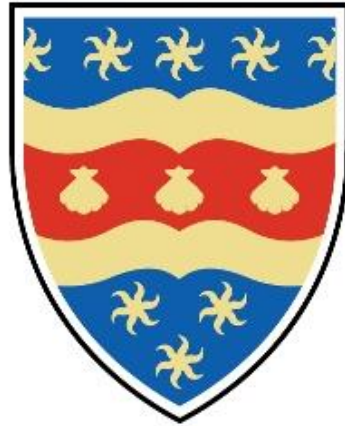


VR Wipeout: Final Report
COMP3000: Final Stage Computing Project
2020/2021



UNIVERSITY OF PLYMOUTH

Dom Sleightholme, 10574310

BSc (Hons) Computing and Games Development
School of Engineering, Computing, and Mathematics

Acknowledgements

Firstly, I would like to thank Mr Marius Varga for his continued support and feedback over the course of the project, despite the global pandemic, Marius was able to support me and my work for the entirety of the project. I would like to thank all the Computing and Games Development staff at the university for their support in-class and remotely during my time at university.

I would like to thank Mr Jamie Stoneman for providing support on my report and my time during university. I would like to thank my family and friends for their support throughout the project and my time at the University. I would like to thank my course mates, Ross Doran, Samuel Rosewell, and Martin Mckenna for their support during my time at the University.

Finally, I would like to thank my house mates, Michael Gooding, Kieran Wheatley, Connor Stevenson, and Robert Parnell for providing feedback and ideas for the project and supporting me during the pandemic and my time at university.

Abstract

This report covers the development of my final year project, VR Wipeout, a single player assault course game developed in virtual reality. The project was undertaken as a concept into the possibilities of how a physics-based concept like competing in assault courses can be applied using virtual reality technology. This project aimed to understand people's preferences or issues when playing video games, allowing for accessibility when playing my product, the project was undertaken during the global COVID pandemic, which gave the idea to incorporate an experimental multiplayer mechanic so people can enjoy the game in their own homes with friends.

This report begins with describing the overview of the game, the purpose of making the game and the audience I am trying to develop for, the project goes on to discuss the background information of the technologies I am using and to provide research on one of the issues of virtual reality, motion sickness. The report goes on to talk about the history and background information on assault courses and how I carried out a competitor analysis on other products on the market, similar to my project.

The main body of my report goes into detail on how I plan to achieve a good UX design, my SWOT analysis I have carried out on the project, user story map about the project and a roadmap I have made for the project's development. This area of the report discusses the methods I use in the project, including how I reduce motion sickness in my game, this area of the report talks about the issues and considerations of my project including what age I believe is suitable for my game. It also talks about how I applied project management to my project development including how I use version control on the project. Finally, the main body of the report talks about the implementation of the project, including how I developed my player controller and the design of the game levels I have worked on.

The final section of my report goes on to discuss all the milestones I had during the development of my project and a reflection on the final product, including how I used the technology in the project, how I applied my chosen methods, the positives, and negatives on my project. I conclude the report with what I would improve in the product and how I would go about the development of my project in the future with the knowledge I have gained over the project development.

Table of Contents

Acknowledgements	2
Abstract	3
Table of Contents	4
Table of Figures	7
Links	7
1 - Introduction	9
1.1 - Overview	9
1.1 - Purpose	9
1.3 - Audience	10
2 – Background and Project Objectives	10
2.1 - Technology Background.....	10
2.2 - Motion Sickness Research	11
2.3 - Assault Course Background	11
2.4 - Competitor Analysis.....	12
2.5 - Project Objectives	13
3 - Product	14
3.1 - Minimum Viable Product (MVP)	14
3.2 - Minimum Viable Experience (MVE).....	14
3.3 - Maximum Awesome Product (MAP)	14
3.4 - UX.....	14
3.4.1 - Functionality	15
3.4.2 - Usability	15
3.5 - SWOT Analysis	15
3.6 - User Story Map	16
3.7 - Project Roadmap.....	17
4 - Methods	18
4.1 – Methodologies	18
4.2 - Technologies	18
4.3 - User Testing	19
4.4 - Reducing Motion Sickness	19
5 - Issues and Considerations	20
5.1 - Legal	20
5.2 - Social	20
5.3 - Ethical.....	21
5.4 - PEGI Rating.....	21

6 - Project Management Tools	22
6.1 - Project Management	22
6.2 - Version Control	23
6.3 - Fortnightly Development Reports	23
7 - Implementation	23
7.1 - Player Controller	23
7.2 - User Interface (UI)	25
7.3 - Using PlayerPrefs	26
7.4 - Obstacles.....	27
7.5 - Main Levels	28
7.6 - Tutorial.....	31
7.7 - Multiplayer.....	32
8 - Development Milestones	33
8.1 - Sprints	33
8.2 – Feedback	35
8.2.1 - Project Feedback 1.....	35
8.2.2 - Project Feedback 2.....	36
8.2.3 - Project Feedback 3.....	36
8.2.4 - Project Feedback 4.....	38
8.2.5 - Project Feedback 5.....	38
8.2.6 - Project Feedback 6.....	39
8.3 - Project Initiation	40
8.4 - Project Showcase.....	40
9 - Project Evaluation	41
9.1 - Method Evaluation	41
9.2 - Technology Evaluation.....	42
9.3 - Game Evaluation.....	43
9.4 - Meeting Initial Objectives.....	44
9.5 - Improvements for Future Development.....	44
10 - References	46
11 -Appendix	47
Appendix 1: Project Initiation:	47
Appendix 2: Questionnaire	49
Appendix 3: Controller Scheme	52
Appendix 4: GDD.....	52
Appendix 5: Sprints.....	56

Appendix 5.1: Sprint Zero	56
Appendix 5.2: Sprint One	57
Appendix 5.3: Sprint Two	58
Appendix 5.4: Sprint Three	59
Appendix 5.5: Sprint Four	60
Appendix 5.6: Sprint Five	61
Appendix 5.7: Sprint Six	62
Appendix 5.8: Sprint Sevan	63
Appendix 5.9: Sprint Eight.....	64
Appendix 5.10: Sprint Nine	65
Appendix 5.11: Sprint Ten.....	66
Appendix 5.12: Sprint Eleven	67
Appendix 5.13: Sprint Twelve	68
Appendix 5.14: Sprint Thirteen	69
Appendix 5.15: Sprint Fourteen.....	70
Appendix 6: Industry Engagement.....	70
Appendix 7: Links to all Testing Sessions	71
Appendix 8: Programs Used.....	72
Appendix 9: Third Party Assets	72
Appendix 10: Installation Guide.....	72
10.1 - Itch.io	72
10.2 – Github.....	73

Table of Figures

Figure 1: This figure showcases my Competitor Analysis I carried out.	12
Figure 2: This figure showcases my SWOT Analysis I have carried.....	16
Figure 3: Showcasing my User Story Map for my project.....	16
Figure 4: Showcasing my Project Roadmap.....	17
Figure 5: Camera vignette I have applied for the game.	19
Figure 6: Screenshot of my current planning board on Microsoft Planner.	22
Figure 7: Code snippet for in-game camera following Players Position.	23
Figure 8: Code snippet for Player Position and Rotation.....	24
Figure 9: Code snippet for Haptic Feedback in the Game.	24
Figure 10: Code snippet for Jump Mechanic.	24
Figure 11: Code snippet for Climbing.....	25
Figure 12: Player UI on the watch I designed.	26
Figure 13: Code snippet of PlayerPrefs in my game.	26
Figure 14: Various obstacles used in the game.	27
Figure 15: Code snippet from the Turbine Obstacle.....	28
Figure 16: In-game image of the first level of my game, Hill Dash.	28
Figure 17: In-game image of the second level of my game, Mega-Sweep.....	29
Figure 18: In-game image of the third level of my game, The Balancer.....	30
Figure 19: In-game image of the fourth level of my game, The Impersonator.	31
Figure 20: In-game image of the tutorial level I have worked on.....	31
Figure 21: In-game image of the Multiplayer level.....	32
Figure 22: Code snippet of how I achieve my multiplayer component.....	33
Figure 23: Showcasing the results from my first testing session.....	35
Figure 24: Showcasing the results from my second testing session.....	36
Figure 25: Showcasing the results from my third testing session.	36
Figure 26: Showcasing the results from my graphic design questions in the third testing session.	37
Figure 27: Showcasing the results from the game mode question in the third testing session.....	37
Figure 28: Showcasing the results from my fourth testing session.	38
Figure 29: Showcasing the results from my fifth testing session.	38
Figure 30: Showcasing the results from my sixth and final testing session.....	39
Figure 31: Showcasing my poster I used for my Project Showcase.....	41

Links

Due to the size of my project files, I have included Github link where you can access the project and the exe build, see Appendix 10 for installation guide. I have also included a link to my showcase poster.

- Microsoft Planner: <https://tasks.office.com/live.plymouth.ac.uk/Home/PlanViews/1P6Wre24aEOzB8g9dachOJYABHmj?Type=PlanLink&Channel=Link&CreatedTime=637581137539430000>
- Github: <https://github.com/DomSleightholme/VRAssaultCourse>
- Itch.io: <https://pixel-silver.itch.io/vr-wipeout>
- Weekly Updates: <https://dle.plymouth.ac.uk/mod/oublog/view.php?id=922745>

- Showcase Poster: https://liveplymouthac-my.sharepoint.com/:f:/g/personal/dominic_sleightholme_students_plymouth_ac_uk/Em4Wb_OuaE9HpqItAAILASsBSX2n4Lqpx5bAf9UxcN8D3g?e=1g5hLB

1 - Introduction

1.1 - Overview

VR WIPEOUT

VR Wipeout is a virtual reality assault course game based on popular tv shows such as Total Wipeout and Takeshis Castle, the game is built on the Oculus Rift S using the Unity3D game engine and the Unity Interaction Toolkit which supports wired and wireless VR headsets. The game includes a couple of different variations of assault courses to compete in to achieve high scores, the game also features a level showcasing multiplayer functionality and how this feature is implemented into my game. Players will achieve medals and score values depending on the completion time and how the player plays the level, the game is developed to showcase how the extreme physical experience of assault courses can be implemented into a virtual reality game, the game is also being developed to showcase the VR technology and what this new technology has to offer in its current state.

1.1 - Purpose

The purpose of VR Wipeout is to create a VR game that is engaging for newcomers to the new technology and for players who use the technology regularly and have played multiple VR Games, I wanted to make VR Wipeout as user friendly, accessible, and enjoyable as possible. The reason as to why I wanted to cater VR Wipeout for newcomers of the technology is because I feel that VR is a new and upcoming technology which will revolutionize the gaming industry but at the current state of the technology, newcomers are put off for multiple reasons like the overall price of the set up required to play VR and the risk of motion sickness in certain VR games. The reason as to why I wanted to also cater VR Wipeout for players who enjoy VR on a regular basis is that there are not many video games that use VR technology and are based around competing in assault courses, because of this I believed that the technology combined with the assault course concept will make a dynamic experience for all types of players of the technology, included the regular VR user. The reason I included user friendly and accessible when talking about the purpose of the game is that I feel that some VR games do not support users who have difficulties when playing games, I wanted to develop a product which is enjoyable for all players, no matter the issues they could have when playing VR Wipeout.

1.3 - Audience

When developing VR Wipeout, I have been developing the game to not be restricted to adult audiences but have the game be available to all audiences aged twelve years old or above, I have chosen to have the game for any age above twelve years old is because the VR technology can be damaging to young minds and most VR games like my product have their age audience as twelve or above. I have been developing VR Wipeout for all types of players using VR, whether players are new to the technology and want to try out what the technology has to offer or hardcore VR players who have been using the technology for a while. My product is for anyone who enjoys assault courses or sports games, VR Wipeout is more designed to be a simulation product, not a fantasy experience, a similar game to my product is Sprint Vector, a VR multiplayer adrenaline platformer where players race against each other in a variety of levels. During the development process of the game, I have tailored the experience to be a non-time committing game, VR Wipeout is a game where you can pick up and play whenever you like as it is designed to be a non-intensive experience. Although I am developing VR Wipeout to be a non-profit product, the game is being released for VR headsets what also use the support of computer hardware to run their products, I plan to release the game for wireless or console headsets soon.

2 – Background and Project Objectives

2.1 - Technology Background

Virtual Reality (VR) is an experience where a person can interact within a computer-generated environment, the VR experience is created using special headsets and hand controllers, some VR applications use special gloves instead of controllers to capture the virtual experience. VR allows us to be fully immersed in the video game world as though we, the player, is a character in the video game, to learn how to perform heart surgery or improve the quality of sports training to maximise performance (Iberdrola, 2021). Although the technology is quite advanced, there have been cases in which people suffer from 'motion sickness' when interacting with technology, this is something that I will use as one of the keys focuses when developing my VR game. This technology can be applied to our day-to-day life in many ways such as VR being used for training in the military, The Spanish National Research Council has succeeded in reducing the effects of Parkinson's in several patients by applying a treatment that uses VR (Iberdrola, 2021). For the purpose of my project, I plan to use the technology to develop an immersive, entertainment experience to simulate the player in competing assault courses.

For my project, I plan to develop my product using the Unity game-engine, this game-engine is developed by Unity Technologies first released in June 2005, initially the program was to be a Mac OS X exclusive but later added support for Microsoft Windows and Web Browsers. The game engine supports 2D, 3D, VR and AR development, the game-engine is particularly popular for iOS and Android mobile game development and used for games such as Pokémon Go, Monument Valley, Call of Duty: Mobile, Beat Saber and Cuphead (Wikipedia, 2021). Although the game-engine is mostly used for game development, the engine has been used for purposes such as film, automotive, architecture, engineering, and construction. For the purpose of my project, I plan to use the game-engine to develop my VR game using Unity's recent package to the engine, XR Interaction Toolkit. For Unity and other programs used in the project versions, see Appendix 8.

2.2 - Motion Sickness Research

Motion sickness is caused when the body experiences a difference between actual and expected motions on the body, the only difference between this and the VR version of motion sickness is how the body reacts to the difference between the actual body movement and the virtual body movement. VR motion sickness happens when the brain receives conflicting signals about movement in the virtual world and the actual world, the difference between the two disturbs the brain's equilibrium and you begin to feel the effects of VR motion sickness. This problem can be caused to all types of players when entering a virtual environment for multiple reasons, either depending on the player or the developer, when experiencing this issue, you can experience harsh sensations such as nausea, headaches and many more symptoms that can ruin the player's experience of the technology.

Developers of VR games have implemented methods or reducing motion sickness in the game to improve the virtual experience, some of the methods in which developers have used to reduce motion sickness have been:

- Teleportation:
 - Many VR games are using the teleportation movement as the main locomotion in their games, this method movement removes the movement visualization which tends to be the cause of motion sickness, the bonus feature to this method is that the teleportation movement allows the player to explore a vast environment while using a small and compact play area.
- Optimized VR Experience:
 - One of the key things to have when playing VR games is how fast the game runs, if the VR experience is running below the specified platform being used then this could cause the player to feel motion sickness. You should optimize the game to run at the correct FPS (Frames Per Second) requirement for the chosen headset. Improving the graphics requirements of the game or using the in-game engine performance testing can help improve this.
- Add a static reference frame:
 - This type of method may not be best for some games but for games such as EVE: Valkyrie, a multiplayer dogfighting shooter game set in the EVE franchise, this game gives the player a static reference of the cockpit to help ground players with the motion around them, a bonus feature to this method used in the game is that the cockpit being used as the static frame also adds immersion to this game.

2.3 - Assault Course Background

An Assault Course, also known as a Trim Trail, is a trail of activities which involve the combination of running and exercising, assault courses were more popular in the 1970s than today. Assault courses are heavily used in military training, the idea of an assault course is to evaluate the progression and the weaknesses of the people taking part in the course. Assault courses can help improve; general physical fitness, strength, stamina and mobility, assault courses can help improve teamwork skills when competing the course as a team, they can vary in size depending on the activities involved. Assault courses have featured in popular tv shows like Total Wipeout UK, where twenty contestants

take on extreme obstacles to win £10,000, another popular tv show based on assault courses is the classic, Takeshi's Castle where dozens of contestants throw themselves into a variety of physical challenges to claim the grand prize of 1 million yen. A key difference between a Trim Trail and an Assault Course is that at each exercise station the exercise is usually repeated multiple times as an exercise set, on an Assault Course the obstacle is only crossed once. (Wikipedia, 2021)

2.4 - Competitor Analysis

	My Product	Competitor One	Competitor Two	Competitor Three
Critical Elements	VR Wipeout	Doritos Crash Course	Fall Guys: Ultimate Knockout	Awesome Obstacle Challenge
Unique Selling Proposition (USP)	Can be played on different VR Systems	One of the First of its genre	Battle Royale style Assault Course	Includes Global Records of Time Completions
Platforms	Windows	Xbox 360	Windows, Android, PlayStation 4	Windows
VR Feature	Yes	No	No	Yes
Cooperative Feature	Yes	Yes	Yes	No
Audience	Ages 12+	Ages 7+	Ages 3+	Ages 12+
Price	Free	Free	£15.99	£5.99
Downloads (December 2020)	Unknown	1.4 million	7 million on Steam	Unknown
Strength	Can play with Gamepad or Keyboard	Can be played either locally or online	Massive Online Presence	Low Demanding PC Specification
Weakness	VR Headset Required	Only released on Xbox 360	Cannot play Single Player Mode	VR Equipment Required
Player Reviews	In Progress	9 / 10	9 / 10	8 / 10

Figure 1: This figure showcases my Competitor Analysis I carried out.

A competitor analysis is a strategy where you identify major competitors with similar products to your product and research their product, for this analysis I will be reviewing three games which are like my planned product and how these competitors are portrayed by the public including their features, strengths, and weaknesses. The three competitors I will be using are Doritos Crash Course, 2D side scrolling platforming adventure game developed by Wanako Games, Fall Guys: Ultimate Knockout, platformer battle royale game developed by Mediatonic and published by Devolver Digital and Awesome Obstacle Challenge, VR-only game where you use the VR technology to complete dozens of courses. Using these three competitors will allow me to identify how the market reacts to

these types of games and identify potential opportunities where I can out-perform the competition in my product.

Reviewing my competitors USP, they each have different qualities which can be implemented into my product, using this information I can adapt their USP in my product by including Global Records of Time Completions for levels in my product and include the feature of co-op into my product. After reviewing which platforms my competitors are played on, I have planned that it is best to develop my product to support as many platforms as possible to improve sales and engage with a greater audience. After evaluating if my competitors have an included VR feature in their game, this information shows that there is an area in the market for my VR product as the only competitor which includes a VR feature in their product is Awesome Obstacle Challenge. After evaluating if my competitors also have an included cooperative feature in their game and their reviews, this information shows that the gaming community enjoy this genre of video games including a cooperative feature, this information will support my feature to also include co-op in my product.

All the competitors I am using for my competitor analysis have an age rating of either 3,7 and 12, this information shows that the lower the age rating for their game, the bigger the audience to enjoy the product, this information has benefited me as I have chosen to go with an age rating of 12+ for my product, the reasoning being that you must be 12 and over to use a VR headset. Each of my competitors have a price of either £15.99, £5.99 or sell the product for free, this information gives me a mixed message as the most expensive competitor is the best valued out of the three, I have chosen to sell my product for free. After reviewing the competitors with download stats of their product, as of December 2020 Fall Guys had the most downloads with 7 million on Steam, a video game digital distribution service by Valve, Doritos Crash Course has 1.4 million downloads on Xbox 360 as of December 2020. The figures for downloads of Awesome Obstacle Challenge were unavailable. This information shows that a large amount of the gaming community is interested in this genre of video games.

2.5 - Project Objectives

The objectives of the project I am developing are as follows:

- Deliver a product that captures a successful game-loop, allowing the player to compete in multiple courses and a tutorial level.
- Explore the technology of VR being applied to an Assault Course game.
- Create a physics-based VR game which is realistic for the player and the game environment.
- To create a great user experience which is accessible to all variations of players and keep the same level of enjoyment depending on their preference.
- To create a VR game that supports multiplayer technology and keeping the user-friendly experience.

The result of my project I am trying to achieve is a product which has initial gameplay elements included with room to add more content in the future, the product will be used as the initial test into how VR can be applied to a physics-based assault course. I plan to complete the project with a bug-free, user friendly experience, I will be providing the game as an '.exe' file and plan to allow the game to be used on as many VR headsets as possible. I will be using Microsoft planner to showcase

my development of the project; I also plan to use my social media platform and the weekly report posts to showcase the development of my product.

3 - Product

3.1 - Minimum Viable Product (MVP)

I want to develop a VR game based off assault courses featured in famous tv shows such as Total Wipeout, I want to make a series of levels which make players face off against a series of obstacles using the VR technology and the Unity3D game engine. I want to develop my game to feature as much accessibility, the integration of using a gamepad instead of Oculus motion controllers will be a feature in my game.

3.2 - Minimum Viable Experience (MVE)

As I am developing a game using VR technology, I want to create the most immersive experience possible! I will be using regular user testing every month to engage with player's feedback on the VR implementation and how immersive my game is. Although I am wanting to develop the ultimate immersive experience, I also want to develop features which reduce the risk of motion sickness, this will be an important topic in my testing every month.

3.3 - Maximum Awesome Product (MAP)

My product will put all that VR technology has to offer in my game to demonstrate the capabilities VR can achieve in game development, I want to achieve a product which has full accessibility for all players to fit their needs when playing my game, the game I am developing will have the options to play with the VR motion controllers, gamepad or even keyboard and mouse. My game I am striving to complete will let all types of people enjoy VR, whether you are an experienced gamer or new to the technology, my game will be an enjoyable experience for all! The game will have multiple levels, whether it is assault courses or mini games, my game I am developing will combine the VR technology and the power of the Unity3D game engine together to create a great experience.

3.4 - UX

UX (User Experience) is a discipline of design, centred around the psychology of the player, how the player behaves in game, their thinking processes, and capabilities, UX is science between the player playing the video game and the design of the game. User experience is important because it tries to fulfil the user's needs, it aims to provide positive experiences that keep a user loyal to the product or brand (Gandgadharan, 2019), based on my project, my aim is to develop an immersive experience for all types of VR players and keep them engaged in the game experience, whether they are newcomers to the technology or use the technology regularly. One of the methods I use to improve my UX regularly during the project's development is user testing every month, this method gives me feedback on what players enjoy about the project and how I can improve certain mechanics before release.

3.4.1 - Functionality

When looking into the functionality on my project, there are three key areas I focus on to improve the functionality, these key areas are: player collision with the environment and obstacles, improving the immersive experience and working constantly on the player controller to improve the quality of the game. When developing a VR game, there are certain areas to manage to allow for an enjoyable experience, one of those areas being motion sickness, if I develop my game in a way which could cause motion sickness, I will ruin the experience and not have a constant engagement on the game, therefore I took the time to research motion sickness and how I can tackle this issue in my product.

3.4.2 - Usability

When looking into the usability on my project, there are three key areas I focus on to improve, the key areas are: designing the user interface to be easy to understand and support the VR technology, designing the controls to be simple and understandable for the player to use and developing custom settings to support each player's experience. When developing the usability side of the UX experience, I have been looking into allowing custom controller support to suit the player needs, some players might struggle with the concept of using the VR controllers so I have taken the time to look into gamepad support, for testing purposes I will be developing this mechanic using an Xbox One controller, I believe this mechanic will improve the usability of the game and offer the experience to a wider range of players.

3.5 - SWOT Analysis

During the planning stage of my product, I took the time to complete a SWOT analysis on my project and where I assess the strengths and weaknesses of my product, I also assess the opportunities or risks my product could face. I choose to complete this analysis as I believe this process would give me ideas for future and support the ideas, I have for the project so far.



Figure 2: This figure showcases my SWOT Analysis I have carried.

3.6 - User Story Map

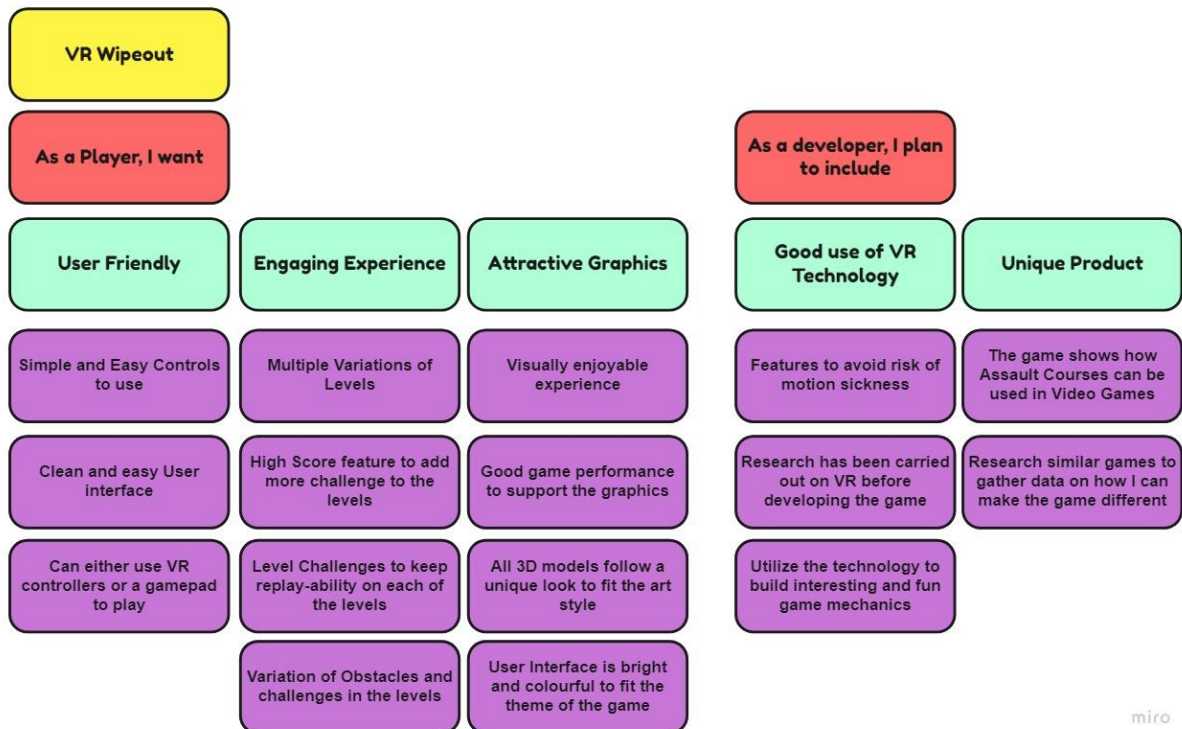


Figure 3: Showcasing my User Story Map for my project.

I chose to create a user story map for my project because this solution will help me identify any strong points or weak points of the experience I am trying to make, helping me create the best user experience as possible for the final product.

3.7 - Project Roadmap

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Submissions								
Project Initiation								
Showcase Materials								
Final Submission								
VIVAS								
VIVA #1								
VIVA #2								
VIVA #3								
VIVA #4								
VIVA #5								
VIVA #6								
Modes								
Free play								
Tutorial								
Multiplayer								
Championship								
Party Modes								
Player								
Movement								
Interaction								
Bug Fixing								
User Interface								
Design								
Obstacles								
Level Design								
User Interface								

Figure 4: Showcasing my Project Roadmap.

I have taken the time to develop a project roadmap to illustrate my goals and deliverables, I aim to achieve by the end of development, the roadmap begins from when I started development on the project and concludes when I finish development and submit my final project. I have taken the time to separate my goals and deliverables in sections based on areas of development for my project, these sections are as followed: Submissions, VIVAS, Modes, Player and Design. I used these sections in my roadmap to clearly illustrate my goals for the project and plan development around which sections are complete or need more development time. The reason I developed a roadmap for my project is to easily recognize priority tasks and manage my development time on these tasks effectively, identify potential risks and plan ways to reduce risks before they even threaten the project and build an effective schedule to maximise my time and effort on the project for best results.

4 - Methods

4.1 – Methodologies

One of the methods I have been going about using during the development of my project is using the agile project management, iterative approach to delivering a project throughout its life cycle (Association for Project Management, 2021). Agile, also known as agile methodology, is a way of managing your project and planning how you go about developing your product. Using agile, I was able to create sprints that lasted two weeks, these sprints were a combination of all my tasks I want to complete in the two weeks I allocated for the sprint. I was able to break down the sprints into five sections: the task, the priority level of the task being either low, medium, or high priority, the start date of the task, the end date of the task and whether I completed the task or not. Using the fortnightly sprints, I was able to produce testing sessions at the end of every month, these testing sessions would test the work I have completed in the previous sprint, helping me gain feedback and improve my project.

Using agile practices in my project has allowed me to produce high quality work and maintain staying efficient in completing all my tasks on time, the reason I choose to use agile practices in my project compared to similar practices is because I believe agile is a more efficient and productive method of project development compared to similar methods such as the waterfall method.

4.2 - Technologies

One of the technologies I use in my project is the PUN2 free package from Photon networking, this type of technology is used to create my multiplayer functionality in VR Wipeout. When planning my project, I choose to use PUN2 instead of other multiplayer packages because this type of multiplayer technology is supported by Unity and is used in big titles such as Gorilla Tag, the new VR tag game which has been very popular on platforms such as YouTube. Another reason why I chose to use the PUN2 technology for my multiplayer mechanic is that this technology handles all the backend functionality, for example the transfer of data and handling the joining / hosting of multiplayer sessions. Using PUN2, I plan to develop a basic multiplayer feature where I can showcase how I was successful in integrating a multiplayer feature with a VR game such as VR Wipeout, the multiplayer feature will include the ability to set a player name, join a server or create your own server, I will also allow players to manage the player count in their servers from two players up to six players.

The XR Interaction toolkit from Unity is the driving force of my project, The XR Interaction Toolkit package is a high-level, component-based, interaction system for creating VR and AR experiences (Unity, 2021), this technology is used to develop the player controller and how the VR controller interacts with the world of VR Wipeout. The XR Interaction Toolkit package provides a set of locomotion primitives that offer the means to move about a scene during an XR experience (Unity, 2021), for the purpose of my project I use the components: XR Rig to control the player, along with the locomotion system to support movement from the XR Rig, although the toolkit contains systems for movement and teleportation, I choose to develop these features myself to create the movement the way I envisioned it to be in the final release. Using the XR Interaction Toolkit and the PUN2 technology, I am able to develop my product using the agile practices spoken about before, to release a product which fits my objectives of the project development.

4.3 - User Testing

To develop a great and immersive experience for my game, I implemented User Testing every month to gather feedback on my development so far and how I can improve on what I had developed, these User Testing sessions I will be carrying out are called VIVAs. For each VIVA I will present the current prototype I have so far and a Google form to fill out the questions based on the prototype, these questions will give me a clear indication of what users enjoy of my prototype and what I need to improve on, the feedback will be reviewed and will be used when planning the next sprint. Due to COVID-19 pandemic, I am unavailable to carry out my VIVAs in-person so I have accompanied the prototype feedback form with a video of the prototype being played, these videos will give users gameplay of my progress and the features done so far.

4.4 - Reducing Motion Sickness

Motion sickness can damage the overall experience of the game and cause players not to come back to play, I believe motion sickness should be one of the main focuses of developing a VR game because of this, after taking the time to research this threat to my game, I have developed specific features to tackle this. Alongside these features I have been working on to reduce motion sickness, I have also carried out regular user testing where people can address any concerns if there is a risk of motion sickness in the gameplay, I show them. Starting with the first feature I worked on was the camera vignette on the player controller, this mechanic has been tested in the first two user testing sessions and has been improved upon using user feedback. The Vignette is displayed when there is an active motion applied to the player, whether they are moving around the level or hit by an obstacle, the camera vignette will increase around the screen for a short period of time, this feature was developed using the research I carried out early in development.



Figure 5: Camera vignette I have applied for the game.

The second feature I have been working on to reduce the risk of motion sickness in VR Wipeout is to develop the obstacles in a way what is enjoyable but suitable for the VR technology, to go into more detail about this, when designing the models I had to plan how they will interact in game and if they are suitable for VR, for example I allowed the sweeper in the game as it did not cause any motion

sickness but something like the bouncing balls what shoot people in the air like in the famous tv show, Total Wipeout was not added because I believed this would cause motion sickness. The final feature I worked on to reduce the risk of motion sickness was player rest periods, this feature was an idea I had before I started developing VR Wipeout, the features work by telling the player to take a rest from VR after a certain amount of time, I thought about this feature because I believe it was a simple concept but would be effective in reducing motion sickness in VR Wipeout.

5 - Issues and Considerations

5.1 - Legal

When discussing the legal issues and considerations of my project, there are three areas I have considered during development of the game, the first legal issue I have considered is the risk that my product is like games such as Fall Guys, because of this I have tried to avoid similarities between games with similar concepts to my project. If I did not consider this issue, I could risk having a copyright strike issued on my project. The second legal issue I have considered is the age rating of the game, because of research I have gathered on how VR technology may be damaging to young minds. I have considered the possibility of setting a higher age range for the project, although my game does not include any content that could set the game at a high PEGI rating. The third and final legal issue I have considered is using intellectual property without the owner's consent, in the project I have used third party assets such as 3D models or audio, before I included this content I have considered if I can use the content, they have made and how I can include them in the credits. Because of this I have made sure that all third-party assets are allowed in my product and every developer who worked on the third-party assets is credited.

5.2 - Social

When discussing the social issues and considerations of my project, I have focused on three issues that could happen in my product, the first issue I have will be discussing is how immersive I want VR Wipeout, after looking into immersion to help improve the quality in my game I realised the issue of VR Wipeout becoming too immersive came up in discussion. One of my goals for the project is to create a great immersive game, although this can be seen as a good thing, I have taken the time to understand that this could become an issue more than a good feature, because of this I am developing a break feature where the game would tell the player to take a break from the game after a certain period of time, this feature will help people getting too attached to the game if the issue ever came up. The second social issue I have thought about when working on VR Wipeout is the multiplayer feature and how it could bring in bullying and abuse depending on the features I brought into the game, if I were to add a chat feature or a voice feature to communicate with other players, there is always the risk of abuse or bullying. Because of this I am only working to the core multiplayer mechanic, before I think about any voice or chat features, as I have not specified this in my objectives at the beginning of the project. The final social issue I considered during development of my product is how my testing sessions are completed, because of the coronavirus pandemic, I carried out all testing sessions remotely using Google forms and gameplay clips where I showcased what I wanted to test.

5.3 - Ethical

When discussing the ethical issues and consideration of my project, I have focused on two issues in my project, the first issue being the questionnaires I sent out regularly for testing purposes. Before the users completed the form, I informed them that the questionnaire being given was anonymous and I did not require any personal information from the tester. The second issue I thought about during the development of my project is the transparency of the form, before the user took the form to complete my testing sessions, I informed the user what I would be using the information they provided me for, I explained all information gathered from the form was to enhance the experience of VR Wipeout and for my final report.

5.4 - PEGI Rating

PEGI, also known as Pan European Game Information, is a European video game rating system established to support consumers buying video games or applications using the use of the PEGI age rating system and the content descriptors of the product, the European rating system PEGI (Pan European Game Information) rates games into the following five categories: 3+, 7+, 12+, 16+ and 18+, and gives additional guidance through content descriptors (Osborneclarke, 2016). The content descriptors are categorized in the following:

- Bad Language
- Discrimination
- Drugs
- Fear
- Gambling
- Sex
- Violence
- In-Game Purchases
- Online

The age rating system was introduced in April 2003, developed by Interactive Software Federation of Europe (ISFE), this system replaced all previous versions of national age rating systems with this single European rating system which is used for all video games released in Europe. Since VR is a recent upcoming technology, the impact of VR technology on age rating has not been widely discussed in legal literature, but some differentiating approaches have already surfaced. PEGI is considering re-evaluating the criteria for “fear” and “horror” once VR technology gains more market relevance, and some voices have called for dedicated rating systems for VR games (Osborneclarke, 2016).

I have chosen to set the age rating on my game as 12+, the decision for this is due to the technology being used for game and not the content of the game itself, although my game is friendly and does not include any violence or gore similar to games at the same age rating, the VR technology is powerful and could be damaging to children of younger ages, a recent article called Virtual Reality 101: What You Need to Know About Kids and VR by common sense discussed the effects of VR on younger minds, the article stated points such as “The long-term effects of children’s use of

immersive VR on their still-developing brains and health are unknown, but most parents are concerned, and experts advocate moderation and supervision.” The article conducted a study where Only one in five U.S. parents (21 percent) today report living in a household with VR, and the majority (65 percent) are not planning to purchase VR hardware. However, the interest levels of U.S. children are high, while parent interest is mixed (Common Sense Media, 2018). To conclude my point to why I have set my age rating of this product as 12+ is although I want as many people as possible to take part in the experience I am developing, I support the idea that VR could be challenging to younger minds and damaging in the long run.

6 - Project Management Tools

6.1 - Project Management

Project management is the process of leading the development of yourself or a team to achieve project goals and complete given deadlines, the idea of project management is to achieve all the development goals and meet deadlines correctly and efficiently. To maintain efficient development of my project, I use a project management tool to assign tasks and plan future tasks for my project, to maintain efficient development on the project I use Microsoft Planner as my planning tool. Microsoft Planner is a planning application where you or your team can create plans, assign development tasks, and view progress on tasks using its in-build chart feature, this tool is necessary to my agile approach on my project because I am able to plan out all my tasks efficiently and display a high level of project content for others to view and understand the development process of my project.

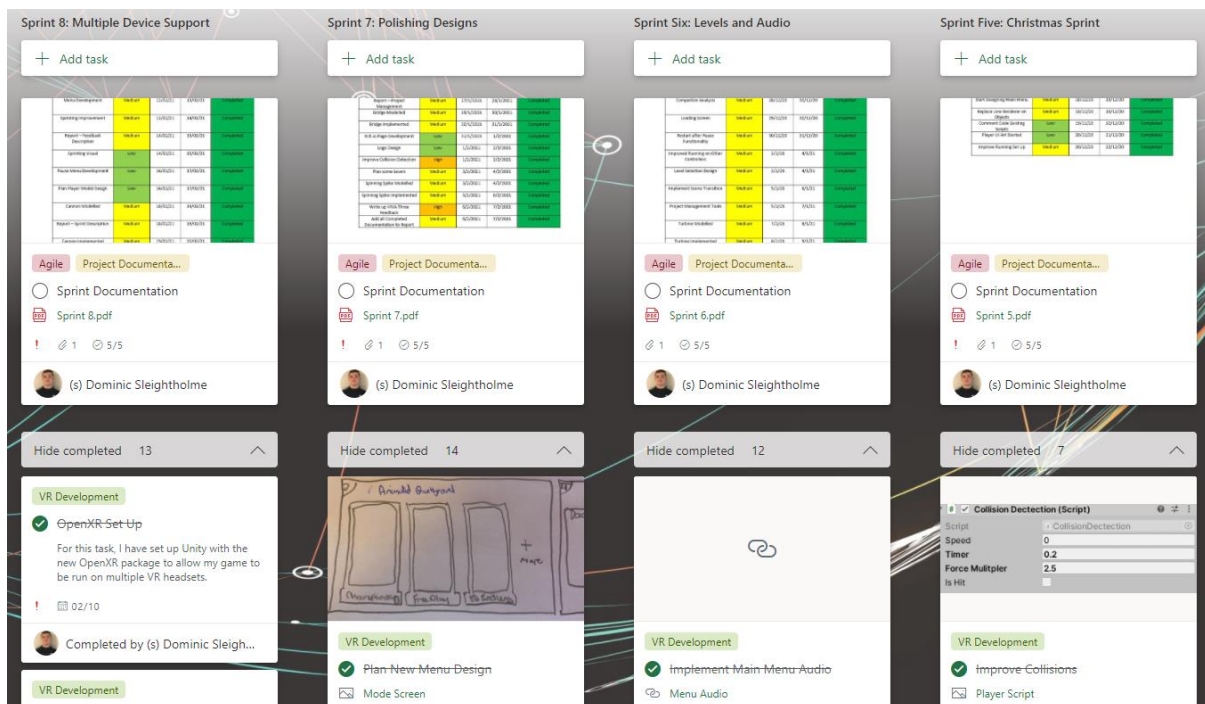


Figure 6: Screenshot of my current planning board on Microsoft Planner.

6.2 - Version Control

Version control also known as source control is the process of tracking and managing changes to the software of a given project, as development environments have accelerated, version control systems help software teams work faster and smarter (Atlassian, 2021). In my project I will be using version control when developing my game to avoid software crashes and to maintain a staple prototype build for my testing sessions or presentation showcases. Version control handles issues such as mistakes in code or even losing vital elements of the project, using this method of storage I have the availability to grab earlier versions of my project I pushed if there are risks to my current project. I will be using Github to handle my version control in my project, I chose to use this program to handle my version control because it is free to use, and I have and previous experience using the program for other projects and my summer internship.

6.3 - Fortnightly Development Reports

As part of my overall submission, I have been uploading blog posts of my current progress on the project every fortnight, this post includes a PDF document detailing what I have been doing in the previous fortnight with images to back up my points, I also include a section detailing what I will be working on next on my project. On the PDF document and the blog post itself, I have included links to my Github repository and my Microsoft planner for the project, showcasing all my sprints and completion of tasks. To present my blog posts, I have provided a link to the following section with every blog post I have completed since the beginning of the project.

Link: <https://dle.plymouth.ac.uk/mod/oublog/view.php?id=922745>

7 - Implementation

7.1 - Player Controller

The player controller is the main part of VR Wipeout, the controller is used to move the player around the level using Unity's physics engine and the VR technology implemented into the project. The player controller includes the movement system, world interaction and other features including jumping and crouching. Starting off with the first section of the player controller, the movement, this feature is the main part of the controller and is used to move the player around the level, I have designed the camera to follow the player's VR headset, because of this the player is able to rotate the body using the VR headset. Below I have attached a code snippet of how the in-game camera follows the player's position.

```
1 reference
void FollowHeadset()
{
    //Get the capsule component
    CapsuleCollider capsuleCollider = GetComponent<CapsuleCollider>();
    capsuleCollider.height = Rig.cameraInRigSpaceHeight;
    Cam.transform.localPosition = new Vector3(0, 1, 0);

    //Adjust the capsule collider size to fit with the players headset
    Vector3 capsuleCenter = transform.InverseTransformPoint(Rig.cameraGameObject.transform.position);
    capsuleCollider.center = new Vector3(capsuleCenter.x, capsuleCollider.height / 2 + capsuleCollider.radius, capsuleCenter.z);
}
```

Figure 7: Code snippet for in-game camera following Players Position.

Another way you can rotate the player is using the thumb stick from either the Oculus hand controller or an external gamepad. Using the rotation of the player, the controller can calculate the

direction the player wants to go when the thumb stick for movement is used, below I have attached the code snippet showing this mechanic being used.

```
//Position
Quaternion headYaw = Quaternion.Euler(0, Rig.cameraGameObject.transform.eulerAngles.y, 0);
Vector3 direction = headYaw * new Vector3(inputAxis.x, RB.velocity.y, inputAxis.y) * Time.fixedDeltaTime * Speed;
RB.MovePosition(RB.position + direction);

//Rotation
Vector3 rotation = rotationAxis * Time.fixedDeltaTime * RotationSpeed;
transform.Rotate(transform.localRotation.x, rotation.x, transform.localRotation.x);
```

Figure 8: Code snippet for Player Position and Rotation.

I developed a simple jump mechanic, allowing the player to jump across platforms and improve the immersion of playing an assault course. To use the jump mechanic in VR Wipeout, the player uses the button labelled A on the right Oculus controller or an external gamepad, I choose this button as it is a very familiar button for jumping in video games. I have added the feature to send haptic feedback to the player's Oculus controller when the jump feature is used, this feature finds all the controllers in use and sends a haptic impulse to the player, I made this feature for the Oculus controllers only. Below I have attached a code snippet showing this feature off.

```
1 reference
public void HapticInput(float amp, float duration)
{
    for(int i = 0; i < Hands.Count; i++)
    {
        Hands[i].SendHapticImpulse(amp, duration);
    }
}
```

Figure 9: Code snippet for Haptic Feedback in the Game.

If the player is on an object that is classed as a ground object, the player will force in an upwards direction using the Rigidbody component attached to the player, the jump mechanic is physics based so any collisions will react the same when the player is jumping. Below I have attached a code snippet displaying how I created the jump mechanic.

```
//Jump
InputDevice jumpController = InputDevices.GetDeviceAtXRNode(jumpInput);
jumpController.TryGetFeatureValue(CommonUsages.primaryButton, out bool jumpPressed);
if (jumpPressed)
    Jump();
}

1 reference
public bool Jump()
{
    if (isGrounded)
    {
        RB.AddForce(Vector3.up * JumpForce * Time.fixedDeltaTime, ForceMode.Impulse);
        return true;
    }
    else
    {
        return false;
    }
}
```

Figure 10: Code snippet for Jump Mechanic.

In VR Wipeout, there are multiple elements of world interaction, from being knocked back by the turbine obstacle or climbing up huge walls, VR Wipeout offers it all in this action-packed assault course. The world interaction is mostly used by the physics engine included in the Unity Engine, but I have completed some code for the other elements of world interaction. The scripts I have completed for the world interaction in the game go as follows; grabbing objects, knocked back if a large force is applied on the player, climbing up walls and using the zipline. Below I have attached a code snippet from one of the scripts for the world interaction in VR Wipeout, the climbing up walls.

```
protected override void OnSelectEntered(XRBaseInteractor interactor)
{
    base.OnSelectEntered(interactor);

    Debug.Log("Select Enter");

    if (interactor is XRDirectInteractor)
        Climber.climbingHand = interactor.GetComponent<XRController>();
}

0 references
protected override void OnSelectExited(XRBaseInteractor interactor)
{
    base.OnSelectExited(interactor);

    Debug.Log("Select Exit");

    if(interactor is XRDirectInteractor)
    {
        if(Climber.climbingHand && Climber.climbingHand.name == interactor.name)
        {
            Climber.climbingHand = null;
        }
    }
}
```

Figure 11: Code snippet for Climbing.

These features combined, make up the player controller I have implemented into VR Wipeout, they allow the player to move around the levels I have designed and interact with the obstacles I have developed.

7.2 - User Interface (UI)

The user interface (UI) in my game has gone through many iterations and has been used in multiple testing sessions, the reason being is that I want to develop an interface that is comfortable and easy to use when playing the product, as the player will be using the UI a lot when playing the game, I wanted to take the time to make sure the UI was suitable for the VR technology and felt good for players. When I first started working on the UI, I had the feature on the player's camera like in most first-person games, after much consideration and showing off this feature in one of my testing sessions, I went back and reworked the UI again, this time being on a watch, allowing the player to look at their hand when they want to view the UI.

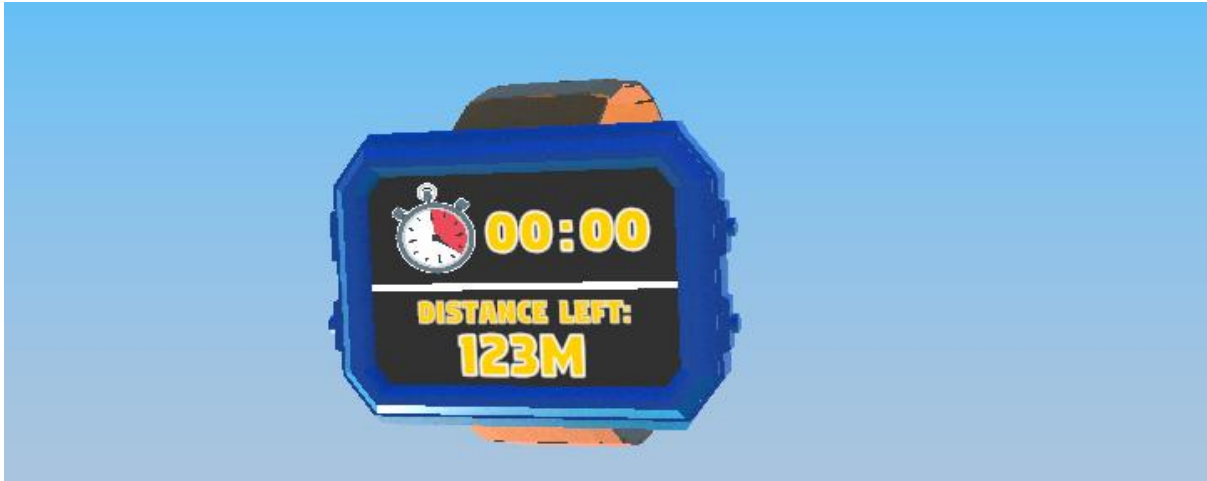


Figure 12: Player UI on the watch I designed.

I choose to have the UI on a watch instead of the camera as this type of UI is used a lot in VR games on the market today and allowed the camera to be completely clear to add more immersion to the game. After showcasing the watch UI in my testing sessions, I received positive feedback compared to the previous iteration of the UI. The in-game UI is simple for the player to understand when playing the game: you have a level timer which starts when the player is competing in the level and a distance tracker to notify the player how much further they have to go before completing the course, I choose to include these features and make the UI simple because I want the player to focus on the level and not constantly checking the watch. Other UI elements in the game are shown in world space and not centred on the camera, similar to how the player's watch works.

7.3 - Using PlayerPrefs

As my project contains multiple scenes and there are certain data values that need to be sent between these different scenes in my project, I used Unity's PlayerPrefs utility to solve this issue, this utility is built-in the Unity game engine to persist certain data types between scenes, these types being: string, float, and integer. I use this utility for my player settings and player scores on each level of the game, this feature was easy to set up and helped me when working on these two features of my game, the data stored is saved between game sessions also. Below I have showcased how I use PlayerPrefs in my game.

```
1 reference
private void getData()
{
    //Color
    setColor();

    //Float
    TurnAngleValue = PlayerPrefs.GetFloat("TurnAngleValue");

    //Int
    GUISMenuDistance = PlayerPrefs.GetInt("GUISMenuDistance");
    GUISMenuHeight = PlayerPrefs.GetInt("GUISMenuHeight");
    GraphicsIndex = PlayerPrefs.GetInt("GraphicsIndex");
}
```

Figure 13: Code snippet of PlayerPrefs in my game.

7.4 - Obstacles

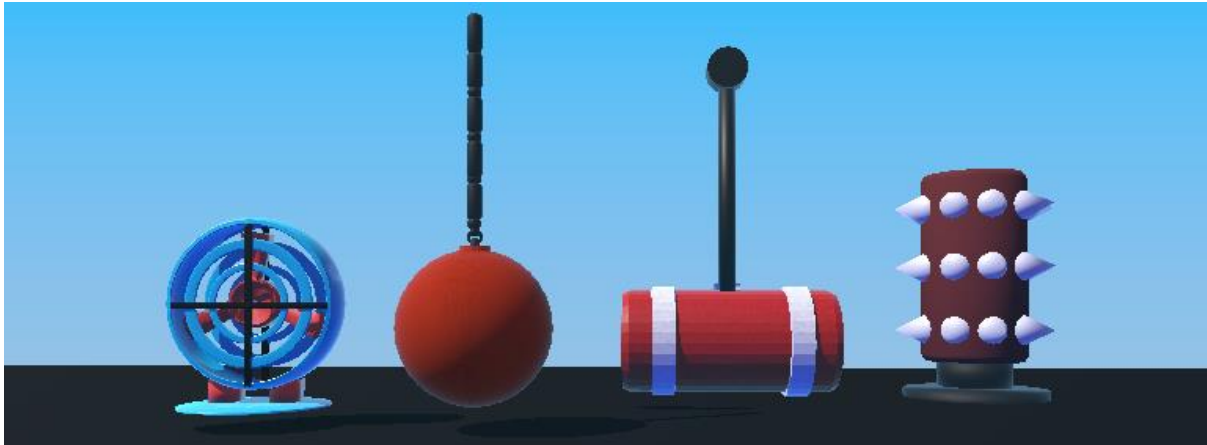


Figure 14: Various obstacles used in the game.

In VR Wipeout, there are numerous obstacles to face off against in each of the levels, these obstacles have been designed using Unity's Physics Engine and multiple types of scripts I have developed myself; the player will react smoothly to each of the obstacles to enhance the immersion feel in VR. All obstacles use scripts to calculate the force of impact on the player except the cannon obstacle, this obstacle has a script attached to determine when to fire the cannon, the fire rate of the cannon and the rotation of the cannon barrel. Having this script on the cannon means I can use multiple cannons in my scenes but each of the cannons will be unique to the other. The obstacles I have developed in VR Wipeout are as follows:

- Wrecking Ball
- Sweeper
- Cannon
- Pendulum
- Spinning Spike
- Turbine
- Punch Glove

Each of the obstacles have been tested thoroughly in online VIVAs to improve their overall quality and realism to the game, I have taken the time to make each of the obstacles feel unique and truly immersive to the experience of VR Wipeout. The most complex obstacle developed for VR Wipeout is the wrecking ball, although each of the obstacles use Unity's physics engine and custom scripts in the game, the wrecking ball's main feature is the use of the physics engine. The main element of the wrecking ball to work in VR Wipeout is the rope the ball is attached to, this rope is made up of multiple mesh objects connected using the Hinge Joint component, provided by Unity, this method allows the wrecking ball to react smoothly and realistic in the world.

```
void LineMeasure()
{
    LineDistance = RotationSpeed / DistanceMultiplier;

    //Set Direction for Rays
    Vector3 forward = transform.TransformDirection(-Vector3.forward) * LineDistance;

    //Get Ray Positions
    Vector3 position1 = new Vector3(RaycastOrigin.position.x, RaycastOrigin.position.y, RaycastOrigin.position.z);
    Vector3 position2 = new Vector3(RaycastOrigin.position.x + 1f, RaycastOrigin.position.y + 0.4f, RaycastOrigin.position.z);
    Vector3 position3 = new Vector3(RaycastOrigin.position.x - 1f, RaycastOrigin.position.y + 0.4f, RaycastOrigin.position.z);
    Vector3 position4 = new Vector3(RaycastOrigin.position.x, RaycastOrigin.position.y + 1f, RaycastOrigin.position.z);

    //Draw the Rays
    ray1 = new Ray(position1, forward);
    ray2 = new Ray(position2, forward);
    ray3 = new Ray(position3, forward);
    ray4 = new Ray(position4, forward);
    Debug.DrawRay(position1, forward, LineColor);
    Debug.DrawRay(position2, forward, LineColor);
    Debug.DrawRay(position3, forward, LineColor);
    Debug.DrawRay(position4, forward, LineColor);
}
```

Figure 15: Code snippet from the Turbine Obstacle.

Using the obstacles, I have listed above, I am able to create individual and unique levels for the player to compete in to gain high scores and complete level specific challenges.

7.5 - Main Levels

VR Wipeout will contain four main levels, a tutorial level, and a multiplayer level, for this section I will be discussing the four main levels. These levels are unique and showcase the development I have completed during the module, the four main levels I will be discussing go as follows: Hill Dash, Mega-Sweep, The Balancer, The Impersonator. To help improve the quality of these levels, I used third-party assets, as credited in Appendix 9.



Figure 16: In-game image of the first level of my game, Hill Dash.

Hill Dash will be showcasing the punching glove obstacle, the sweeper obstacle and the cannon obstacle, the level tasks players with traversing a hill while avoiding the humongous cannon balls flying at the player and the punching gloves on the bridge intersections. The course challenges are to complete the course in under two minutes and 15 seconds, complete the course in under one minute and to complete the course without using the respawn feature. I chose to create this level because the level fits the theme of a typical assault course and takes inspiration from the celebrity cyclone from the famous tv show, I'm a Celebrity Get Me Out of Here.

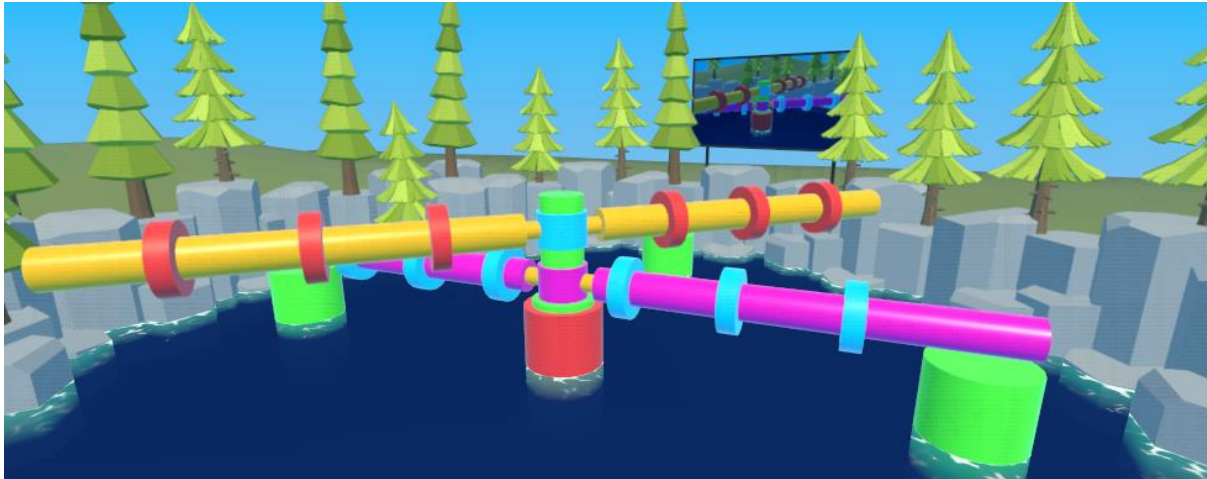


Figure 17: In-game image of the second level of my game, Mega-Sweep.

Going on to my second level, Mega-Sweep, this course will be only showcasing the sweeper obstacle. The aim of this level is to stay on the platform for as long as you can without being knocked off by the mega-sweep, the course challenges are to survive for over one, three or six minutes. The reason I choose to develop this level was I wanted to include a survival-style level into the game like other assault course games, using the sweeper obstacle I have developed, I was successful in creating a survival level to the game.

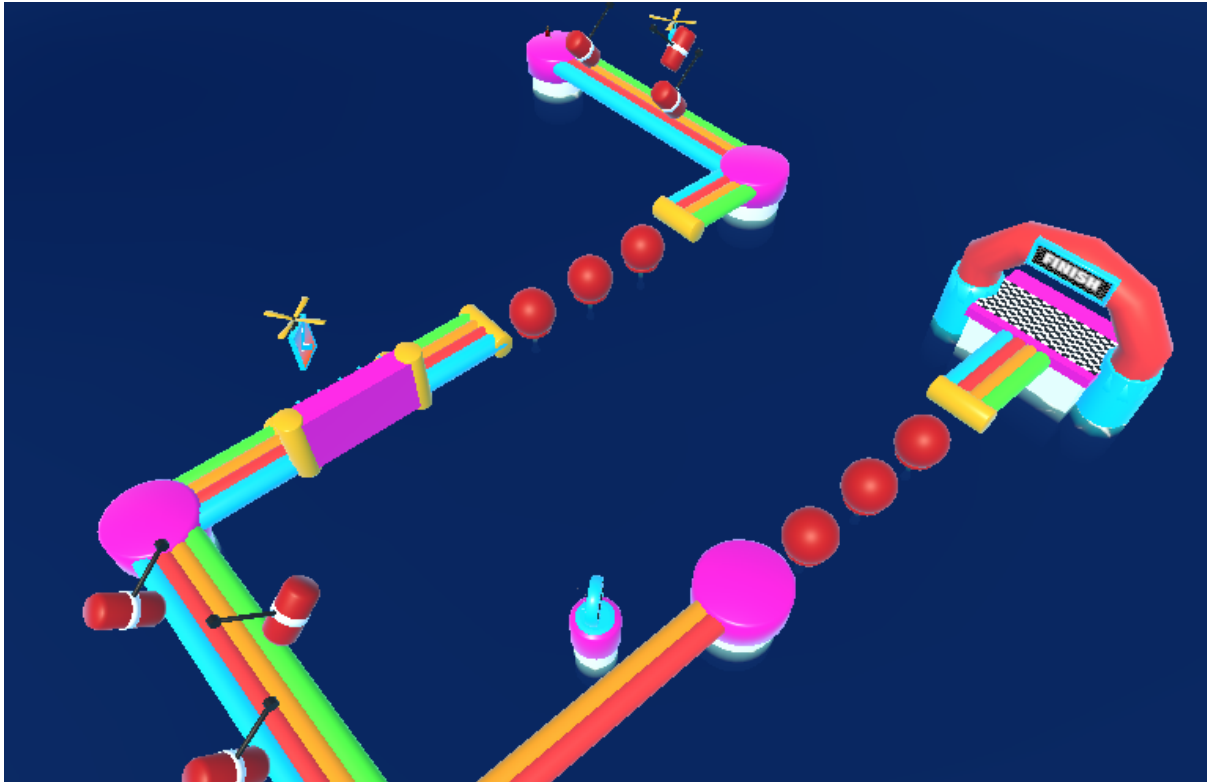


Figure 18: In-game image of the third level of my game, The Balancer.

The third level I have developed for VR Wipeout is The Balancer, this level will include the turbine obstacle, the wrecking ball obstacle, and the pendulum obstacle. The aim of the course is to traverse the level using the bouncing balls without being knocked off the level by the other obstacles. The course challenges are to complete the course without using the respawn feature, collect the hidden VR Wipeout Token and to complete the course in under two minutes and fifteen seconds using the interactable objects in the course. The reason I chose to develop this level was I wanted to include a level which uses the climbing feature I worked on and allows the player to fully try out the interactable features of the game.

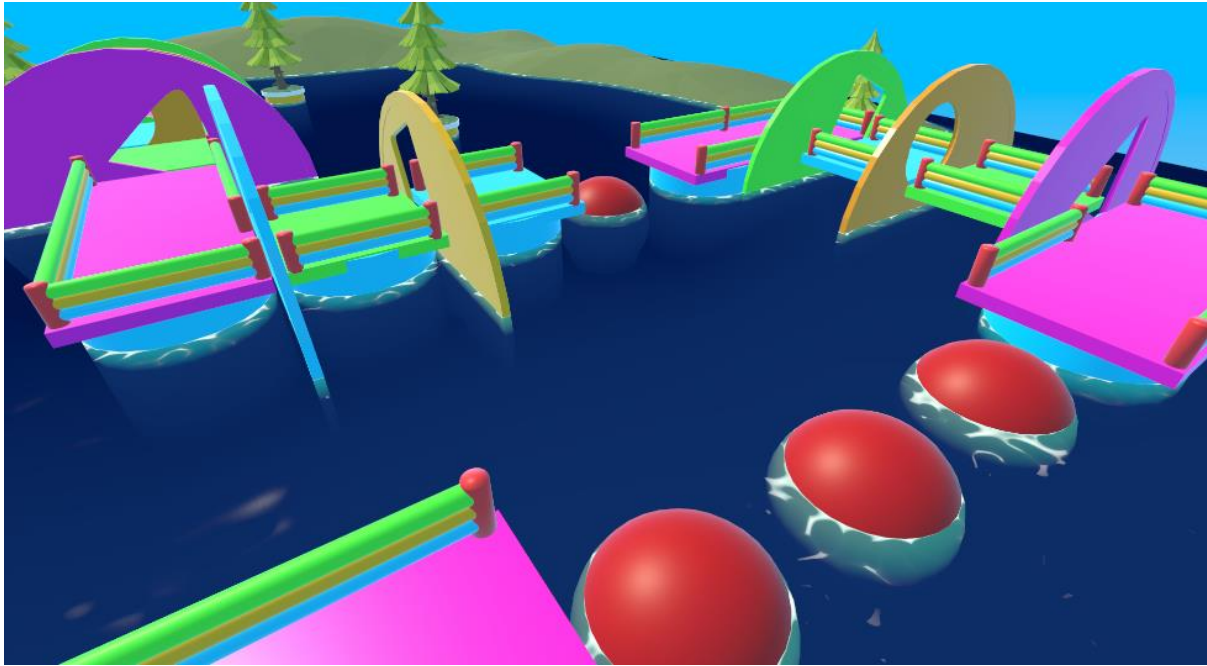


Figure 19: In-game image of the fourth level of my game, The Impersonator.

The fourth and final main level of VR Wipeout is The Impersonator, this level will include the hole in the wall obstacle and the bouncing balls feature I have been working on, the aim of the course is to traverse the course, fit the player through the hole in the wall obstacles, and use the bouncing balls to traverse to the next platform. The course challenges are to find the hidden VR Wipeout token, finish the course in under two minutes thirty seconds, and to complete the course without using the respawn feature. The reason I chose to develop this level was that I wanted to include a hole in the wall style course due to the concept being popular in most well-known assault courses and that the concept could be used in a unique way for VR. Before the player can choose to play the levels, I have discussed in this section, they can try out the tutorial level I have worked on to understand the core mechanics of the game, I will be discussing this level in the next section.

7.6 - Tutorial

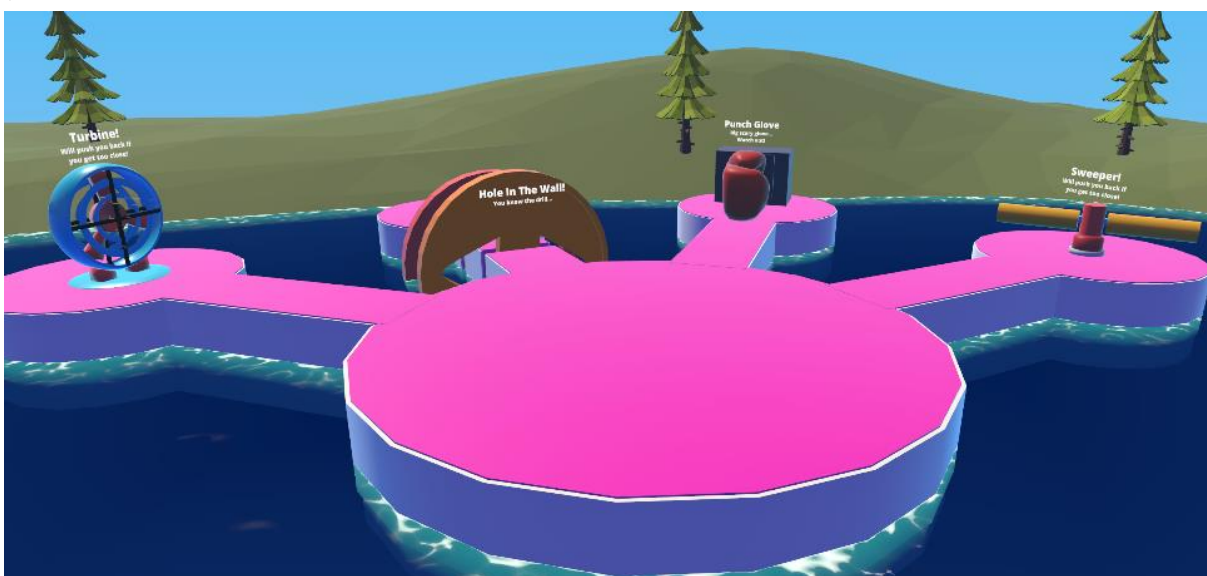


Figure 20: In-game image of the tutorial level I have worked on.

When playing VR Wipeout, players will have the opportunity to complete a tutorial level of the game before they try out the main four levels and multiplayer feature, the aim of this level is teaching the player the controls and how to interact with the world of VR Wipeout. When developing VR Wipeout, I chose to include a tutorial level to showcase the features I will be showing off for a number of reasons: I wanted to showcase all the things VR Wipeout has to offer to the player, I wanted to design a way that can teach the player how to use the mechanics of the game in a unique way, I did not want to force them down a linear path and finally the tutorial will be a way to help new users of the VR technology into the game. The level will include all the obstacles I have been developing for the game. When designing the levels, I chose to keep the tutorial and multiplayer levels similar, this reason being because the players can join a multiplayer session together and try out the mechanics, they have previously learnt in the tutorial together in the multiplayer session, I will be discussing how I designed the multiplayer level and was able to incorporate the feature into my game in the next section.

7.7 - Multiplayer

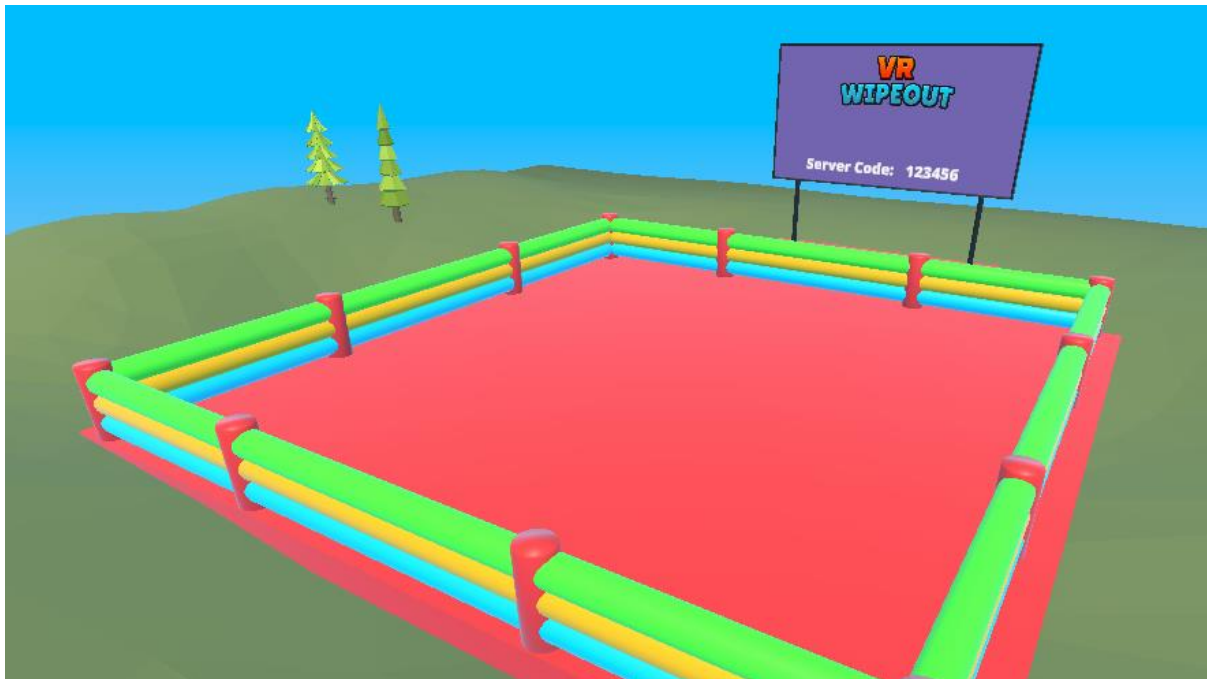


Figure 21: In-game image of the Multiplayer level.

The purpose of the multiplayer level was to showcase how I can incorporate a multiplayer component into my product, VR Wipeout, to showcase how I was successful in delivering this feature in the project, I have developed a short level where users can interact with each other. Before players enter the level, they can choose to either host a game or join a game using a room code, I developed this process to be as simple and user friendly as possible as one of my main objectives of the game is to make VR Wipeout as user friendly as possible. To incorporate the multiplayer feature into the game, I chose to use the Photon Networking package on the Unity asset store, also known as PUN2, I was successful in utilizing the package in my project to create my multiplayer component. I have attached a code snippet below showcasing how I was successful in setting up the feature to create custom room sizes before launching the level.


```

0 references
public void CreateGame()
{
    if (PhotonNetwork.IsConnected)
    {
        PhotonNetwork.CreateRoom(CreateGameInput.text, new Photon.Realtime.RoomOptions() { MaxPlayers = 8 }, null);

        multiplayerManager manager = FindObjectOfType<multiplayerManager>();
        manager.Roomcode = JoinGameInput.text;
        manager.Username = UsernameInput.text;
    }
}

0 references
public void JoinGame()
{
    if (PhotonNetwork.IsConnected)
    {
        Photon.Realtime.RoomOptions roomOptions = new Photon.Realtime.RoomOptions();
        roomOptions.MaxPlayers = 4;
        PhotonNetwork.JoinOrCreateRoom(JoinGameInput.text, roomOptions, default);

        multiplayerManager manager = FindObjectOfType<multiplayerManager>();
        manager.Roomcode = JoinGameInput.text;
        manager.Username = UsernameInput.text;
    }
}

```

Figure 22: Code snippet of how I achieve my multiplayer component.

8 - Development Milestones

8.1 - Sprints

Sprints are short periods of time, where you work to complete a set amount of development on a project, in team projects sprints are run by a Scrum Master, these sprints are an important of scrum and agile methodologies. The reason I choose to use sprints during my project is because sprints make project development more manageable due to planning a set amount of work for each sprint and sprints allow for flexibility to adapt to change and errors easily during development. I use sprints in my project by establishing a two-week time frame for each sprint, planning what tasks I will be completing in the sprint, set the priority of each task, assign the tasks with start and end dates to allow myself to plan out my workflow efficiently and accordingly to the current sprint in progress. I use priority levels in my sprints to determine how important a given task is, the levels of priorities go as follows: low – not an important task but still needs completion, medium – an average task what needs completion on time and high – an important task what will need time for planning and is a necessity to the project at the given time. I include here a summary of each sprint I have completed in the project and described what I did on that sprint, for the full sprint documents, see Appendix 5.

- Sprint Zero:
 - For this sprint, I worked on preparing the unity project for development, this included setting up the correct VR plugins and connected the project to my Github to support version control. In this sprint I also worked on a simple movement script for the player to move around a level.
- Sprint One:
 - For this sprint, I worked on a template for my final report and completed some word documents including my questionnaire results, referenced in Appendix 2 and research into motion sickness. In this sprint, I worked on improving the grabbing mechanics on objects and implementing hand animations.
- Sprint Two:
 - For this sprint, I worked on my first two obstacles of the game, the wrecking ball and the sweeper using Unity's physics system and blender for the modelling. In this sprint, I also worked on getting feedback for my first testing session and started to add Word documents to my final report.

- Sprint Three:
 - For this sprint, I worked on my third obstacle of the game, the pendulum using Unity's physics system and blender for the modelling, I also worked on a player watch to display the UI. In this sprint I also worked on my games design document (GDD), as shown in Appendix 4, and researched assault course background.
- Sprint Four:
 - For this sprint, I worked on the fourth obstacle of the game, hoop run using a simple rotation script I developed and blender for the modelling, I also worked on getting feedback for my second testing session. In this sprint, I was planning the menu and logo design of the game.
- Sprint Five:
 - For this sprint, I worked on improving the collisions in the game and implementing the player user interface, because of this sprint being in the Christmas holidays, I choose to give myself seven tasks for this sprint.
- Sprint Six:
 - For this sprint, I worked on implementing audio into the game, this included running audio and main menu audio, I also used this sprint to work on my fifth obstacle of the game, the turbine using Unity's raycast feature and blender for the modelling. In this sprint I also worked on some sections of my report and preparing for one of my testing sessions.
- Sprint Seven:
 - For this sprint, I worked on implementing the new menu design of the game, improving the turbine obstacle after feedback from the testing session and some sections of my report. In this sprint I also worked on the spinning spike obstacle and a physics-based bridge, using Unity's physics engine.
- Sprint Eight:
 - For this sprint, I worked on the cannon obstacle and implementing a jump feature, I also worked on a wall climbing mechanic for the player controller. In this sprint, I also worked on some sections of my report and trying out the new input system and OpenXR package from Unity.
- Sprint Nine:
 - For this sprint, I worked on the player model of the game, this included modelling the player using blender and applying the texture I made in photoshop, I also worked on some sections of my final report. In this sprint I worked on my project showcase submission and designing my first level.
- Sprint Ten:
 - For this sprint, I worked on improving the textures for the pendulum, wrecking ball, and the sweeper obstacles, I also worked on a zipline feature. In this sprint I also worked on some sections of my report and worked on my poster for the project showcase submission.
- Sprint Eleven:
 - For this sprint, I worked on creating the punch glove obstacle and the moving platform feature for my game, I also worked on implementing post processing effects and improving the textures of models.
- Sprint Twelve:
 - For this sprint, I worked on planning and development of the tutorial level, planned how I would design the landscape in all the levels and began developing the settings for the

accessibility side of my game. In this sprint I worked on some areas of my final report and worked on the scoring system in the game.

- Sprint Thirteen:
 - For this sprint, I worked on improving the overall graphics of the game, this included setting up occlusion culling and improving the overall lighting of the game. In this sprint I worked on the first two levels of the game, improving the user interface, and worked on some features of the multiplayer.
- Sprint Fourteen:
 - For this sprint, I worked on completing my final testing session for the project, this testing session was to showcase my final product and gain some feedback about peoples' impressions of the game in its final form. In this sprint, I also worked on bug testing and cleaning my code, I also inserted comments into my scripts to explain how the code works to anyone new to the project. Lastly, for this sprint I worked on the two final levels of my game and planned out the level challenges I will include in the final game.

8.2 – Feedback

To develop a great and immersive experience for my game, I implemented User Testing every month to gather feedback on my development so far and how I can improve on what I had developed, these User Testing sessions I will be carrying out are called VIVAs. For each VIVA I will present the current prototype I have so far and a Google form to fill out the questions based on the prototype, these questions will give me a clear indication of what users enjoy of my prototype and what I need to improve on, the feedback will be reviewed and will be used when planning the next sprint. Due to COVID-19 pandemic, I am unavailable to carry out my VIVAs in-person so I have accompanied the prototype feedback form with a video of the prototype being played, these videos will give users gameplay of my progress and the features done so far. I have included the results for each of the testing sessions I have carried out below, I have included the links to the testing sessions in Appendix 7.

8.2.1 - Project Feedback 1

Features Tested:	Player Movement, Player Crouch, Player Rotation, Player hands	
Question One:	What did you think about the Players Movement around the map?	4 / 5
Question Two:	What did you think about the crouching ability?	2 / 5
Question Three:	What did you think about the Rotation Mechanic?	3 / 5
Question Four:	What did you think about the Player Hands?	3 / 5
Features to Improve:	Crouching ability was hard to understand and use, rotation and players need general improvements.	
Features working Well:	The players movement was smooth and responded well with testing feedback.	

Figure 23: Showcasing the results from my first testing session.

8.2.2 - Project Feedback 2

Features Tested:	Highlight Feature, Pendulum, Sweeper, Wrecking Ball, Updated Camera Blur	
Question One:	What did you think of the Highlight Feature on Objects?	4 / 5
Question Two:	What did you think of the Pendulums?	3 / 5
Question Three:	What did you think of the Sweeper?	4 / 5
Question Four:	What did you think of the Wrecking Ball?	4 / 5
Question Five:	How would you rate the updated Camera Blur when Moving?	4 / 5
Features to Improve:	Improved Collisions between the Player and the Obstacles, User Interface, Camera Blur too dark	
Features working Well:	The Highlight feature, how the obstacles work so far	

Figure 24: Showcasing the results from my second testing session.

8.2.3 - Project Feedback 3

Features Tested:	Highlight Feature, Pendulum, Sweeper, Wrecking Ball, Updated Camera Blur	
Question One:	What did you think of the Highlight Feature on Objects?	4 / 5
Question Two:	What did you think of the new UI in game?	3 / 5
Question Three:	What did you think of the Distance Tracker?	4 / 5
Question Four:	What did you think of the Turbine?	4 / 5
Question Five:	What did you think of the Sprint Mechanic?	4 / 5
Features to Improve:	Sprint mechanic is okay but has minor bugs, the UI is okay but should be more VR Friendly	
Features working Well:	The Highlight feature has been improved, Turbine and Distance Tracker are good features in the game.	

Figure 25: Showcasing the results from my third testing session.

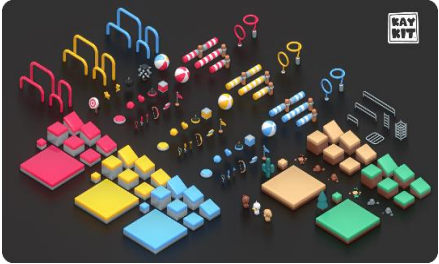
What do you think about the design above? Do you think it suits my product idea?	
	Yeah, looks good.
	Bright and cartoony, looks inviting and fun to play. It does suit the idea
	Yes, like the red stripey
	Perfect
	I like it, fits well
	They look good, think they are a good fit for the product
	Fun design, could be very visually pleasing
Can you imagine my game to be cartoon or realistic? Explain your reason below.	
I like both but maybe include post processing effects and lighting	
Bright vibrant colours give the game a cartoony feel	
Cartoon would be fun for kids	
I like either design for the game, but movement should be realistic	
Cartoon graphics but realistic movement	
A bit of both, movements are realistic, but the graphics and obstacles have cartoony visuals to them	
Cartoon but realistic movement	

Figure 26: Showcasing the results from my graphic design questions in the third testing session.

What do you think about the mode ideas? Do you like them or not? Please Explain Below	
<ul style="list-style-type: none"> Assault Course Complete a series of courses with different obstacles and challenges, reach the finish line in the fastest time possible! Endless Mode You are stuck on a moving platform, your task is to dodge the obstacles coming at you and survive if you can, based on subway surfers. Floor is Lava. Traverse through the level avoiding the Lava, there will be lava in your path so stay careful and avoid the lava 	Yes, good.
	Those game modes would add to the game, more game modes will lead to more people enjoying the game as they will have different preferences to game modes. Also increases the games play time as there are more than just the standard game mode.
	All the ideas could be decent if some properly
	I like the modes
	Nice
	Good, maybe add more
	Good, would like to see different types of the modes like Endless Mode has certain add-ons to get better score like skulls in Halo 3

Figure 27: Showcasing the results from the game mode question in the third testing session.

8.2.4 - Project Feedback 4

Features Tested:	Bridge using realistic physics, the new cannon obstacle, implementation of new jump mechanic, improved collision system.	
Question One:	What did you think of the Bridge Mechanics?	4 / 5
Question Two:	What did you think of Cannon Obstacle?	3 / 5
Question Three:	What did you think of the Jump Mechanic?	4 / 5
Question Four:	What did you think of the new collision system?	4 / 5
Features to Improve:	Jump mechanic is good but has a few bugs and does not work properly at times, the cannon model was imported correctly.	
Features working Well:	Collision system is smooth and major improvement to the game, other than the small bugs what have been noted, progress is going well.	

Figure 28: Showcasing the results from my fourth testing session.

8.2.5 - Project Feedback 5

Features Tested:	Post Processing, Punch Glove Obstacle, Moving Platforms, Tutorial Level	
Question One:	What did you think of the Post Processing Effects?	5/ 5
Question Two:	What did you think of the Punch Glove Obstacle?	3 / 5
Question Three:	What did you think of the Moving Platforms?	3/ 5
Question Four:	What did you think of the new Tutorial Level?	4 / 5
Features to Improve:	Moving Platform should have markers for where its going, Punch Glove should have a better design.	
Features working Well:	Post Processing is a great feature to the game, Tutorial level is good and easy to understand.	

Figure 29: Showcasing the results from my fifth testing session.

8.2.6 - Project Feedback 6

Features Tested:	Testing all the courses in the game including the Tutorial Level.	
Question One:	What did you think of the first level, Hill Dash?	4 / 5
Question Two:	What did you think of the second level, Mega-Sweep?	5 / 5
Question Three:	What did you think of the third level, The Balancer?	3 / 5
Question Four:	What did you think of the fourth level, The Impersonator?	4.5 / 5
Question Five:	What did you think of the Tutorial Level?	4 / 5
Overall Comments:	<ul style="list-style-type: none"> • Great game really enjoyed how you brought the VR tech into this genre of games! Cannot wait to see more in the future. • Great game, been very exciting to watch the development over the past few months. • Really good use of the VR technology implemented into a game like this, can understand how you use the technology to create this game while also thinking about accessibility. • Liked how you managed to implement physics in the game well, good work :) • Good use of technology, quite like how you managed to implement simple controls but still have a good game. 	

Figure 30: Showcasing the results from my sixth and final testing session.

8.3 - Project Initiation

As referenced in Appendix 1, for my first deliverable for the module, I was tasked to completing a project initiation document, this document was to identify the point of my project and where I want to develop this product for my final year project. The first part of the document was to assign my project with a title and a project vision, I choose the name of VR Assault Course for my project title, this name was changed later in development. For my project vision, I discussed the idea of focusing on accessibility in the game, making the game as simple and enjoyable to use for everyone, I would do this by adding settings to tailor the experience to the player. In my project vision I also discussed the idea of connectivity, I wanted to do this by adding a multiplayer feature to the game, I did not specify how multiplayer will work on the mechanics, I did explain how the multiplayer element will work in the game, this being that the multiplayer element will be split into three sections:

- Create a private room and be provided with a server code to share.
- Have a list of open rooms available to choose from.
- Randomly be placed into an open room.

To create the project vision, I aspired for in this document, I discussed the idea of separating the game into two stages of development, the first stage working on the VR implementation and mechanics of the game, the first stage will offer the players multiple levels with variations to compete in, these levels will include challenges depending on the type of level. The second stage was implementing the multiplayer mechanic into the game, due to the multiplayer feature being complex I set myself the goal of setting up a basic room with a room size of 4 and expanding on this feature depending on time constraints. I concluded the document with an initial risk plan detailing my risks I can imagine occurring during development and how I will combat them, I also concluded the document with keywords I believe are related to my project. This project initiation was a key milestone in the development of my product because it gave the reader a brief outline of what I am planning to achieve and how I will go about developing the product I aspire to make.

8.4 - Project Showcase

Later, in the development of my product, I was tasked with completing a poster to showcase for the module submission, this deliverable was important because this submission was a way to get good visibility with potential employers by showcasing the work, I have been doing for my final year project. The poster I was tasked to make was to be based on my project vision and provide a glimpse into the project I am working on; I was to provide images and information to provide the reader an indication into what I am developing. This submission was a key milestone in the development of my project because this was the first time, I was able to showcase my project so far and my aspirations for the project in a professional manner. I used my social platform, Twitter to showcase my poster, I discuss this in Appendix 6.



Figure 31: Showcasing my poster I used for my Project Showcase.

9 - Project Evaluation

9.1 - Method Evaluation

The first area of my project I will be evaluating is how I conducted the use of my methods in the project, the first use of my methods I will be evaluating is how I conducted regular user testing. I chose to do regular user testing as I wanted to get as much feedback as possible to help improve the quality of my project, despite the current global pandemic, I was successful in getting regular feedback on all areas of my game. Another use of my methods I will be evaluating were how I conducted my sprints, these sprints were made up of multiple tasks and conducted every two weeks, after completing the project I think my management of sprints and how I used them in my project was a success, I believe two weeks was good amount of time of sprints to be conducted because this amount of time was enough for me to complete tasks, including if I had any delays on tasks. Because of the sprints having a time period of two weeks and my use of regular user testing, I set myself the goal to complete a testing session every two sprints, this method gave me reassurance that I could get features I had been working on tested at the end of the month and avoid being held back.

Another use of my methods I will be evaluating is how I should have asked about game modes in earlier user testing sessions, if I did this, I would have been able to get a grasp for what people would like the end product to be instead of only focusing on what I had so far in development. I believe I should have been more open to questions and included sections in earlier testing forms to discuss what testers would like to see or give suggestions on big features of the game. Another use of my methods I will be evaluating is I took the time to research before starting development on the project, from the beginning of summer 2020, I knew I wanted to develop a VR game for my final year project, because of this I took the time to research the technology, the limitations of the technology and how I can apply this technology to knowledge I have already learnt at my time at university. I believe conducting research on all the technology I wanted to use before the project was a success and something I believe helped the development of the project by a lot.

Another use of my methods I will be evaluating is the use of Microsoft Planner in my project, although this project was the first time using the application, I have used similar applications in recent projects such as Trello, due to Microsoft Planner being similar to Trello, I was able to get to grips with the program and understand how to use it. During the development of the project, I was able to use Microsoft Planner to complete sprints and showcase the completion of each task with images of my work, I believe if I were to go about the project again, I would still use Microsoft Planner over Trello as my project management tool, this is because I believe Microsoft Planner is a more professional application to use over Trello. The final use of my methods I will be evaluating is the use of Google forms for my testing sessions, I chose to use Google forms as I have used the application for previous testing sessions on other projects, I believe if I were to go about the project again, I would use Google forms again as it was easy to use, and I was able to conduct successful testing sessions using the application and gather feedback without any issues. Overall, I believe I was successful with my methods during the development of the project, I did have some setbacks but overall, I believe I was successful in this section and will use this knowledge I have got after the project to improve my methods towards a project in the future.

9.2 - Technology Evaluation

The second area of my project I will be evaluating is how I conducted the use of my technology in the project, the first situation where I used my technology in my project is how I was able to integrate the use of gamepad/keyboard input as well as the Oculus motion controllers, this feature was implemented as part of one of my key objectives of the project, to allow for accessibility. Using previous knowledge of user input when using gamepad or keyboard, I was able to blend this knowledge with the coding I had previously completed for user input using Oculus controllers, although I was only able to set up general movement and not user interaction with objects or UI, I was successful in implementing user input other than the Oculus controllers. The next use of technology I will be evaluating in my project is how I was successful in understanding what motion sickness is, how it is caused and how I can implement features to reduce this, these features being the break feature I implemented and the camera vignette on the player at all times, both these features were developed based on research I carried out prior to the development of my project, I believe I was successful in understanding this limitation of VR and implemented successful ways to reduce this limitation from occurring.

The next use of technology I will be evaluating in my project is how I was successful when incorporating VR technology into my Unity project, the reason being is that I have taken the time to research how VR is used in Unity prior to developing the project, implementing the technology into the Unity project was simple but my main take back is how I was able to blend the knowledge I have from previous games projects with the VR technology I have implemented. The next use of technology I will be evaluating in my project is how I updated what version of Unity I was using halfway through development of my product, because of this I had issues with my work and had to import everything into a new project with the old version of Unity, this issue may sound small, but it jeopardised the current sprint I was on and I fell behind on work, because of this issue I know not to upgrade my version of Unity during a project. The final use of technology I will be evaluating in my project is that during the development of the project, I was learning the VR technology alongside this, although I did research of the technology and how it is used in game development, I did not have a hands-on experience myself. Because of learning the technology alongside the development of my product, I felt like I fell behind on sprints if the task I was currently doing was VR related and complex for my current understanding, although this issue will not come up in the future for other

projects using VR, I believe this use of technology was an issue for me in this project. Overall, I believe I was successful with my use of technology in my project, I did have some issues understanding the technology at first but overall, I believe I was successful in this section and will use this knowledge I have got after the project to improve my understanding of the included technology in this project towards a project in the future.

9.3 - Game Evaluation

The third area of my project I will be evaluating is the state of the game I have made, the first topic I will be evaluating in my final version of the game is how I used accessibility as a key focus in the game, I wanted to allow as many people as possible to enjoy the experience I am working on, because of this I worked on implementing other forms of input other than the Oculus hand controllers, I worked on implementing gamepad and keyboard input, although I was successful in implementing general movement with other forms of input, I was not able to include interaction features with the other forms of input, I have included a guide to the Oculus controls in Appendix 3. Another feature I implemented to improve my accessibility in my game was to implement a menu for custom settings, these settings can be tailored any way possible for the player's preference, making the game experience unique to them. Implementing these two features helped me improve the level of accessibility in my game and try to achieve my goal of making an enjoyable experience for anyone. Near the end of the development on the game, I encountered issues with the settings I have implemented, I was able to change some of the settings but other settings were not successful, I believe this was because I have not used PlayerPrefs before so I was unsure how to fix issues using the utility, although some of the settings did not work, I believe how I went about improving the accessibility of the game was successful, this PlayerPrefs issue also occurred with how I store player challenges.

The next topic I will be evaluating in my final version of the game is how I focused on implementing an immersive experience for the player, I believe I was successful in this area as I was able to implement the player's UI when competing in levels on a watch, instead of being static to the players camera, I also implemented a realistic crouch so if the player crouches in real life, he will crouch in the game. Other than those two features, I have implemented and worked on smaller features that have helped improve the immersion factor of my game. The next topic I will be evaluating in my final version of the game is how I developed the game to suit experienced VR players and people new to the technology, as one of my aims was to develop the experience for as many people as possible, I took the time to make sure anyone can enjoy the experience, I did this by working on a tutorial level to showcase how to play the game, experienced VR players may not need this but I believe people who are new to the technology will. Another feature I implemented to make the game suitable for all players is to make the game use simple controls, I worked on this using previous VR game controls, I believe I was successful in making the controls for the game as simple as possible but still enjoyable to use.

The next topic I will be evaluating in my final version of the game is that I was not successful in adding more courses or a game mode for mini games in the final version of the game, I was aiming to include some form of mini party games for players but I did not manage to implement this feature, this being because I was focusing my attention on making the player controller as smooth and enjoyable as possible without any issues, this topic will be improved in future development of the game. The last topic I will be evaluating in my final version of the game is that I chose to work on levels later on in development, because of this I did not have enough time to work on the levels, I

believe if I started developing levels earlier on in the project, I would have been able to create more levels for players to compete in instead of the four I am releasing with the final version of the game.

9.4 - Meeting Initial Objectives

In this section, I will go over the objectives I set myself at the beginning of the project and how I either met or did not meet these objectives in the final version of my game.

My first objective was to deliver a product that captures a successful game-loop, allowing the player to compete in multiple courses and a tutorial level, I believe I have met this objective, the reason to this is that I have managed to create a product that includes a successful game loop, I have created four courses for the player to compete and also worked on a tutorial level for the player to try out, I also went beyond this objective and made a simple multiplayer level to show I was successful in making a multiplayer feature in the game. The next objective was to explore the technology of VR being applied to an Assault Course game, I believe I have met this objective because I was successful in making four assault courses for the player to compete in, I developed these courses using the Unity game engine and VR technology to make an assault course game using VR technology.

The next objective I set myself at the start of the project was to create a physics-based VR game which is realistic for the player and the game environment, I believe I was successful with this objective as I have made multiple obstacles that all use Unity's physics engine, I made these obstacles realistic to the player and the game environment, despite some issues with collision detection near the end of the project, I was able to create all obstacles to include physics-based mechanics. The next objective was to create a great user experience which is accessible to all variations of players and keeps the same level of enjoyment depending on their preference, I believe I was successful in some parts of this objective, I was able to create a game that was enjoyable for all types of VR players, I was able to create game settings to help make the game unique to the player. I was able to implement general movement for the player using other forms of controller input, but I did not complete this feature as I was not able to implement interaction with UI and the world using other forms of controller input.

The final objective I set myself at the start of the project was to create a VR game which supports multiplayer technology and keeping the user-friendly experience, I believe I was successful in accomplishing this objective, I was able to create a user-friendly UI to either join or create a multiplayer session, this session is just a simple room with a server code for anyone to join. Although I was successful in completing this objective, I was not able to get user testing on the actual multiplayer feature, I believe this was due to the current COVID pandemic, I was not able to get access to other headsets to try out this feature. To conclude this section, I believe I was able to meet most of my objectives and develop a great, unique experience using VR technology, although I had some setbacks and completing this project during a global pandemic, I believe I was able to accomplish my objectives and use this project as an example of how VR can be implemented in a physics-based game and how you can create a VR experience for everyone.

9.5 - Improvements for Future Development

In this section I will recap what I have discussed in my evaluation and suggest improvements I believe I could implement on my project going forward. The first improvement is to stick with one version of Unity when working on a project, as discussed in the technology evaluation, I updated my project halfway through the year and because of this caused a great deal of issues for myself, I plan

to use one version of Unity for the entirety of the project until I have completed the project, or I move my work to another project. Another improvement I wish to implement in my project is to plan level design early on, because I focused on understanding the technology and implementing it with physics I was trying to achieve, I left my level design until the last minute, I believe if I gave myself more time to focus on level and design then I could have implemented more levels and improved the overall quality of the final product.

Another improvement I wish to implement in my project is test out the technology before starting the project, as mentioned in my technology evaluation, I was learning how to use VR alongside working on the project, although this issue will not happen again, I wish to acknowledge this when evaluating my project. Another improvement I wish to implement in my project is to continue to have regular user testing, although I did complete regular testing on my project, I was only focused on the features being tested, as mentioned in the method evaluation, I wish I took the time to ask about game modes, level design or similar features which could impact the project in a big way, this meaning I wish to improve what I ask when I continue to do regular testing. The final improvement I wish to implement in my project is to continue further development into other inputs for VR other than the hand controllers, as discussed in the game evaluation, I was successful in making the game be playable using gamepad or keyboard for general movement, I did not complete this feature for interacting with objects and UI, I wish to continue this as it is more accessible for people who have difficulties using the hand controllers. I believe the improvements I have listed above are justified for the progress I made on this project, this project started as a concept idea with the theory of "Imagine if you can play assault courses in VR", I have taken this concept and developed this project to say 'yes' to that theory. I wish to come back to this project with new knowledge and release this project commercially as I believe there is a place in the market for a product like this.

For installation of VR Wipeout, please reference Appendix 10 for installation guide.

10 - References

Association for Project Management, 2021. *What is agile project management?*. [Online]
Available at: <https://www.apm.org.uk/resources/find-a-resource/agile-project-management/>
[Accessed April 2021].

Atlassian, 2021. *What is version control?*. [Online]
Available at: <https://www.atlassian.com/git/tutorials/what-is-version-control#:~:text=Version%20control%2C%20also%20known%20as,to%20source%20code%20over%20time.>
[Accessed April 2021].

Common Sense Media, 2018. *Virtual Reality 101: What you need to know about Kids and VR*. [Online]
Available at:
https://www.commonsensemedia.org/sites/default/files/uploads/pdfs/csm_vr101_final.pdf
[Accessed May 2021].

Gandgadhara, P., 2019. *The Importance of User Experience Design*. [Online]
Available at: <https://uxplanet.org/the-importance-of-user-experience-design-988faf6ddca2>
[Accessed 15th January 2021].

Iberdrola, 2021. *Virtual Reality: another world within sight*. [Online]
Available at: <https://www.iberdrola.com/innovation/virtual-reality>
[Accessed May 2021].

Osborneclarke, 2016. *Age rating in Virtual Reality Environments*. [Online]
Available at: <https://www.osborneclarke.com/insights/age-rating-in-virtual-reality-environments/>
[Accessed April 2021].

Unity, 2021. *Locomotion*. [Online]
Available at:
<https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@1.0/manual/locomotion.html>
[Accessed May 2021].

Unity, 2021. *XR Interaction Toolkit*. [Online]
Available at:
<https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@1.0/manual/index.html>
[Accessed May 2021].

Wikipedia, 2021. *Assault Courses*. [Online]
Available at: https://en.wikipedia.org/wiki/Assault_course
[Accessed 14 December 2020].

Wikipedia, 2021. *Unity (game engine)*. [Online]
Available at: [https://en.wikipedia.org/wiki/Unity_\(game_engine\)](https://en.wikipedia.org/wiki/Unity_(game_engine))
[Accessed May 2021].

11 -Appendix

Appendix 1: Project Initiation:

Project Title: VR Assault Course

Links:

Source code: <https://github.com/DomSleightholme/VRAssaultCourse>

Backlog: <https://tasks.office.com/live.plymouth.ac.uk/en-US/Home/Planner/#/plantaskboard?groupId=ede08b4c-57ba-4b10-ac56-b1d5590a24ab&planId=1P6Wre24aEOzB8g9dachOJYABHmj>

Project Vision:

I want to develop a product for anyone who has played with or already owns a Virtual reality headset, the product is being developed to bring in a wider audience to take part in an immersive experience using the Virtual reality technology. I always imagined how it could be developed in VR and how the features of VR could be used to develop a fun and immersive experience from the comfort of your own home. As much as I want to develop a fun VR experience, I want to also focus on two points in the game; Accessibility and Connectivity.

When the COVID-19 pandemic hit, every aspect of life changed for people, I began to see people connecting with friends over social media and gaming, since I am wanting to develop an experience where you feel like you are experiencing it in real life, including multiplayer into my game would support the feeling of completing actives with friends and family! Accessibility is a key point for my project as I want to allow as much people as possible to enjoy the project, my plan is to add features for players to adjust to fit their experience to suit them.

This project will have a working title called VR Assault Course, the game offers a virtually immersive experience in completing assault courses and dodging extreme obstacles, the project will have two stages of development; the first stage will focus on the mechanics and single player aspect of the game, the second stage will focus on the multiplayer aspect of the game allowing connectivity. For the first stage of development, I will be focusing on the core mechanics of VR and the single player aspect of the project, for the second stage of development I will be focusing on the multiplayer aspect on the project and implementing easy functionality for connectivity. For the single player part of the project, there multiple levels with variations, you will be rewarded with badges for completing depending on competition time, if they completed the level successfully and if they completed the level challenges.

Using Photon Unity Networking (PUN) version two, a Unity package for multiplayer games. After doing research I will be enabling multiplayer access by using the free package of PUN 2 as it has all the features as the paid packages except the amount of player, I can have running. For this style of game, I will be using the PUN 2 package to create 'rooms' for players to play in, these rooms will have a variety of options to use and modify. I will be designing the multiplayer to allow users to have three different options of enjoying my multiplayer experience:

- Create a private room and be provide with a server code to share.
- Have a list of open rooms available to choose from.
- Randomly be placed into an open room.

As multiplayer can be a complex thing to achieve, I will be working on have a max room size of 4 with plans to increase the size depending on progress on the game and networking in the game.

Risk Plan:

Ref	Event	Probability	Impact	Solution
R1	Project testing demonstrates errors or deficiencies in design.	Moderate	Moderate	Regularly complete Unit Testing and User Feedback.
R2	Project files becoming corrupted and unusable.	Low	Significant	Use a Git Repository to regular commit files and data.
R3	Changes to requirements specification during development.	Moderate	High	Review specification with supervisor and amend changes.
R4	Due to COVID, there is another national lockdown.	Moderate	Low	Due to having equipment needed at home, this will not influence project progress.
R5	When playing the project, motion sickness becomes a common flaw of the project.	Moderate	High	Implement methods to avoid this issue early in development.
R6	Fall behind on project deadlines or module submissions.	Low	Significant	Maintain Agile methodology on project to avoid missing targets.
R7	Specification takes longer than expected.	Moderate	High	Review project specification with supervisor to work out what went wrong.

Keywords:

- VR
- Virtual Reality
- Unity3D
- Blender
- Multiplayer
- Immersive
- Connectivity
- Accessibility
- Assault Course
- Fun
- Colourful

- Bright

Appendix 2: Questionnaire

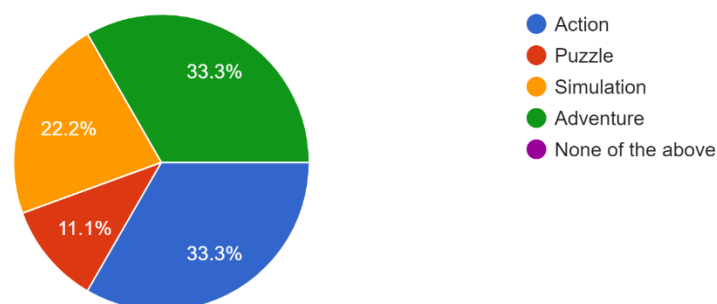
Before I began development on my project, I wanted to collect some data on the general public's knowledge on VR and how this technology is applied in Video Games, this feedback would support my project because it will give me feedback from casual gamers, hardcore gamers and people who do not play video games. For the questionnaire I shared, I divided my questions into three sections: General Knowledge, VR in Video Games and Final Thoughts, these sections would each give myself enough information on their perception on VR.

The first question of this section was "How often do you play Video Games a week?", I wanted to get an understanding at the beginning of how much time the people who took this questionnaire spend playing games for. The results of this question were very balanced overall, 22.2% of people play for 0-5 hours, 10-20 hours and 20 or more, the biggest percentage in hours played was 5-10 hours which came to 33.3%. I went on to ask "If you play Video Games? What system do you use to play?", overall 55.6% of people choose PC as their gaming system, the least amount of chosen responses was the Nintendo Switch and Playstation with 22.2% of people choosing these two systems. Further on, I asked the question "Have you ever used VR before?", overall 66.7% of people chose yes as their response, 33.3% of people chose no as their response. To end this section I asked people "Do you know any games which use VR?", the most mentioned game was Superhot, this game is a VR FPS where time moves only when the player moves.

In this section I wanted to get an insight of people's perception of VR when applied in Video Games, my first question being "Which genre would you be most interested in trying in VR?", overall 33.3% of people chose adventure and action as their responses, 22.2% of people chose the simulation genre and lastly 11.1% of people chose puzzle as their chosen genre. I went on to ask in the questionnaire "Would you prefer the option to play VR sitting down or standing up?". Overall 77.8% of people chose standing as their option whereas 22.2% of people chose sitting down. I was interested in what people thought about for controlling the game so I asked "Do you think players would like to use different controllers to play VR games other than the VR hand controllers?" Overall most people said yes to other controllers compared to only using VR controllers.

Which genre would you be most interest in trying in VR?

9 responses



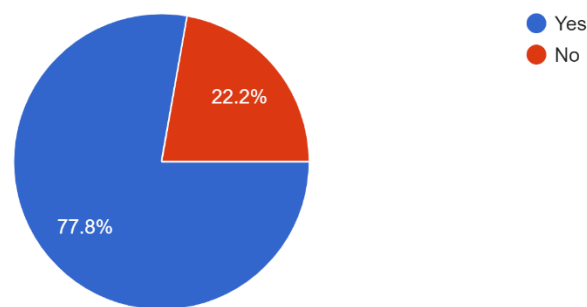
In this section, I wanted to get people's opinion on a way to reduce motion sickness in my game so I asked "VR is known to cause motion sickness to players after using VR for long periods of time, do

you think there should be prompts to tell them to take a break?” overall 77.8% of people said yes to having in-game prompts whereas 22.2% of people said no. I went on to ask people “What game options do you think should be included to make a VR game as accessible as possible?” There were a lot of ideas suggested to improve VR accessibility, these features were;

- Colourblind Settings
- Reduce Field of View when movement is applied
- Motion Blur Options

VR is known to cause motion sickness to players after using VR for long periods of time, do you think there should be prompts to tell them to take a break?

9 responses



Laslty in this section, I went on to ask people “If you could develop any game which uses VR technology, what would it be?” I got a lot of great game suggestions which adopts VR functionality, some of them being;

- Halo
- Fallout 76
- Something like an Escape Room
- Call Of Duty
- Superhero Game
- Horror/Atmospheric
- It’s a Knockout
- Animal Crossing
- Black and White 3

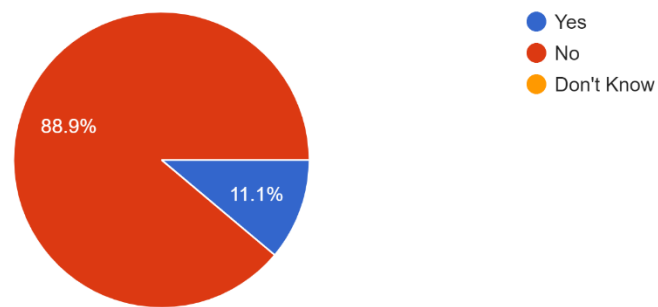
Final Thoughts:

For my final section, I asked people “Do you believe the VR headset is more successful than previous accessories (such as Kinect and PS Move)? Overall 77.8% of people chose yes as their response, 11.1% of people chose either no or don’t know as their responses. I followed up on my previous

question with “Do you believe that VR is a just a short term phase in gaming?” overall 88.9% of people chose no as their response and 11.1% people chose yes as their response. In this section, I went on to ask “Do you believe VR is worth the investment to improve your gaming experience and why?”. Overall people said yes to this question but some common points came up, these points being that VR is expensive to the casual gamer, VR hasn’t got anything game changing just yet but maybe in the future and VR shouldn’t be an investment if it causes motion sickness. I finally ended the questionnaire with this question “Have you ever wanted to try an assault course and if so why?”. Overall people said that they would like to try an assault course, one answer mentioned that an assault course would be cool in VR.

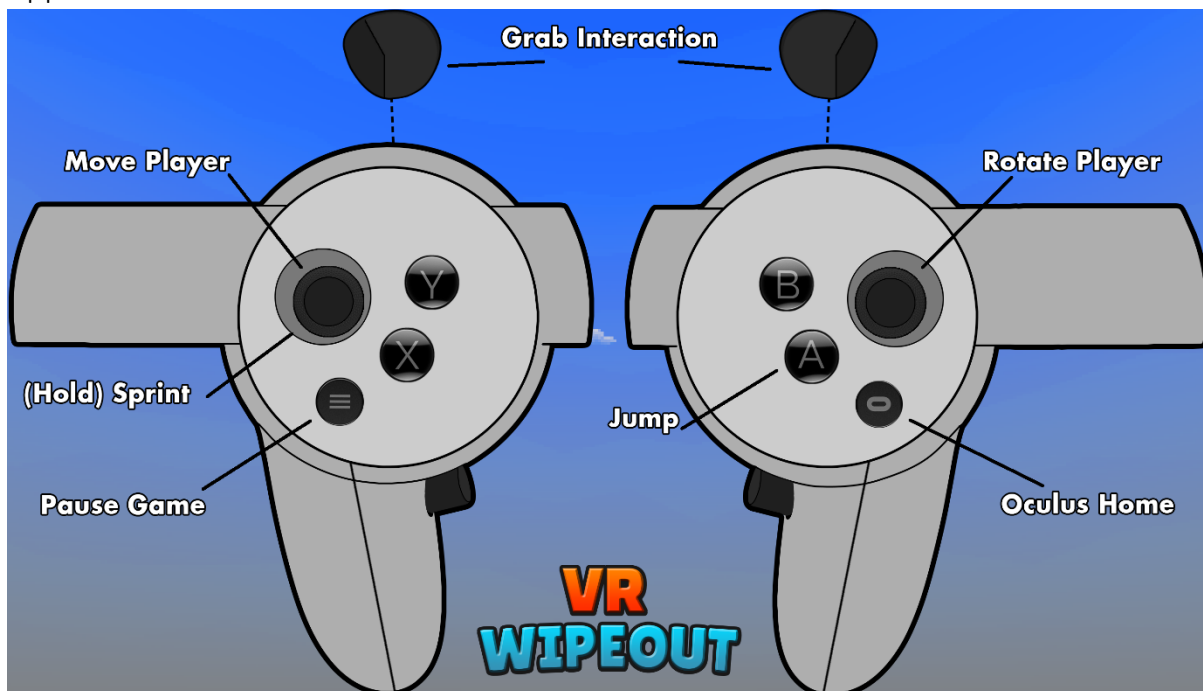
Do you believe that VR is just a short term phase in gaming?

9 responses



After reviewing the feedback from the questionnaire, I would like to thank the people who filled in the feedback, the data given was a great insight into what people’s perception was in VR and how the technology is applied into games. One of the common points brought up in the paper was that VR is expensive, personally I believe that VR is expensive for the casual gamer but for gamers who want a truly immersive experience, this technology is perfect for games immersion.

Appendix 3: Controller Scheme



Appendix 4: GDD

Project Title: VR Assault Course

Author: Dom Sleightholme

Email: dominic.sleightholme@students.plymouth.ac.uk

Links:

- Source Code: <https://github.com/DomSleightholme/VRAssaultCourse>
- Project Backlog: <https://tasks.office.com/live.plymouth.ac.uk/en-US/Home/Planner/#/plantaskboard?groupId=ede08b4c-57ba-4b10-ac56-b1d5590a24ab&planId=1P6Wre24aEOzB8g9dachOJYABHmj>

1. Introduction:

For my final year project, I am planning on developing a virtual reality (VR) assault course game based on the popular tv shows, Total Wipeout and Takeshi's Castle. The main purpose of the game will be focusing on how the VR technology can be implemented in a way I am currently working towards; the player will experience all the types of events and obstacles that assault courses have to offer like humongous wrecking balls or dodging pendulums with water spraying at you. My main aim is to develop a series of fun and exciting levels which have tons of variations in them varying from obstacles and environments for the player to experience.

2. Scope:

I want to develop a product for anyone who has played with or already owns a Virtual reality headset, the product is being developed to bring in a wider audience to take part in an immersive experience using the virtual reality technology. I always imagined how it could be developed in VR and how the features of VR could be used to develop a fun and immersive experience from the

comfort of your own home. When the COVID-19 pandemic hit, every aspect of life changed for people, I began to see people connecting with friends over social media and gaming, since I am wanting to develop an experience where you feel like you are experiencing it in real life, including an experimental multiplayer feature into my game would support the feeling of completing activities with friends and family! Accessibility is a key point for my project as I want to allow as much people as possible to enjoy the project, my plan is to add features for players to adjust to fit their experience to suit them.

3. Target Platforms:

I will be using the Oculus Rift S for my development platform and one of the main target platforms for my game, the headset uses desktop components to present the games graphics to the headset, because of this the headset must be connected to a desktop with suitable specifications to enjoy the virtual experience. I will be developing the graphics to be simplistic and colourful, because of this I could present my game on the wireless VR headsets such as the Oculus Quest 2 which is a wireless device.

4. Development Software:

- Engine Software:

For the engine software, I will be using Unity3D to complete development on my target project, Unity3D is a cross-platform game engine developed by Unity Technologies, the software was first announced and released in June 2005 at the Apple Worldwide Developers conference as a Mac exclusive game engine but got extended to over 25 platforms in 2018. I am using Unity3D as my engine software for my project as it has a great XR interaction toolkit which is updated regularly with exciting new VR and AR technology, a necessity for what I am trying to develop.

Program Link: <https://unity.com/>

- Programming Software:

For the programming software, I will be using Visual Studio to complete the programming side of my project, Visual Studio is an integrated development environment from Microsoft, the software is used to develop computer programs, websites, apps and much more! I will be using Visual Studio for my chosen programming software as it is integrated with Unity3D as a coding platform already and I have the most experience using this programming software, using the previous knowledge I have of the software, I can use this knowledge to develop a fun and exciting VR experience.

Software Link: <https://visualstudio.microsoft.com/>

- Artwork Software:

The first software I will be using to complete my artwork for my project will be Blender, the software is a free and open-source 3D computer graphics software toolset used for creating three-dimensional graphics. I want to use Blender as one of my artwork software applications as Blender is a great tool to developing 3D models for my game and I currently have the most experience in Blender compared to most 3D modelling software. The second piece of software I will be using for the artwork of my game will be Photoshop, this software is a raster graphics editor developed and published by Adobe Inc. I will be using Photoshop to design and create all the 2D artwork for my game, I have chosen to use Photoshop for the 2D artwork because the software is user friendly, easy

to edit images using the in-house features and that I have the most experience using the software compared to other 2D editing software.

Photoshop Link:

https://www.adobe.com/products/photoshop.html?sdid=KKQIN&mv=search&kw=photoshop&ef_id=Cj0KCQjw16KFBhCgARIsALB0g8IF2qRR2sf7VySFaOC0KyRgnpefly2ZeD3YfHCyFGG_OQtDtRiR0saAmh2EALw_wcB:G:s&s_kwcid=AL!3085!3!442365416141!e!!g!!photoshop&gclid=Cj0KCQjw16KFBhCgARIsALB0g8IF2qRR2sf7VySFaOC0KyRgnpefly2ZeD3YfHCyFGG_OQtDtRiR0saAmh2EALw_wcB

Blender Link: <https://www.blender.org/>

5. Specification:

The game will be separated into two modes to compete in, these modes being.

- Free play: Players compete in levels varying from different environments and obstacles to face to complete challenges and beat time records, completing levels will give the player access to more levels to choose from.
- Multiplayer: This is an experimental mode to test the multiplayer functionality in a VR game, this mode will let players either join a lobby using a code or let players host their own lobbies.

Players will take part in a variety of levels in different environments to complete assault courses tailored to the VR experience. Players will complete assault courses to complete challenges, these challenges will vary depending on the level environment and difficulty of the level, I want players to keep playing levels they had previously completed to get better scores or complete the level in a faster time overall.

6. Graphics:

For the graphics of my target game, I want to design the graphics to be as simplistic but still be fun and engaging. I am working on making the product bright and colourful but have simple graphics so I can release the product on as many VR systems as possible. For the style of graphics for my game, I will be taking inspiration from games such as Team Fortress, Surgeon Simulator 2, and Hot Lava. All the games I am using as inspiration for my game do not have triple A graphics but have fun and unique graphics which consumers enjoy just as much as the average triple A games. To achieve my end goal for having the game run on as many VR devices as possible, trying to achieve fun and exciting graphics but also have great FPS is a necessity in the later stages of development.



7. Hardware:

The main hardware for my game will be the Oculus Rift S, this piece of hardware is a virtual reality headset developed by Oculus VR and Lenovo, the headset was released on March 20, 2019. The headset comes with two 2nd generation Oculus Touch motion tracked controllers and integrated speakers in the headset, to connect the headset to a desktop, the Oculus headset uses DisplayPort 1.2 and USB 3.0. The main selling point of my game is that the game is developed and played in VR only, the Rift S allows me to create a fun and immersive experience using the hardware power of both the headset and the desktop I am using. If possible, I want to try and use other VR headsets which do not use the supported desktop power to play the game.

8. External Resources:

One of the external resources I will be using to complete my game is the XR Interaction Toolkit package in Unity, the package is a high-level, component-based interaction system used for VR and AR development in games, I will be focusing on the VR aspect of the package. The package provides the framework for VR interaction with 3D objects or UI elements available from Unity input events, the package also allows the framework for controlling characters movement around an environment. The Interaction Toolkit will be used for all the interaction elements of my VR player controller and how the controller will interact with the world I am developing, I will be using the package for basic VR implement, then I will further improve on with my own development and learning of VR implementation in games.

Developed by Sigtrap, VR Tunnelling Pro is a Unity package which improves VR movement and reduces the risk of motion sickness by reducing player's peripheral vision when movement is applied to the player. This technique in the package, is used in VR games to reduce motion-sickness. The package offers a large variety of options to fit the VR tunnelling into the game easily, this feature of my game will be tested regularly to find the best possible settings for all players!

XR Interaction Toolkit Documentation:

<https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@0.9/manual/index.html>

VR Tunnelling Pro Documentation:

<http://www.sigtrapgames.com/VrTunnellingPro/html/index.html>

Appendix 5: Sprints

Appendix 5.1: Sprint Zero

Task	Priority	Start Date	End Date	Status
Prepare Project files on Local Devices and Git	Low	5/10/20	7/10/20	Completed
Hand out questionnaire to gain feedback on public's perception to Virtual Reality	Medium	5/10/20	8/10/20	Completed
Develop Script to allow Continuous Movement for the Player	High	5/10/20	7/10/20	Completed
Design Documentation Templates to support Agile Methodologies	Medium	5/10/20	9/10/20	Completed
Use Unity based Scripts to Develop Camera Movement and Grabbing Interactions	High	5/10/20	6/10/20	Completed
Refine Camera Movement to feel fully Immersive	Low	8/10/20	12/10/20	Completed
Refine Player Movement to feel fully Immersive	Low	8/10/20	12/10/20	Completed
Create Project Backlog on Office Planner	Medium	6/10/20	8/10/20	Completed
Develop initial Prototype of Concept so far	High	5/10/20	12/10/20	Completed
Write up Project Risk Plan	Medium	9/10/20	12/10/20	Completed
Complete Project Initiation Document	Medium	9/10/20	15/10/20	Completed
Develop Prototype Map to display VR Movement	High	9/10/20	11/10/20	Completed

Appendix 5.2: Sprint One

Task	Priority	Start Date	End Date	Status
Complete Write Up for Questionnaire Results	Medium	28/10/20	1/11/20	Completed
Implement Camera to Reduce Motion Sickness	High	21/10/20	25/10/20	Completed
Research into Motion Sickness	Medium	21/10/20	26/10/20	Completed
Improve Grabbing Mechanics	Medium	26/10/20	28/10/20	Completed
Begin Final Report Template	Low	26/10/20	1/11/20	Completed
Develop First VIVA Prototype for Movement	High	29/10/20	1/11/20	Completed
Improve Project Backlog with Comments and Checklists	Low	26/10/20	30/10/20	Completed
Complete Project README on Projects Repo	Low	19/10/20	20/10/20	Completed
Optimize Current Project Files	Medium	23/10/20	25/10/20	Completed
Replace Current VR Hands with Animations	Medium	21/10/20	23/10/20	Completed
Start Drafting UI Ideas and Design	Low	28/10/20	1/11/20	Completed

Appendix 5.3: Sprint Two

Task	Priority	Start Date	End Date	Status
Create Wrecking Ball Model	Medium	2/11/20	4/11/20	Completed
Implement Wrecking Ball into Game	Medium	5/11/20	7/11/20	Completed
Draft Material Designs for Objects	Medium	2/11/20	10/11/20	Completed
Add Highlight Function to Objects	Medium	9/11/20	10/11/20	Completed
Get User Feedback on Initial Viva	High	1/11/20	6/11/20	Completed
Create Sweeper Model	Medium	11/11/20	13/11/20	Completed
Implement Sweeper into Game	Medium	13/11/20	15/11/20	Completed
Start Rough Idea of Main Menu	Low	14/11/20	15/11/20	Completed
Add Previous Write Ups to Main Report	Medium	9/11/20	10/22/20	Completed
Write Up Initial Viva Feedback	Medium	6/11/20	9/11/20	Completed
Implement Sound Asset for Grabbing Interaction	Low	11/11/20	12/11/20	Completed

Appendix 5.4: Sprint Three

Task	Priority	Start Date	End Date	Status
Create Game Design Document (GDD)	High	16/11/20	28/11/20	Completed
Improve Game FPS	Medium	16/11/20	28/11/20	Completed
Improve Motion Blur Settings	Medium	18/11/20	20/11/20	Completed
Create Technical Design Document (TDD)	High	20/11/20	29/11/20	Completed
Create Pendulum Model	Medium	20/11/20	21/11/20	Completed
Implement Pendulum Model into Unity	Medium	21/11/20	22/11/20	Completed
Assault Course Background	Medium	23/11/20	25/11/20	Completed
Create Player Watch	Low	24/11/20	25/11/20	Completed
Implement Player Watch into Unity	Low	26/11/20	27/11/20	Completed
MVP, MVE, MAP	Medium	27/11/20	29/11/20	Completed
Develop VIVA Prototype	High	27/11/20	29/11/20	Completed

Appendix 5.5: Sprint Four

Task	Priority	Start Date	End Date	Status
Get User Feedback on Second VIVA	High	30/11/20	4/12/20	Completed
Writing GDD after Feedback	Medium	2/12/20	4/12/20	Completed
Final Report: Overview Section	Medium	30/11/20	2/12/20	Completed
Distance Left Feature Implemented	Medium	30/11/20	2/12/20	Completed
Level Timer Implemented	Medium	3/12/20	4/12/20	Completed
Write up Second User Feedback	High	5/12/20	6/12/20	Completed
Hoop Run Modelled	Medium	7/12/20	8/12/20	Completed
Hoop Run Implemented	Medium	9/12/20	10/12/20	Completed
Pause Menu	Medium	10/12/20	11/12/20	Completed
Decide on Menu Design	Low	12/12/20	13/12/20	Completed
Decide on Logo	Low	12/12/20	13/12/20	Completed

Appendix 5.6: Sprint Five

- This sprint is will be short as I will be taking time off for Christmas

Task	Priority	Start Date	End Date	Status
Improve Collisions	High	14/12/20	16/12/20	Completed
New Input System Set Up	Medium	15/12/20	17/12/20	Completed
Start Designing Main Menu	Medium	18/12/20	19/12/20	Completed
Replace Line Renderer on Objects	Medium	18/12/20	19/12/20	Completed
Comment Code Existing Scripts	Low	19/12/20	20/12/20	Completed
Player UI Art Started	Low	20/12/20	21/12/20	Completed
Improve Running Set Up	Medium	20/12/20	22/12/20	Completed

Appendix 5.7: Sprint Six

Task	Priority	Start Date	End Date	Status
Implement Main Menu Audio	Low	28/12/20	29/12/20	Completed
Implement Running Audio	Low	28/12/20	29/12/20	Completed
Competitor Analysis	Medium	28/12/20	30/12/20	Completed
Loading Screen	Medium	29/12/20	30/12/20	Completed
Restart after Pause Functionality	Medium	30/12/20	31/12/20	Completed
Improved Running on Other Controllers	Medium	2/1/21	4/1/21	Completed
Level Selection Design	Medium	2/1/21	4/1/21	Completed
Implement Scene Transition	Medium	5/1/21	6/1/21	Completed
Project Management Tools	Medium	5/1/21	7/1/21	Completed
Turbine Modelled	Medium	7/1/21	8/1/21	Completed
Turbine Implemented	Medium	8/1/21	9/1/21	Completed
Develop VIVA Prototype	High	9/1/21	10/1/21	Completed

Appendix 5.8: Sprint Sevan

Task	Priority	Start Date	End Date	Status
Plan New Menu Design	Low	25/1/2021	26/1/2021	Completed
Improve Turbine	High	25/1/2021	27/1/2021	Completed
Implement new Menu Design	Low	27/1/2021	29/1/2021	Completed
Report – Project Management	Medium	27/1/2021	28/1/2021	Completed
Bridge Modelled	Medium	29/1/2021	30/1/2021	Completed
Bridge Implemented	Medium	30/1/2021	31/1/2021	Completed
Itch.io Page Development	Low	31/1/2021	1/2/2021	Completed
Logo Design	Low	1/2/2021	2/2/2021	Completed
Improve Collision Detection	High	1/2/2021	3/2/2021	Completed
Plan some Levels	Medium	3/2/2021	4/2/2021	Completed
Spinning Spike Modelled	Medium	3/2/2021	4/2/2021	Completed
Spinning Spike Implemented	Medium	5/2/2021	6/2/2021	Completed
Write up VIVA Three Feedback	High	6/2/2021	7/2/2021	Completed
Add all Completed Documentation to Report	Medium	6/2/2021	7/2/2021	Completed

Appendix 5.9: Sprint Eight

Task	Priority	Start Date	End Date	Status
OpenXR Set Up	High	8/02/21	10/02/21	Completed
Input System Revamped	High	10/02/21	11/02/21	Completed
Menu Development	Medium	12/02/21	13/02/21	Completed
Sprinting Improvement	Medium	12/02/21	14/02/21	Completed
Report – Feedback Description	Medium	14/02/21	15/02/21	Completed
Sprinting Visual	Low	14/02/21	15/02/21	Completed
Pause Menu Development	Low	16/02/21	17/02/21	Completed
Plan Player Model Design	Low	16/02/21	17/02/21	Completed
Cannon Modelled	Medium	18/02/21	19/02/21	Completed
Report – Sprint Description	Medium	18/02/21	19/02/21	Completed
Cannon Implemented	Medium	19/02/21	20/02/21	Completed
Wall Climb Mechanic Started	High	19/02/21	20/02/21	Completed
Jump Mechanic	Medium	20/02/21	21/02/21	Completed

Appendix 5.10: Sprint Nine

Task	Priority	Start Date	End Date	Status
Report - Fortnightly Blog	Medium	22/2/2021	23/2/2021	Completed
Design Player Model	High	22/2/2021	24/2/2021	Completed
Texture Player Model	Medium	24/2/2021	25/2/2021	Completed
Menu Development	Medium	25/2/2021	26/2/2021	Completed
Report – PEGI Rating	Medium	25/2/2021	26/2/2021	Completed
Rig Player in Game	High	26/2/2021	28/2/2021	Completed
Design First Level	High	27/2/2021	28/2/2021	Completed
Wall Grips Modelled	Medium	28/2/2021	1/3/2021	Completed
Finish Wall Climbing Mechanic	Medium	1/3/2021	3/3/2021	Completed
Report – Project Roadmap	High	1/3/2021	3/3/32021	Completed
Improved Loading Screen	Low	4/3/2021	5/3/2021	Completed
Project Showcase Work	High	5/3/2021	7/3/2021	Completed
Zipline Modelled	Low	5/3/2021	6/3/2021	Completed
Develop VIVA Prototype	High	5/3/2021	7/3/2021	Completed

Appendix 5.11: Sprint Ten

Task	Priority	Start Date	End Date	Status
Finish off Rigging Player.	Medium	8/3/2021	10/02/2021	Completed
TV Screen Implementation	Medium	9/3/2021	10/02/2021	Completed
Texture Pendulum	High	10/03/2021	11/03/2021	Completed
Texture Wrecking Ball	High	10/03/2021	11/03/2021	Completed
Lighting in First Level	Medium	11/03/2021	13/03/2021	Completed
Write up VIVA Feedback.	High	13/03/2021	14/03/2021	Completed
Report – Jumping.	Medium	13/03/2021	14/03/2021	Completed
Get Feedback from VR Devs	Medium	14/03/2021	15/03/2021	Completed
Project Showcase Work	High	14/03/2021	15/03/2021	Completed
First Level Design Complete	High	15/03/2021	17/03/2021	Completed
Report - Course Props	Low	15/03/2021	17/03/2021	Completed
Zipline Implementation	Medium	18/03/2021	20/03/2021	Completed
Texture Sweeper	High	20/03/2021	21/03/2021	Completed

Appendix 5.12: Sprint Eleven

Task	Priority	Start Date	End Date	Status
Submit Showcase Poster	High	22/03/2021	24/03/2021	Completed
Punch Glove Model	Medium	22/03/2021	24/03/2021	Completed
Improve Model Textures	High	25/03/2021	27/03/2021	Completed
Report: UX	Medium	25/03/2021	27/03/2021	Completed
Implement Punch Glove	Medium	27/03/2021	28/03/2021	Completed
Moving Platform Implementation	Medium	28/03/2021	30/03/2021	Completed
Improve FX Effects	Medium	28/03/2021	30/03/2021	Completed
Research VR Game Settings	Low	30/03/2021	1/04/2021	Completed
Implement Post Processing	Low	1/04/2021	2/04/2021	Completed
Improve User Interface	Medium	1/04/2021	3/04/2021	Completed
Begin Multiplayer Development	High	2/04/2021	4/04/2021	Completed
Start Implementation of Game Settings	Medium	2/04/2021	4/04/2021	Completed

Appendix 5.13: Sprint Twelve

Task	Priority	Start Date	End Date	Status
Tutorial Level Planned	High	5/4/2021	6/4/2021	Completed
Report – Swot Analysis	Medium	5/4/2021	6/4/2021	Completed
Water Raft Model Set Up	Medium	7/4/2021	8/4/2021	Completed
Tutorial Level Started	High	7/4/2021	9/4/2021	Completed
Report – Reducing Motion Sickness	Medium	8/4/2021	9/4/2021	Completed
Water Raft Level Planned	Medium	10/4/2021	11/4/2021	Completed
Level Landscape Planned	Low	10/4/2021	11/4/2021	Completed
Multiplayer Development	High	12/4/2021	14/4/2021	Completed
Report - Project Installation	Low	12/4/2021	13/4/2021	Completed
Settings Coding Started	Medium	13/4/2021	14/4/2021	Completed
Scoring System Code	High	15/4/2021	17/4/2021	Completed
Respawn System Developed	Medium	17/4/2021	18/4/2021	Completed
Report - Player Controller	Medium	17/4/2021	18/4/2021	Completed
Prepare Testing Prototype	High	17/4/2021	18/4/2021	Completed

Appendix 5.14: Sprint Thirteen

Task	Priority	Start Date	End Date	Status
Occlusion Culling Set Up	Medium	19/4/21	20/4/21	Completed
Water Raft – Level Prefabs Designed	Medium	19/4/21	21/4/21	Completed
Water Raft – Procedural Generation	High	21/4/21	23/4/21	Completed
Improved Lighting	High	21/4/21	23/4/21	Completed
Work on Level One	Medium	23/4/21	26/4/21	Completed
Work on Level Two	Medium	23/4/21	26/4/21	Completed
Multiplayer Development	High	24/4/21	27/4/21	Completed
Finishing Line Modelled	Medium	27/4/21	28/4/21	Completed
Import new version of Player Model	Low	27/4/21	28/4/21	Completed
Report – Purpose	Medium	28/4/21	29/4/21	Completed
Report – Audience	Medium	29/4/21	30/4/21	Completed
Report – User Story Map	Medium	30/4/21	1/5/21	Completed
User Interface Improved	High	1/5/21	2/5/21	Completed
Keyboard Input Set up	Medium	1/5/21	2/5/21	Completed

Appendix 5.15: Sprint Fourteen

Task	Priority	Start Date	End Date	Status
Prepare for Final Testing Session	High	3/5/2021	6/5/2021	Completed
Report – Implementation Section	High	3/5/2021	5/5/2021	Completed
Work on Level Three	Medium	5/5/2021	7/5/2021	Completed
Plan Challenges for Levels	Low	5/5/2021	6/5/2021	Completed
Report – Issues and Considerations	Medium	6/5/2021	8/5/2021	Completed
Clean and Comment Code	Medium	6/5/2021	7/5/2021	Completed
Work on Level Four	Medium	7/5/2021	10/5/2021	Completed
Gather Data from Final Testing Session	High	8/5/2021	12/5/2021	Completed
Bug Testing	High	8/5/2021	9/5/2021	Completed
Report – Methods	Medium	10/5/2021	11/5/2021	Completed
Bouncing Ball Modelled	Low	11/5/2021	12/5/2021	Completed
Break Feature Implementation	Medium	12/5/2021	13/5/2021	Completed
Report – Industry Engagement	Medium	12/5/2021	13/5/2021	Completed
Bouncing Ball Implementation	Medium	13/5/2021	14/5/2021	Completed

Appendix 6: Industry Engagement

To gain advice and feedback for my product, I used my social platforms to showcase the development of VR Wipeout and any development milestones I have met, I wanted to do this because I felt like my final year project would be a good way to engage with the industry on social platforms such as Twitter. As shown in the image below, I have posted a development update where I showcased my second level, Mega Sweep on Twitter, by using this platform I was able to gain an insight into what people thought of the game and what they would like to see more of, I can then use this feedback and improve the quality of game as well as using testing sessions.



During the development of VR Wipeout, I joined a discord channel called XR Creators, this channel was used by VR developers to chat about upcoming technology and give advice on any projects they are working on, I used this oppunitys to engage with other developers to learn an insight into their experiences developing VR products and any advice they can offer me. Using my professional platform, LinkedIn, I used VR Wipeout as one of my most important portfolio projects and showcased the project on my profile, by doing this, VR Wipeout has been brought up in all my interviews for jobs after university as recruiters are interested in the project.

Appendix 7: Links to all Testing Sessions

- Testing Session 1:
https://docs.google.com/forms/d/e/1FAIpQLSfcZ7E2gxCkv7ghZ77n1EKv_5TyMKwx8UAOyFxlxJRYAQ5Kmw/viewform
- Testing Session 2:
https://docs.google.com/forms/d/e/1FAIpQLScyQ_-IMlxvBdXsgd67nYQfiL4j7iEKXT3FVuHKAYR7Scf-Gg/viewform
- Testing Session 3:
<https://docs.google.com/forms/d/e/1FAIpQLSdiW2CdHhtEWlgCTNvWIS2dVzeO8cyZ-WaBvOO17m0FtuKkFA/viewform>
- Testing Session 4:
<https://docs.google.com/forms/d/e/1FAIpQLSf1gDVYOhu2b7XwnMoWP4PzWtiAl37MI3ZgqHtbw5AXqsMV6Q/viewform>

- Testing Session 5:

https://docs.google.com/forms/d/e/1FAIpQLSe_5jhZri1Q7NEWdu6Jv9darWYS0idFwJIKAWigcNxrNGr6Ug/viewform

- Testing Session 6:

https://docs.google.com/forms/d/e/1FAIpQLScMN_q2oSrij9IW8mhM_FCquU-OUvzNDHRubSLRxxxmcrBTkA/viewform

Appendix 8: Programs Used

In this section, I identify all the programs used to develop my product and which version of the programs I used:

- Unity 2019.3.8f1: <https://unity.com/>
- Visual Studio 2019: <https://visualstudio.microsoft.com/>
- Blender 2.80: <https://www.blender.org/>
- Adobe Photoshop CS6:
https://www.adobe.com/products/photoshop.html?sdid=KKQIN&mv=search&kw=photoshop&ef_id=Cj0KCQjw16KFBhCgARIsALB0g8IF2qRR2sf7VySFaOC0KyRgnpefly2ZeD3YfHCyFGG_OQtDtRiR0saAmh2EALw_wcB:G:s&s_kwcid=AL!3085!3!442365416141!e!!g!!photoshop&gclid=Cj0KCQjw16KFBhCgARIsALB0g8IF2qRR2sf7VySFaOC0KyRgnpefly2ZeD3YfHCyFGG_OQtDtRiR0saAmh2EALw_wcB

Appendix 9: Third Party Assets

- Modern UI Pack: <https://assetstore.unity.com/packages/tools/gui/modern-ui-pack-150824>
- Quick Outline: <https://assetstore.unity.com/packages/tools/particles-effects/quick-outline-115488>
- Low Poly Wind: <https://assetstore.unity.com/packages/vfx/shaders/low-poly-wind-182586>
- Large Water Shader: <https://assetstore.unity.com/packages/vfx/shaders/large-water-shader-free-asset-171172>
- Main Backing Track: <https://www.youtube.com/watch?v=tiThUOVNzU0>
- Level Backing Track: <https://www.youtube.com/watch?v=5S623yzR6SY>

Appendix 10: Installation Guide

Before downloading the game, a VR headset is required to play the game.

10.1 - Itch.io

- a. Download the ZIP file called “VR Wipeout”.
- b. Extract the files contents.

- c. Open the file called “Build”.
- d. To run the game, click on the exe “VR Wipeout”.

10.2 – Github

1. Download the ZIP file called “VRAssaultCourse”.
2. Extract the files contents.
3. There will be two folders in the unzipped VRAssaultCourse file.
 - a. Build: This folder contains the build files of the game, extract the Build.zip, click on the exe called ‘VR Wipeout’ to run the latest build.
 - b. Project: This file contains the Unity project I have been using to develop the game.