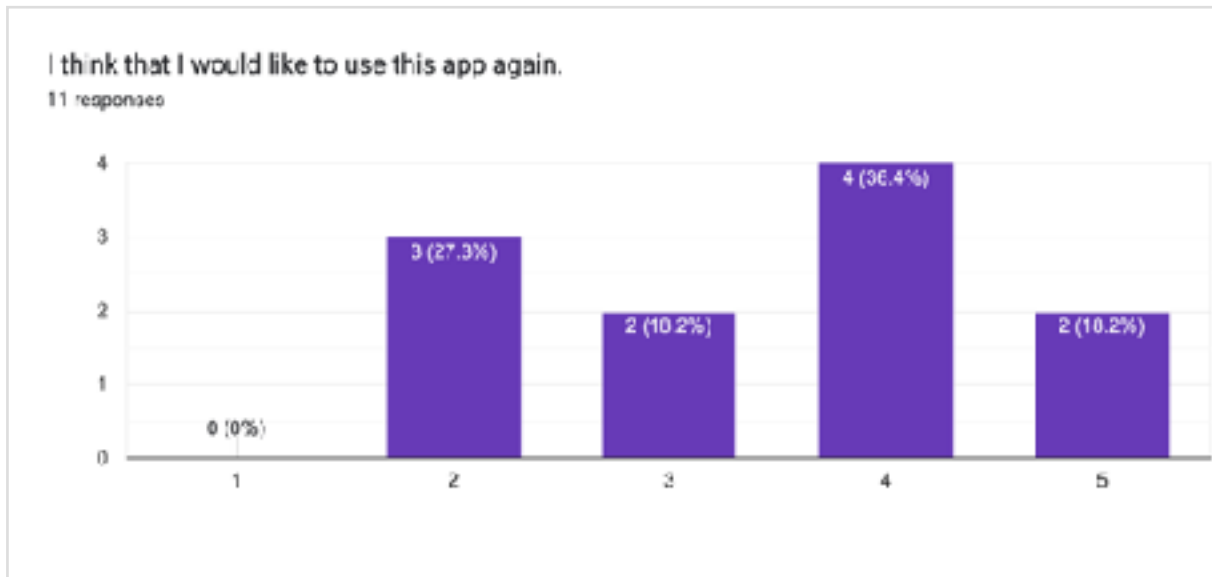


Figure 23: Responses to survey question

Figure 23 above shows the responses to the statement “I think that I would like to use this app again.”. It shows that 27.3% of users disagree with this statement, while 18.2% were neutral. The comments made by participants during the trial suggest that this was not due to usability issues, but simply because they did not feel they would be interested in the app more than once or did not have a need for it. However, 54.6% agreed or strongly agreed, showing that the majority of users were interested in using the app again.

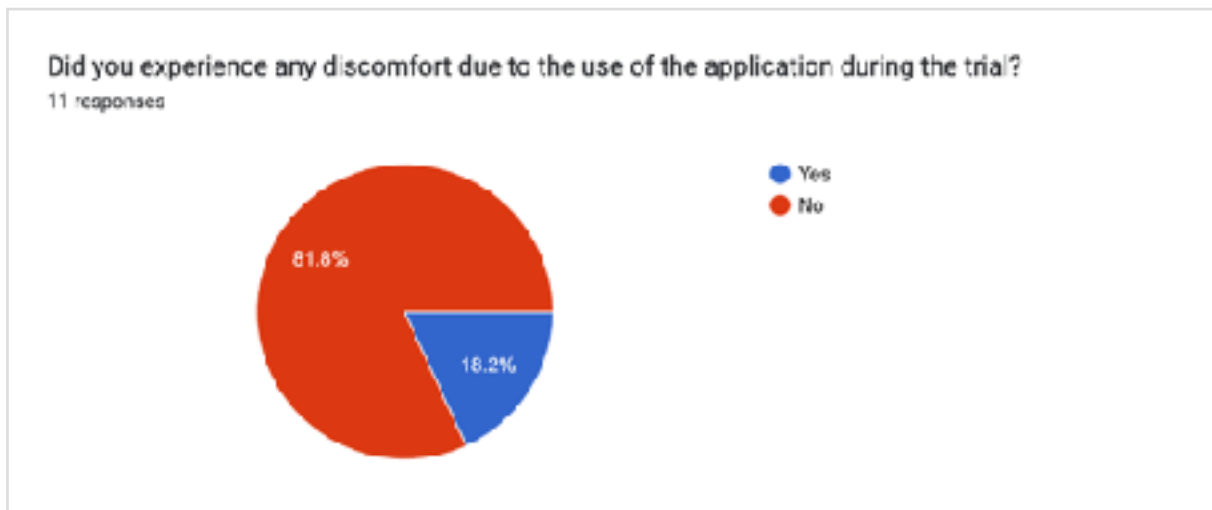


Figure 24: Responses to survey question

Figure 24 above shows that most participants did not experience any discomfort while using the app. 81.8% of participants responded “No” to the question regarding whether they felt any discomfort, while 18.2% responded “Yes”. The explanation given by the participants responding “Yes” were that one of them got sore arms from holding the headset up, and the other got a headache, as they were not wearing their glasses while using the app. These are both problems with the hardware of the application, rather than a software issue and would need to be further evaluated independently.

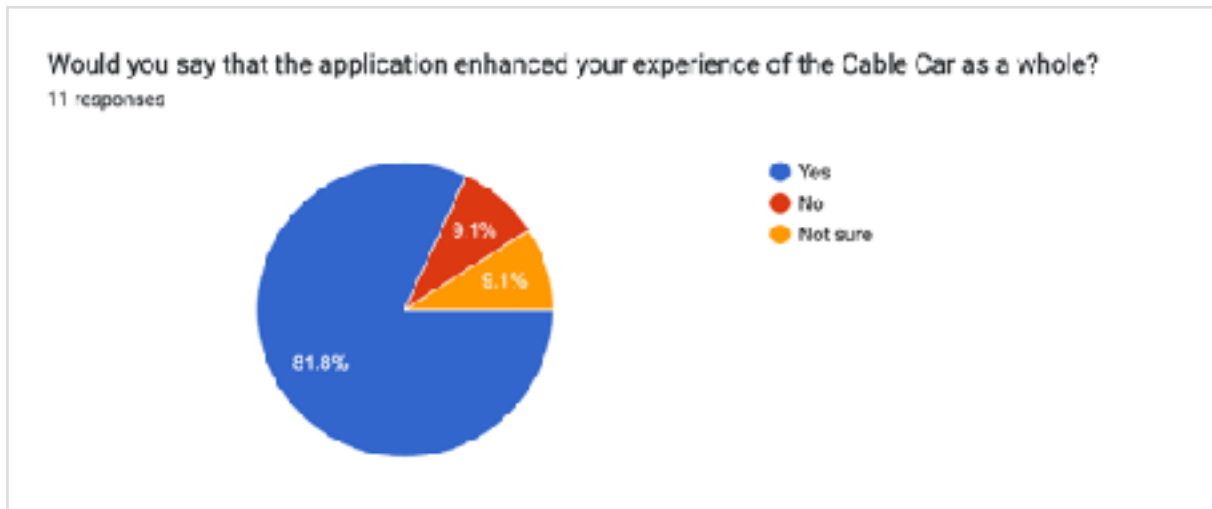


Figure 25: Responses to survey question

Figure 25 above shows that the vast majority of participants would say that the application enhanced their experience of the cable car as a whole. The graph shows that 81.8% responded “Yes”, while only 9.1% responded “No”, and another 9.1% responded “Not Sure”. The majority of participants responding “Yes” is evidence that the outcome of the project satisfies the requirement that the app should enhance the cable car experience.

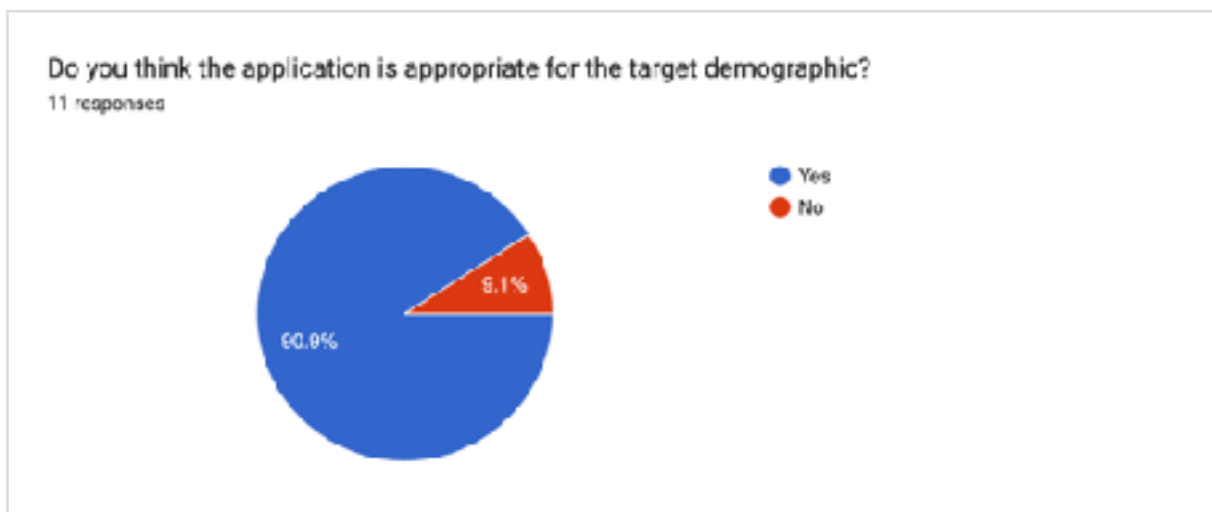


Figure 26: Figure 25: Responses to survey question

Figure 26 above shows that almost all participants thought that the application was appropriate for the target demographic. A majority of 90.9% of participants responded “Yes” while only 9.1% responded “No”.

Using the System Usability Scale (SUS), the app scored a 69.5 on a scale of 0 to 100. This calculation is made by summing the SUS scores of each of the first 10 SUS questions, and does not include the last 7 questions which I added. A study assessing 5000 users across 500 different evaluations found that the average SUS score was 68 [24]. This puts the VR app at slightly above average in terms of its usability score on the SUS scale.

## 5.7. Discussion

The results of the evaluation suggest that the app is a promising concept but needs much more development before it is ready to be used by the public. The first goal in the evaluation was to identify issues with navigation and interaction. In the evaluation it is clear that the most challenging aspect of the app for most users was the navigation. Many users suggested adding lines or a pattern on the ground so that when the user looks down to move forward, they can see where they are going and how far they have moved. The other issue I identified was that the movement in the app was not intuitive. Many applicants attempted to walk forwards in real life to move in the virtual world, despite having been explicitly told not to do this. This indicates that the most intuitive action for users is to move forward physically. Due to this, it took most users a while to figure out how to move. After receiving initial guidance on how to tilt the headset to move, almost all users became more and more accurate in their attempts to move as the trial went on. This could indicate that the problem is not so much with the movement but with the instructions at the beginning. If participants had a more comprehensive explanation when first using the app, they may find it a lot easier to move around the environment. Despite these issues, most users did think that the app enhanced their experience of the cable car, and I found when running the trials that tourists were very interested in the content that is currently in the app.

The second goal was to understand whether the app enhances users experience of the app. Although almost a third of participants did not agree that they would like to use the app again, the feedback users gave in their comments throughout the trial and in the survey was almost entirely positive, and a large majority agreed that it did enhance their experience of the cable car. This leads me to believe that these participants did enjoy the app but felt that it was something that they did not need to use repeatedly. This could be attributed to the small quantity of content in the app, since the participants had already looked at everything available. This app was designed to be a proof of concept and therefore did not require a large quantity of content. This is an aspect of the app that is scalable and can easily be expanded in future development.

Considering the measure of success for the project that I outlined in the requirements, the project was at least somewhat successful. It satisfies the requirement that the app should enhance the cable car experience, even though there are definite improvements that need to be made to the usability of the app before the app can be considered a success. However, as this was intended as a prototype to base future work on, I believe the project was successful in that it provides a strong concept for further development and offers valuable feedback to developers working on it in the future.

## 6. Conclusions and Future Work

### 6.1. Conclusions

In this project I worked closely with the client to create a concept for a VR app that can be used in conjunction with the Wellington Cable Car to showcase its history and create engagement with tourists. I implemented a prototype of this concept and evaluated it through user trials done with the target demographic. The aim of the design was to create an app that enhances the cable car experience and attracts tourists. This goal was successfully accomplished, as shown in the evaluation. The evaluation has shown that the app did enhance participants' experience of the cable car, satisfying one of the main requirements. Though there were some issues with the usability of the app, it did score above average on the SUS [24], and the headsets chosen are easily portable, therefore satisfying the other main requirement of the project, that the app be easy for tourists to use. I personally felt very satisfied with the outcome of this project and the work I was able to do despite the many challenges that arose. I believe that the evaluation of the app offers valuable insight to future students who may do more with this project.

To summarise, the contributions I made in this project are as follows:

- The conceptualisation of a VR app that engages tourists and enhances the cable car experience
- The design of the virtual world within the VR app
- A functional prototype of a VR app that implements this design
- An evaluation of both the usability of this app and user enjoyment of the app

### 6.2. Future Work

This project provides several opportunities for future work. There is potential for WCCL to team up with the cable car museum to develop this into an educational experience that can be used not only for tourists but also for school children. This could act as an exciting new activity for schools to engage with. WCCL and future students may want to develop the app further to include more varying forms of media such as audio. Alternatively, future work could focus solely on the 360 video aspects and create 360 tours of the cable car and cable car museum. Depending on what direction future projects go in, the app could be extended to provide a comprehensive gallery of historical images and video of the cable car.

The app could also be shifted to a different platform such as Oculus Quest to become a more interactive application. This would cater to a different use case than the one outlined in this project, and would provide an opportunity for WCCL to advertise a location based experience to tourists additionally to the cable car journey.

Future students could also focus on addressing the issues raised in the evaluation and continue on the same path that the current project was aimed at. To improve the app they could add a map on the ground similar to that found in hospitals, to lead users to the images and videos. They could also find a different solution to navigation, such as pointing the headset in directions they want to move and gesturing some other way to signal to the app that they want to move.

The app could also be used as a prototype for a similar VR experience in a different context, such as for the university to display historical images of the campus in order to share its heritage. There are many directions this project could go in the future, and this project has provided a stepping stone to further development and valuable insight into the user experience.



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## 8. Appendix

### 8.1. Proposal

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## Improving the Cable Car Experience with XR

Annastasi Ense

Supervisor(s): Craig Anslow and Simon McCallum

Submitted in partial fulfilment of the requirements for  
Bachelor of Engineering with Honours in Software Engineering



### **Abstract**

Since the COVID-19 pandemic began, borders have been closed to most and the tourism industry in New Zealand has suffered. Wellington Cable Car (WCCL), a popular spot for tourists before the pandemic, has seen a large reduction in traffic through its one-of-a-kind funicular railway. However, as restrictions ease in New Zealand and borders are set to reopen later this year, WCCL anticipates the return of what used to be their main consumer group. With Wellington's many tourist attractions, there is sure to be some competition for the attention of these overseas travellers. In order to stand out and draw tourists in, WCCL needs something new and exciting, to contrast against its rich history. Although many things had to take a standstill during the pandemic, technology was not one of these things. More and more people are becoming interested in participating in Augmented and Virtual Reality (XR) experiences, and XR has even become an option for commuters. In order to draw tourists in, this project aims to develop and evaluate an XR application that can be used in transit on the cable car and will enhance the journey and give them a unique experience to remember when they return home.

## 1. Introduction

The worldwide pandemic of Covid-19 has had quite an impact on the tourism industry. Since international borders have been closed, tourist attractions across Aotearoa have seen a drastic change in the number of visitors they see annually. The Wellington Cable Car is no exception to this, seeing less than 50% of its usual ~1.2 million passengers enjoying its scenic view in the first year of the pandemic [1]. This forced WCCL to adapt its business model in order to engage domestic customers more. Borders are set to reopen to some tourists this year and WCCL hopes to welcome them once again. But it is not the only major tourist attraction in the city, so how will they compete with other attractions who are also preparing for the coming wave of tourists, and secure their spot as the second most visited attraction in Wellington [1]? The aim of this project is to create an Augmented or Virtual Reality application that is easy for passengers on the cable car to use in transit, in order to enhance the experience and get tourists excited about the cable car again. I will then be assessing the efficacy of this solution by conducting user evaluations.

## 2. The Problem

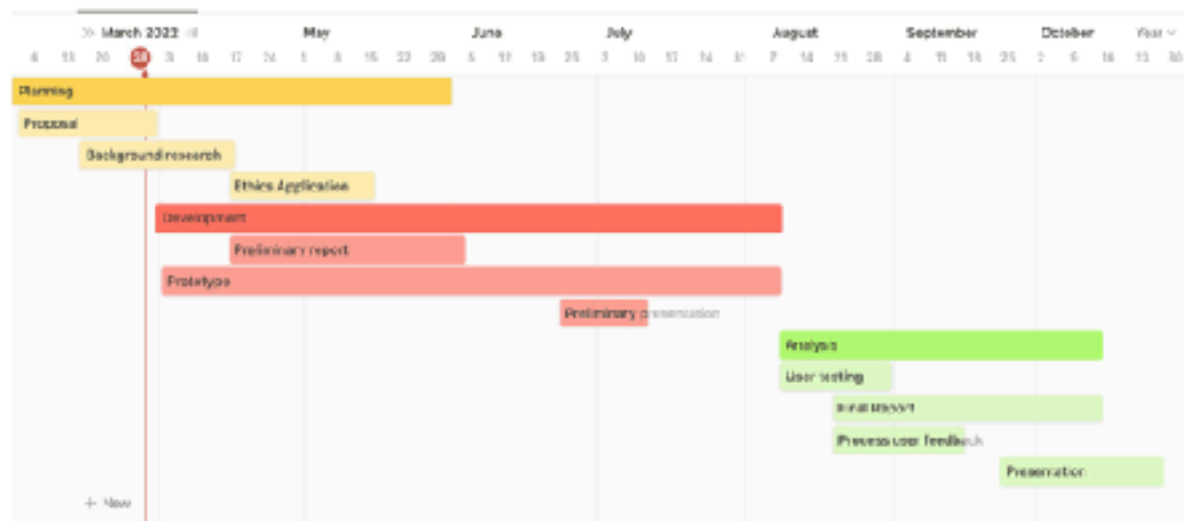
After a challenging couple of years for the tourism industry, borders are opening once again to international visitors. Wellington Cable Car expects this reopening to bring the return of what was its primary demographic pre-Covid: Tourists. In a post-covid world, the attention span of people all over the world has been getting shorter and shorter. We have been locked up at home watching Netflix so much of the time, that many people have forgotten how to enjoy things that move slowly. When tourists return to Wellington, WCCL will be competing with other tourist attractions for this limited attention from tourists. To ensure that riding the cable car will be just as sought after an experience as it used to be, WCCL will need to do all they can to attract tourists. As people have been staying inside more of the time, we have turned to technology to entertain us, and this means that more people are becoming interested in technological advancements and new devices, such as Augmented or Virtual Reality. To captivate tourists, WCCL would like to develop an AR or VR application that can be used in transit on the cable car. However, the use of VR on public transport may not be recommended, as it completely occludes users from the real-world, making them entirely unaware of their surroundings, which may cause motion sickness side-effects [2], as well as discomfort for the user, as they may not feel safe being fully distracted while surrounded by other passengers. A study from 2021 found that people were hesitant to use VR on shorter journeys in public transport largely due to the lack of awareness of their surroundings [3]. Things they worried about included disrupting other passengers, missing a stop, and experiencing motion sickness. The use of VR would also mean that passengers miss out on the fantastic views and scenery that the cable car is famous for. For this reason, this project proposes to develop an AR

### 3. Proposed Solution

Augmented Reality technology is an interesting solution to enhance the cable car experience, without distracting too much from the fantastic views and scenery. AR has many exciting opportunities, and it is something that not everyone has experienced, so it would be sure to peak the interest of tourists. The proposed AR application would enable the overlay of virtual elements into the landscape around them in order to make the journey more enjoyable and perhaps even meditative, without entirely occluding the user from the real world. As well as providing a more entertaining experience in transit, this could also reduce the possible effects of motion sickness that may become a hazard of using VR where the passenger is fully immersed in the virtual world. This should resolve the issues with VR as stated in the previous section in the following ways.

The use of AR allows passengers to remain connected to their physical environment as it is simply an overlay of digital media over the real-world landscape. This means that they will still have visual access to the real world while using the application. This is different from VR, which is entirely contained within a digital environment and does not allow for the user to have a visual awareness of their surroundings. Due to this, AR would be a more suitable option for WCCL, as it is the scenery and view which they are known for. When using AR passengers would be able to see passengers around them and the outside scenery, with some virtual elements overlaid, such as images of the cable car 100 years ago, or digital art pieces. This ability to still see the physical environment around them should also prevent symptoms of motion sickness, as they will not feel disoriented and can still look outside and predict the movement of the vehicle, as well as easily being able to put their device down if they do feel unwell.

As well as continuous development testing, the application will be tested by potential users in the context of a trip on the Wellington Cable Car. To make the testing process easier, this project will be done in collaboration with Wellington Cable Car. They will therefore be able to provide us with the space to conduct user trials and ensure that we are not disrupting the public. They may also be able to provide some form of



compensation for test applicants, such as vouchers.

### **3.1. Timeline**

As pictured, this project is taking place from March 2022, until the end of October 2022. This time is divided into 3 main stages; planning, development, and analysis. The planning phase, beginning in March and ending at the end of May, involves discussing and clarifying the goals of the project, doing some background research, and applying for ethics approval for the upcoming testing. The development phase, beginning in April and continuing on until mid-August, involves mostly technical work, where the prototype is created. The last phase, analysis, begins mid-August and ends in October. This phase involves conducting user testing, evaluating the feedback from this, and completing the final report. These timeframes are only estimates and may be subject to change.

## **4. Evaluating your Solution**

To evaluate the application produced, continuous development testing throughout the project will be conducted, to ensure things are working correctly. In addition to this, user tests will be conducted on Wellington Cable Car by 10 - 20 volunteers and feedback will be gathered by interviewing candidates after the experience as well as recording any real-time feedback they give while they are using the application. The interview questions will focus on the functionality of the application (does it do what is expected), any potential physical effects (motion sickness, discomfort), and overall enjoyment of the experience.

The results of these trials will then be evaluated and presented in the final report. This testing should provide some insight on potential improvements that can be made to the application, as well as an understanding of whether the proposed solution was or could be successful with further development. This information will be extremely useful as it will help determine whether it is worth investing in further development of this application.

## **5. Ethics and Resourcing**

In order to complete this project, I will need access to hardware for Augmented Reality applications, which my supervisor has access to. To develop the software of the

application, I will be using Unreal Engine, or similar software.

### **5.1. Ethics and Resourcing**

When conducting user testing, there are some ethical considerations that will need to be addressed. This will need ethical approval.

### **5.2. Risks and Hazards**

Some foreseeable risks of conducting user testing on Wellington Cable Car include:

- Candidates experiencing motion sickness while in transit or after the test is conducted.
- Stress or anxiety caused by the experience.
- Disruption to other passengers, as the test will take place in a public area.
- The ongoing risks of Covid-19 when using public transport and coming in close contact with others throughout the trial.

### **5.3. Safety**

To ensure the safety of all people involved in the testing of the application, Wellington Cable Car has agreed to cordon off a section of the carriage for us to conduct testing, this will prevent the candidates from disrupting other passengers around them, and will allow for someone (most likely I will be riding up and down with them) to supervise the candidates and ensure they are not in distress or feeling unwell while testing the application. If candidates do begin to feel unwell or distressed at any point during testing, they are free to stop using the application and will be supported with anything they need afterward. Candidates and all people involved in testing will also strictly comply with any Covid-19 guidelines that are in place in the area, as well as wearing masks and following basic hygiene principles such as washing hands before and after using the equipment. Candidates will also be asked to stay home if they are feeling unwell to avoid

potential Covid-19 exposure events. If Wellington is in a lockdown at the expected time of testing, an alternative strategy will need to be used to test the application. This can be done by sending candidates video footage of the application and asking for their feedback on this.

Unfortunately, in this scenario it will not be possible to carry out tests on the physical aspects of the application, as candidates will not be able to meet in person at the cable car. Depending on the length of a lockdown, it may be possible to postpone the tests and conduct them more thoroughly when we are able to meet in person again.

## **3. Budget**

A budget of \$200 will be sufficient to provide candidates for user testing with vouchers to thank them for their contribution. This will be 20 vouchers of \$10 each.

## **4. Space and Access**

During development, I will be working largely from home or in the university labs available for the 489 courses. I will also have access to the HCI lab (CO140). Wellington Cable Car has also offered space in its offices to work there if I would like to. User testing will need to be done on-site at the cable car. WCC has confirmed that this will be possible and that they can cordon off an area of the cable car and/or the station to carry out the tests.



## 8.2. Proposal Updates

### **Improving the Cable Car Experience with XR**

#### **Introduction**

The main purpose of this document is to clarify the project goals and make sure everyone is on the same page. It also provides a clear outline to refer back to later on during development including an outline of the requirements for this project. This is a brief update to the original proposal document.

#### **Application**

The goal for this project is to develop a prototype for an application that will enhance the experience of the cable car and can be a fond reminder of tourists' journey on the cable car when they return home. This application will be a Virtual Reality experience using portable cardboard virtual reality headsets, such as the Google Cardboard. It is important to the client that the headsets be something easily portable and that the user can keep afterwards, so that they can have it as a souvenir of their visit.

The experience will be a virtual gallery of some of the photos and other media showing the history of the cable car. Users will be able to navigate the gallery and select images/videos to get a better look at and read about its history. This could also include audio recordings that play while viewing an image. For the prototype of this app, there may only be a few of these to start with, just to get a sense of what the experience would be like. If possible, the environment for this gallery will be shot in one of the historic cable cars that are in the cable car museum. If this isn't possible it could also be an area in the winding room, or just a simple virtual environment.

The intended location for this will be the top of the cable car, however users will be able to take the cardboard headsets home with them and keep the app on their phones, so they can share it with family and friends anywhere.

#### **Scope**

A realistic expectation for this project would be an app that can be used as a prototype for further development. It will include a virtual environment with ~3 items for the user to select. Each of these may contain an image, a blurb, and potentially video or audio recordings further explaining the image. Having this layout will leave room for further development, so that the app is expandable. In the future, the client may wish to add more content or extend some of the explanations/details of each item.

## **Requirements**

The software I will be using for this project will likely be some combination of Xcode, Unity, Unreal Engine, or similar applications.

The images, videos, blurbs and audio for the content of the app will be provided by the client (some examples have already been provided). I will need at least one example of each of these media types by the end of June. Finalised versions will be needed by the end of July, preferably mid July. This should give time for any hiccups to be resolved before testing, which will be conducted in mid-August.

In terms of hardware, current demos have been done using the cardboard headsets available at the university. However, after discussing this with the clients, we may need to get ahold of some other headsets with a button, to allow for user interaction, as this is an important aspect of the experience. An option for this is the Google Cardboard headsets, but this would require purchasing these and has not yet been finalised.

### **8.3. Human Ethics Application**

# Human Ethics Application

Application ID : 0000030368  
Application Title : Improving the Cable Car Experience with XR  
Date of Submission : 09/06/2022  
Primary Investigator : Ms Anastasia Ease (Principal Investigator)  
Other Personnel : Dr Craig Anslow (Supervisor)

## Research Form

### Application Type

Is this application for:\*

Research  Teaching only

You must select '**Research**' in the dropdown box below then select '**Save**' to access the rest of the form.

\*

Research

## Research Overview

### Application Details

1. Application ID

0000030368

2. Title of project

(Click the ? icon for more info)\*

Improving the Cable Car Experience with XR

3. School or research centre\*

V U W



4. The following questions will help the committee assess whether your application is categorised as a Category A (more than low risk) or Category B (low risk). Please check all of the boxes that apply. You will be asked for more information about some of these questions later in the application.

Check the box if your study:

4a Is health research\*

Yes  No

4b Is an intervention study\*

Yes  No

4c Involves the use, collection or storage of human tissue\*

Yes  No

114d Involves processes that use EEG, ECG, MRI, TMS, FMRI, EMG, radiation, invasive or surface recordings\*

Yes  No

4e Involves collection of information about illegal behaviour, or information that has been obtained illegally\*

Yes  No

4f Involves people who are not giving consent to be part of the study (other than observational research in a public place)\*

Yes  No

4g Involves participants under the age of 16\*

Yes  No

4g (i) Will a parent/guardian be asked to give consent for the child/young person to participate in research?\*

Yes  No  N/A

4g (ii) Will more than one meeting be held with the child/young people without others present? \*

Yes  No  N/A

4h Involves participants whose ability to consent freely is compromised due to context (e.g. people in prison), or a limited capability to make independent rational decisions (e.g. those with a serious intellectual disability).\*

Yes  No

4i Involves the use of concealment or covert observations, including those conducted online or conducted in social media. \*

Yes  No

4j Involves the use of previously collected personal information, other data, or biological samples for the collection of which there was no explicit consent for use in research.\*

Yes  No

4k Involves deception of the participants, including concealment of the true purpose of the research\*

Yes  No

4l Involves the use of highly sensitive information (see policy for definition)\*

Yes  No

4m Involves a focus on, has particular importance for, or impacts on Māori\*

Yes  No

4n Involves any other group (for example cultural or religious), other than Māori, and has the potential to cause discomfort or disruption to members of that group\*

Yes  No

4o Involves any direct financial interest in the outcome of the research by any member of the research team or external sponsor\*

Yes  No

4p Involve a conflict of interest or the appearance of a conflict of interest for the researcher (for example, where the researcher is also the lecturer/teacher/treatment provider/colleague/manager or employer of the participants)\*

Yes  No

4q Involve any situation which may put the researcher at risk of harm (e.g. overseas in politically unstable countries)\*

Yes  No

4r Involve a reasonable expectation that participants may experience (at a greater level than in everyday life) physical discomfort, emotional discomfort, or psychological or spiritual harm (e.g. asking participants to recall upsetting events)\*

Yes  No

### Relationship to other Projects

5. Does this application relate to any previous applications submitted to an ethics committee (at VUW or other Institute)?\*

Yes

No

### Personnel

Personnel

To add other researchers, click 'Add' and search by first or last name (whichever is the most unusual). Click the search icon to run the search, and click on the name of the person to be added. Update the 'Position' and 'Primary Investigator?' details. Click on '**OK**' at the bottom left of the table.

1	Preferred First Name	Anastasia
	Preferred Last Name	Ease
	Preferred Full Name	Ms Anastasia Ease
	AOU system code	
	Position	Principal Investigator
	Primary Investigator?	Yes

6. Are any of the researchers from outside Victoria?\*

Yes

No

7. Is the principal investigator a student?\*

Yes

No

### Student Researcher

7a. What is your course code (e.g. ANTH 690)?\*

ENGR489

7b. Supervisor

To add your supervisor, click 'Add' and search by first or last name (whichever is the most unusual). Click the search icon to run the search and click on the name of the person to be added. Update the 'Position' details if necessary. Click on '**OK**' at the bottom left of the table.\*

1	Given Name	Craig
	Surname	Anslow
	Full Name	Dr Craig Anslow
	AOU	Engineering and Computer Science
	Position	Supervisor

7c. What is your email address? (this is needed in case the committee needs to contact you about this application)\*

ana.ease@gmail.com

## Scope of Research

### Project Details

8. Describe the aims and objectives of this project

Provide a brief summary in plain language of the purpose, research questions/hypothesis, and objectives of your project. \*

The aim of the project is to create a Virtual Reality app that can be used in conjunction with Wellington Cable Car. The research question I will be focussed on is whether the application enhances the experience of the journey and if it is easy for users to navigate for the first time.

9. Describe the benefits and scholarly value of the project

Briefly place the project in perspective, explaining its significance and worthwhile outcomes. Include how this project will build on relevant literature, including references if appropriate.

\*

This project will give me the opportunity to make a positive impact on the community, as it will help Wellington Cable Car draw in more tourists since they have felt the impacts of Covid and the closing of the borders. I will also get to learn valuable technical and soft skills as I learn how to develop a virtual reality app and gain experience working with a client.

10. Explain any ethical issues your research raises for participants, yourself as the researcher, or wider communities and institutions, and how you will address these. This is an opportunity to present what you think the key risks are in your project and show how you have taken them into account.\*

Because user testing will need to be conducted in person, this brings about the risk of COVID19 infection. This will be mitigated by following social distancing protocols where possible and wearing masks. I will also make sure to find fully vaccinated people to do the study to reduce the risk further. Another risk is the general disruption that may be caused by conducting the study in a public space (at the top of the cable car). If it is crowded then it may be hard to avoid disrupting others while users test out the VR experience. WCCL has offered to cordon off an area for testing, so as to avoid running into people. The tests will also be conducted during less busy hours, and not peak hours. It is also possible that some users will find the VR experience slightly distressing or uncomfortable, as it is a virtual environment and can be overwhelming for some. To mitigate this I will make sure to monitor users carefully and if they show any signs of discomfort let them know they can stop the test and provide them with anything they may need to feel better. The VR headsets we will be using are small handheld ones that are held up to your eyes, as opposed to strapped onto your head. This means that it is very easy for users to quickly remove the headset if need be.

### Key Dates

If approved, this application will cover this research project from the date of approval for up to 3 years.

11. Proposed start date for data collection\*

01/07/2022

12. Proposed end date for data collection\*

27/10/2022

13. Proposed end date for research project\*

12/11/2022

### Proposed source of funding and other ethical considerations

14. Indicate any sources of funding

- Internally: by a University grant, such as the University Research Fund
- Externally: funding from an external organisation for this project, or a scholarship awarded by an external organisation

- Selffunded: paying for research costs such as travel, postage etc. from your own funds

Tick all that apply:

- Internally funded
- Externally funded
- Selffunded

15. Is any professional code of ethics to be followed?\*

- Yes
- No

16. Do you require ethical approval from any other organisation, such as another tertiary institution in New Zealand or overseas, or a District Health Board?\*

- Yes
- No

## Data Collection and Recruitment

### Data Collection

17. Please select all forms of data collection you will use in your project\*

- Interviews
- Focus groups
- Questionnaires
- Observation
- Other

18. Provide an explanation of the sampling rationale for your study.

E.g. representative sampling of a particular population, purposive sampling, convenience sampling. Include here your eligibility criteria for potential participants will there be particular criteria for participants to be included in your study, or criteria that will exclude them? \*

Participants must be vaccinated against COVID19.

Participants will be selected by Wellington Cable Car, from people working at the office as well as through word of mouth. Some participants will also be selected from the public on sight on the day of testing, if any of them would like to volunteer.

This should give a good sample that is indicative of the target demographic for the application. This demographic will be comprised of 2070year olds and family tourists who are the most likely to visit the Cable Car as a tourist attraction.

19. How many participants will be involved in your research?

Please specify how many groups and how many participants in each group. \*

One group of 10 participants will be involved. They will be conducting the tests individually.

20. What are the characteristics of the people you will be recruiting?\*

Between 2070 years of age.

Potential users or current users of the Wellington Cable Car.

Vaccinated against Covid19.

May be domestic or international tourists.

21. Outline in detail the method(s) of recruitment you will use for participants in your study. Include here how potential participants will be identified, who will contact them and how. Please include copies of all advertisements, online posts or recruitment emails in the 'Documents' section. \*

The Wellington Cable Car people I am working with have said that they will be able to find participants for the study. They will do this by asking around with their coworkers and friends, to see who is interested in participating. They will then be given the consent form and will confirm whether they would like to take part and a slot for testing will be scheduled for them. On the day, I will be at the Cable Car asking people who have been riding the Cable Car if they would like to participate in the study and if they are interested they will be given the consent form and if they confirm they would like to do it then the study will take place there and then.

22. Explain the details of the method of data collection. For example, describe the location of your research procedures, if appropriate (e.g. where your interviews will take place). If necessary, upload a research protocol in the 'Documents' section. \*

The study will take place at Wellington Cable Car in the lookout area at the top of the cable car. The space will be cordoned off by WCCL to allow us to conduct the study without disturbing people. The participants will be asked to describe their experiences and give feedback as they go and I will be taking notes on the things they say. Then they will be asked to answer some questions about the experience. This will be done in the same area and the answers the participants provide will also be written down.

23. Will your research project take place overseas?\*

- Yes  
 No

24. Does the research involve any other situation which may put the researcher at risk of harm (e.g. gathering data in private homes)?\*

- Yes  
 No

### Participants and Informed Consent

25. Does your research target members of a vulnerable population?

This includes, but is not limited to, children under the age of 16, people with significant mental illness, people with serious intellectual disability, prisoners, employees and students of a researcher, and people whose health, employment, citizenship or housing status is compromised. Vulnerability is a broad category and encompasses people who may lack the ability to consent freely or may be particularly susceptible to harm.\*

- Yes  
 No

26. Have you undertaken any consultation with the groups from which you will be recruiting, regarding your method of recruitment, data collection, or your project more widely?\*

- Yes  
 No

27. Will your participants receive any gifts/koha in return for participating?\*

- Yes  
 No

27a. Describe the gifts/koha and the rationale.\*

They will receive a \$10 supermarket voucher.

28. Will your participants receive any compensation for participation (for instance, meals, transport, or reimbursement of expenses)?\*

- Yes  
 No

29. How will informed consent be obtained? (tick all that apply to the research you are describing in this application)\*

- Informed consent will be implied through voluntary participation (anonymous research only)  
 Informed consent will be obtained through a signed consent form  
 Informed consent will be obtained by some other method

### Treaty of Waitangi

### Treaty of Waitangi

30. How does your research conform to the University's Treaty of Waitangi Statute? (you can access the statute from Victoria's [Treaty of Waitangi page](#))\*

We will ensure that Māori participants are included in the survey in order to conform to the principle of Participation (Whai wāhi), and make sure we get a Māori perspective on the project. There will also be consent forms given to everyone who is participating and it will be made clear to them that it is their choice whether to participate or not. We will be addressing any concerns raised by Māori participants, conforming to the principle of Redress (Whakaoranga).

### Project Risks



**Minimisation of Harm**

31. Is it possible that participants may experience any physical discomfort as a result of the research?\*

- Yes
- No

## 8.4. Media Consent Form



### Video Permission Form

#### INFORMATION SHEET FOR PUBLIC

I will be gathering footage in the Cable car museum/cable car area for a University Project.

#### Who am I?

My name is Anastasia and I am a student in ENGR489 at Victoria University of Wellington. The footage collected will be used in an app I am developing as part of this course.

#### What is the aim of the project?

This product is a Virtual Reality App created for Wellington Cable Car to help them celebrate their 120th birthday and to draw in more tourists. It has been developed by me (Anastasia Ease). The product is intended for use by patrons of the Wellington Cable Car, specifically tourists.

#### How are you involved?

You may be in the background of some of the footage, although it will not be focused on you and I am aiming to get footage with less people in it.

#### What will the project produce?

The app I am developing is meant to be used as a prototype and the footage will likely not be used in future development of the project.

#### If you have any questions or problems, who can you contact?

If you have any questions, either now or in the future, please feel free to contact either:

#### Student:

Name: Anastasia Ease

University email address:  
easeanas@myvuw.ac.nz

#### Course Coordinator:

Name: Craig Anslow

Role: Senior Lecturer in Software  
Engineering

School: Engineering and Computer Science

Phone: +64 4 463 6449

craig.anslow@vuw.ac.nz



### Video Permission Form

- I give permission for my image(s)/video(s) to be used as outlined
- I give permission for my child/ren's image(s)/video(s) to be used as outlined

Signature of participant: \_\_\_\_\_

Name of participant: \_\_\_\_\_

Date: \_\_\_\_\_

Contact details: \_\_\_\_\_

## 8.5. Information Sheet



### Software Usability Testing

#### INFORMATION SHEET FOR PARTICIPANTS

You are invited to take part in this research. Please read this information before deciding whether or not to take part. If you decide to participate, thank you. If you decide not to participate, thank you for considering this request.

#### Who am I / are We?

My name is Anastasia and I am a student in ENGR489 at Victoria University of Wellington. This analysis of the usability of this tool is part of the completion of the course.

#### What is the aim of the project?

This product is a Virtual Reality App created for Wellington Cable Car to help them celebrate their 120th birthday and to draw in more tourists. It has been developed by me (Anastasia Ease). Your participation will support this research by providing an evaluation of the usability of the tool that we developed or are testing. The product is intended for use by patrons of the Wellington Cable Car, specifically tourists. This teaching activity has been approved by the Victoria University of Wellington Human Ethics Committee with approval #0000030368

#### How can you help?

If you agree to take part you will be asked to use the VR app on a smartphone with a cardboard VR headset that we will provide at Wellington Cable Car. We will make notes of your use of the app. We will invite you to be interviewed after about your experience of using the app.

The research will take 30 minutes. You can stop the user testing at any time by removing the headset and letting us know, without giving a reason. You can withdraw from the study by contacting me or the course coordinator at any time before the end of Trimester. If you withdraw, the information you provided will be destroyed or returned to you.

#### What will happen to the information you give?

This research is confidential. This means that the students conducting this user test will be aware of your identity but the research data will be combined and your identity will not be revealed in any reports, presentations, or public documentation.

Only my supervisors and I will access the notes or transcript of the interview and user test. The material I collect will be kept securely and destroyed 1 month after the end of the Trimester in which the course runs.

#### **What will the project produce?**

The information from this usability test will form part of the submitted work for the course ENGR489 Engineering Project. In some situations the projects developed in this course may be developed beyond the end of the course and the feedback provided can be used to inform that development, but all personal information will be anonymised.

#### **If you accept this invitation, what are your rights as a research participant?**

You do not have to accept this invitation if you don't want to. If you do decide to participate, you have the right to:

- choose not to answer any question;
- stop the interview or test at any time;
- withdraw from the study at any time;
- ask any questions about the study at any time;
- receive a copy of your interview transcript;
- read over and comment on a written summary of your interview;
- be able to read the final report a week after this assignment/project work has submitted by emailing the researcher to request a copy.

#### **If you have any questions or problems, who can you contact?**

If you have any questions, either now or in the future, please feel free to contact either:

##### **Student:**

Name: Anastasia Ease  
University email address:  
easeanas@myvuw.ac.nz

##### **Course Coordinator:**

Name: Craig Anslow  
Role: Senior Lecturer in Software  
Engineering  
School: Engineering and Computer Science  
Phone: +64 4 463 6449  
craig.anslow@vuw.ac.nz

#### **Human Ethics Committee information**

If you have any concerns about the ethical conduct of the research you may contact the Te Herenga Waka—Victoria University of Wellington HEC Convenor, Associate Professor Rhonda Shaw, by emailing [hec@vuw.ac.nz](mailto:hec@vuw.ac.nz) or telephone +64-4-463 6028.

#### **Wellbeing Resources**

Healthline - 0800 611 116  
Lifeline - 0300 543 354  
Youthline - 0800 376 633

## 8.6. Usability Testing Consent Form



### ENGR489

#### CONSENT TO PARTICIPATE IN USER TESTING

This consent form will be held for 5 years.

Researcher: Anastasia Ease Engineering and Computer Science, Victoria University of Wellington

- I have read the Information Sheet and the project has been explained to me. My questions have been answered to my satisfaction. I understand that I can ask further questions at any time.
- I agree to take part in this user test.

I understand that:

- I may withdraw from this study at any point before the 10th October 2022 and any information that I have provided will be returned to me or destroyed.
- The identifiable information I have provided will be destroyed one month after the end of this Trimester.
- Any information I provide will be included in a final report but the observation notes kept confidential to the researcher and the course coordinator/lecturer.
- I understand that the results will be used for a report
- My name will not be used in reports and utmost care will be taken not to disclose any information that would identify me.
  
- I would like a copy of the transcript of my interview: Yes  No
- I would like a summary of my interview: Yes  No
- I would like to receive a copy of the final report and have added my email address below. Yes  No

Signature of participant: \_\_\_\_\_

Name of participant: \_\_\_\_\_

Date: \_\_\_\_\_

Contact details: \_\_\_\_\_

## 8.7. Usability Survey

### Usability Testing

 [\[Name\] \(not shared\)](#) [Switch account](#)



\* Required

I think that I would like to use this app again. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I found the system unnecessarily complex. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I thought the system was easy to use. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I think that I would need the support of a technical person to be able to use this system. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree





I found the various functions in this system were well integrated. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I thought there was too much inconsistency in this system. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I would imagine that most people would learn to use this system very quickly. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I found the system very cumbersome to use. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I felt very confident using the system. \*

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I needed to learn a lot of things before I could get going with this system. \*

1      2      3      4      5

Strongly Disagree                        Strongly Agree

Did you experience any discomfort due to the use of the application during the trial? \*

- Yes
- No

If you answered yes to the previous question, please explain your answer.

Your answer

Would you say that the application enhanced your experience of the Cable Car as a whole? \*

- Yes
- No
- Not sure

Do you think the application is appropriate for the target demographic? \*

- Yes
- No

What if any improvements do you think need to be made before the application is used by the public?

Your answer

Are there any improvements that you think would make the application better or more enjoyable to use?

Your answer

Do you have any comments or feedback that you have not mentioned yet?

Your answer

Submit

[Clear form](#)