Deliverable K: User Manual

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GNG1103: Engineering Design

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Group 14

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Abstract

"Echoes of Tomorrow" is a pioneering Virtual Reality project developed to showcase the ethical implications and societal impacts of autonomous weaponry. Through an immersive narrative-driven experience, users are engaged in a thought-provoking storyline that explores the potential consequences of AI-powered weapons. This project underscores the importance of VR as an educational tool, offering insights into the challenges surrounding autonomous military technologies. It aims to foster awareness, provoke discussion, and encourage critical thinking among its audience. Therefore, the following document acts as an aid to anyone who wishes to explore the experience that our group has made

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List of Acronyms and Glossary

Table 1 | Clarification of Acronyms Used in Document

Acronym	Term	Definition
AI	Artificial Intelligence	A technology designed to allow computers to learn from given information.
BOM	Bill of Materials	A comprehensive list of software, assets and platforms used in the making of the product.
NPC	Non-Player Character	And character not controlled by a user.
VBA	Visual Basic	A coding language used by unity.
VR	Virtual Reality	A technology which fully immerses the user in an interactable virtual environment.

Table 2 | Clarification of Terms Used in Document

Term	Definition
Autonomous Weapon	An unmanned, computerized weapon which utilizes AI to make decisions.
Script	A section of code which tells unity what to do when it receives certain inputs.
Asset	An element of the environment, this includes sounds, effects, textures and models.
Deliverable	A document previously made by the group that tackles separate tasks in the engineering design process used to finish the game effectively.

1 Introduction

The following document serves as both a comprehensive guide and a user manual, crafted to facilitate a deeper understanding of our Team's cutting-edge Virtual Reality (VR) experience, "Echoes of Tomorrow". Designed with the ambition to unveil the potential societal impacts of artificial intelligence (AI)-powered weaponry—should such a future unfold—this manual acts as a resource not only for VR users eager to immerse themselves in this thought-provoking program but also for designers and developers aiming to leverage VR as a medium for societal awareness. Moreover, it stands as a pivotal reference for any endeavor involving VR creations or applications developed with the Unity engine, detailing the intricacies of crafting immersive VR experiences on this platform. Beyond its practical utility, our product embodies a powerful educational instrument, engineered to foster awareness about the critical issue of autonomous weapons. Professionally developed to meet market standards, it offers seamless integration for clients looking to incorporate such meaningful content into their offerings.

1.1 Related Work

For the group to reach this stage of final conception, the group carefully worked its way through several portions of the design process to achieve a proper and successful solutions. All portions of the engineering design phase are listed below, split into various deliverables which tackles different aspects of this process.

In Deliverable B, which can be accessed through the hyperlink, outlined all the needs described by the clients that had to be taken into account when designing a conceptual design, with the needs being neatly organized into categories such as Accessibility, Storytelling, Communication, Logistics.

In Deliverable C, which can be accessed through the hyperlink, all of the identified needs were subsequently divided into a list of functional requirements, non-functional requirements, and constraints. In part A) all needs are listed and organized into a chart that separates all requirements, then in part B), all of the group's findings in regards to these criteria were benchmarked with other groups project's and other public VR simulations. This helped the group to better understand where to focus and how to change our list of criteria, as well as to set target specifications for the optimization of our design.

In Deliverable D, which can be accessed through the hyperlink, the group had brainstormed several different conceptual ideas in regards to the needs, requirements (functional, non-functional), and constraints identified from the previous deliverables, and merged ideas in order to create a global concept that best fit the client's expectations. The global concept chosen in the referenced deliverable is the one the group will continue to refer to for the duration of this Deliverable.

In Deliverable E, which can be accessed through the hyperlink, the group reinforced what needed to be employed to complete the project by deadline day, which encompassed: when each task must be done, what must be acquired, and how much money can be spent to fit under budget while meeting the

expectations of achieving an A+ grade and meeting the deadline. In addition, the final design was conceptualized and from that point forward the first prototype started development.

In Deliverable F, which can be accessed through the hyperlink, demonstrates the first part of the iterative prototype and testing stage of engineering design process. In this document, Group 14 has emphasized the risks of autonomous robots. Deliverable F details the development process, incorporating client and user feedback and project planning. From initial objectives set after client feedback, the prototype was refined to convey the story and integrate characters within a one-minute duration. Feedback highlighted the need for emotional engagement, the challenge of animation reliance, and avoiding gender stereotypes, prompting narrative and design changes. The report plans for a second prototype with enhanced animation and interactivity, and future accessibility features. This demonstrates the team's ability to adapt, manage resources, and plan strategically, meeting objectives within budget and time constraints.

In Deliverable G, which can be accessed through the hyperlink, demonstrates the continuation of the iterative prototype and testing stage of engineering design process. Deliverable G details the development process, incorporating client and user feedback and project planning for the second prototype of the project. The prototype was refined to make the atmosphere scarier and more ominous, and to add rudimentary animation. The given feedback highlighted the need for character dialogue, animations acting on a timeline, and background music/ambient sounds.

In Deliverable H, which can be accessed through the hyperlink, demonstrates the final part of the iterative prototype and testing stage of engineering design process, as the group finishes its third and final prototype. Deliverable H details the development process, incorporating the last of the user feedback and classroom feedback for our presentation demonstration. The prototype was refined to fix all functionality issues and to be ready to demonstrate at the upcoming design day.

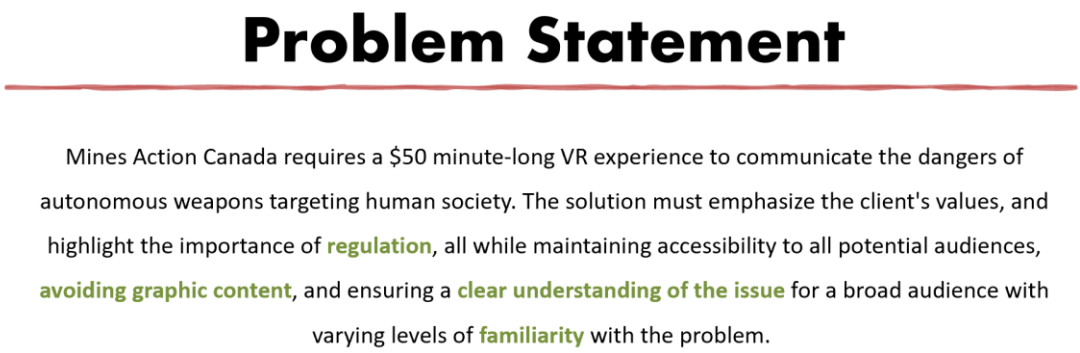
In Deliverable J, our group had created a presentation to the class regarding the status of our project. By the time of our presentation date, which was March 22nd, we were only eligible to showcase the contents of Prototype II. The goal of this deliverable was to practice the group's presentation skills for Design Day, as we will need to effectively pitch a 3-minute presentation to our judges to convince our audience why our project is so effective in communicating the message of the clients. Using the feedback received from this presentation, which is discussed and reflected upon in the later portions of the deliverable, our group can ensure our presentation for Design Day will be amazing.

In Deliverable I, our presented our final submission of our VR experience, "Echoes of tomorrow" to a group of judges and our clients. This deliverable has 3 submissions, including the powerpoint presentation, a script and other relevant work, and the video.

2 Overview

The discourse surrounding autonomous weapons is critical due to the profound implications these technologies hold for the nature of warfare and global security. These systems, capable of independently selecting and engaging targets, introduce complex ethical and legal questions regarding accountability and the sanctity of human decision-making in combat scenarios. The potential for errors in targeting and the unintended escalation of conflicts present tangible risks, emphasizing the need for stringent oversight. There are a significant number of concerns that come with the implementation of AI weapons in modern use, such as the potential to trigger an arms race in military technology, targeted bias, and much more. Therefore, it is imperative to navigate these advancements with a keen sense of responsibility, ensuring that ethical considerations and adherence to international law guide the development and deployment of such technologies, thereby safeguarding human dignity and the principles of humanitarian conduct.

2.1.1 Figure 1 | Problem Statement



With this Problem Statement created, our group intended the game be curated to policymakers and influential figures, as stated by our clients “Mines Action Canada”, and therefore we hope to highlight the ramifications of permitting the advancement of autonomous weapons systems to contribute to the preservation of lives and societal well-being. In doing so, we also tailored our project to accommodate users regardless of their familiarity with such technology, our product integrates extensive support and navigational aids, guaranteeing a seamless and accessible experience for all participants.

2.1 Fundamental Needs

The fundamental needs of the user revolve around creating a short, impactful, and accessible VR experience designed to convey the significant consequences of autonomous weapons development. The essence of this project lies in delivering a powerful message through effective storytelling, prioritizing narrative depth over interactivity to ensure the message is both compelling and comprehensible. Key considerations would include crafting a generic yet immersive environment without resorting to stereotypes or excessive violence, maintaining a focus on human adaptability in the face of autonomous threats, and ensuring the content is accessible to individuals with sensory issues. The project also emphasizes the importance of regulatory measures for autonomous weapons, aiming to educate and influence the audience's understanding and perceptions within a concise one-minute video, all while adhering to a strict budget and copyright constraints. This encapsulates a need for a product that not only informs and engages but also aligns closely with ethical standards and the client's values, ensuring a broad appeal and understanding.

2.1.1 Table 3 | Needs Identification of Client's Demand

The referenced table can be found in Deliverable B, where the team grouped together all the client's needs into an organized criteria and evaluated the level of importance of each topic, in order to gain a better understanding of what needs to be done, and how effort/time should be allocated.

Grouping:	Needs to Address	Importance
Accessibility *Addressing audience*	• Accessible to those with sensory issues • Assume little knowledge of the problem	2
Inoffensive *Be politically correct*	• No harmful stereotypes & prejudices – must be safe for parliament • Do not focus on gory aspects, a bit of blood is fine	3
Story *Engages the audience & conveys the message*	• The story will focus on how autonomous weapons have affected daily life • Focus on the storytelling over intractability & Story must be understandable • Focus on quality over quantity, & story must be easily understandable • Autonomous weapons that specifically target humans (can perfectly distinguish between humans and other living beings)	4
Logistics *Follow group restrictions*	• A short and simple VR experience that fits into a 1-minute video • $50 cost limit for buying assets & avoid copyright • Focuses on the cons of having autonomous weapons • Generic location (preferably not too big and does not need to be a city)	5
Communication *Persuade audience*	• Must emphasize the importance of regulating autonomous weapons • Focus on human behavior adaptability (for instance, how they would resist attacks) • Balance emotionality with information • Properly represent the values of the client in the video • The problem must be clearly understood by the customer watching it	5

2.11 What Differentiates our Group from others

Our project stands out through its strategic use of narrative techniques and emphasis on persuasive storytelling, tailored to resonate with our audience's emotions. This approach has been refined through rigorous testing and feedback cycles with users, coupled with extensive research into effective communication strategies. Drawing on insights from our team's friends with expertise in game development, particularly with Roblox, we discovered the profound impact of emotional engagement through storytelling. A comparative analysis revealed that narratives invoking emotional connections were far more effective in conveying messages than purely informational content. Consequently, our meticulously crafted, minute-long video and accompanying VR experience immerse users in a compelling story that makes them feel an integral part of the unfolding drama. The narrative reaches the climax with the revelation of a son's injury by a robot, which instantly clarifies the perils associated with autonomous weapons. Through 3 iterative feedback sessions with our peers, we honed the project's impact, ensuring it remains aligned with our core message while avoiding graphic violence. Instead, we illustrate the menace of autonomous weapons through the backdrop of a dystopian household and a direct encounter with a robot, striking a balance between showcasing the dangers and maintaining a focus on the narrative's emotional core.

2.1.2 Final Video of Our Game

The following hyperlink will direct you to the final video of our VR experience.
https://drive.google.com/file/d/1Vxor4YOMKpWEPcKR_xWhuk34D1QZkHJI/view?usp=sharing

2.1.2 Figure 2 | Talking to Son (Scene 1)

2.1.3 Figure 3 | Listening to the Radio (Scene 2)

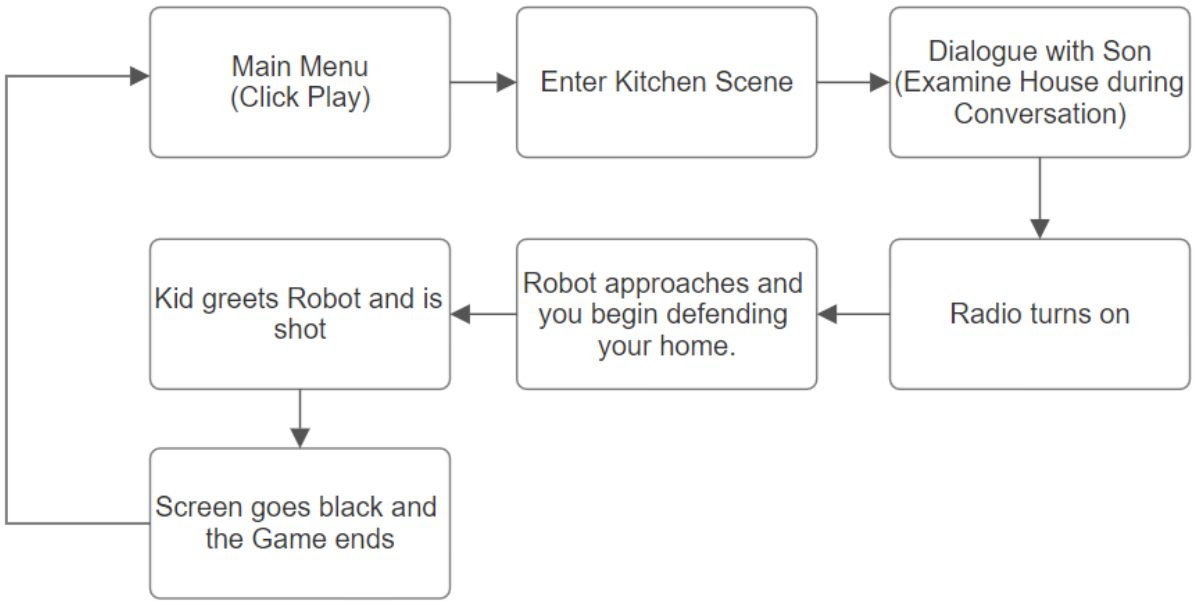
2.1.4 Figure 4 | Robot Begins to Approach (Scene 3)

2.1.5 Figure 5 | Son Rushes to the Door (Scene 4)

2.1.6 Figure 6 | Son Greets Robot at Porch (Scene 5)

2.1.7 Figure 7 | General Overview of Environment

2.1.8 Figure 8 | Block Diagram Explaining Sequential order of Events



2.2 Conventions

- Within the manual, there are various acronyms and concepts which can be understood by referring to the Acronyms and Glossary section.
- Also note that every underlined word is a hyperlink to either a different portion of the document, or a different PDF file altogether. It is common throughout the manual that many sections are cross-referenced.
- Refer to the Appendix for all other critical and important work here and refer to the List of Figures and List of Tables to access all organized data within the document.

2.3 Cautions & Warnings

⚠ Newcomers to VR may encounter nausea or motion sickness. Should any discomfort arise, promptly discontinue use to prevent health complications.

⚠ Using VR can lead to headaches. It's advisable to periodically rest and stay hydrated between sessions.

⚠ Remain cognizant of your physical environment while immersed in VR to avoid accidental collisions.

⚠ Exercise caution during VR interactions to prevent inadvertently releasing the controllers.

⚠ All events that occur within the VR are not real. Although no gore is shown, the storyline is emotionally invoking and can be unsettling or uncomfortable to some audiences.

3 Getting Started

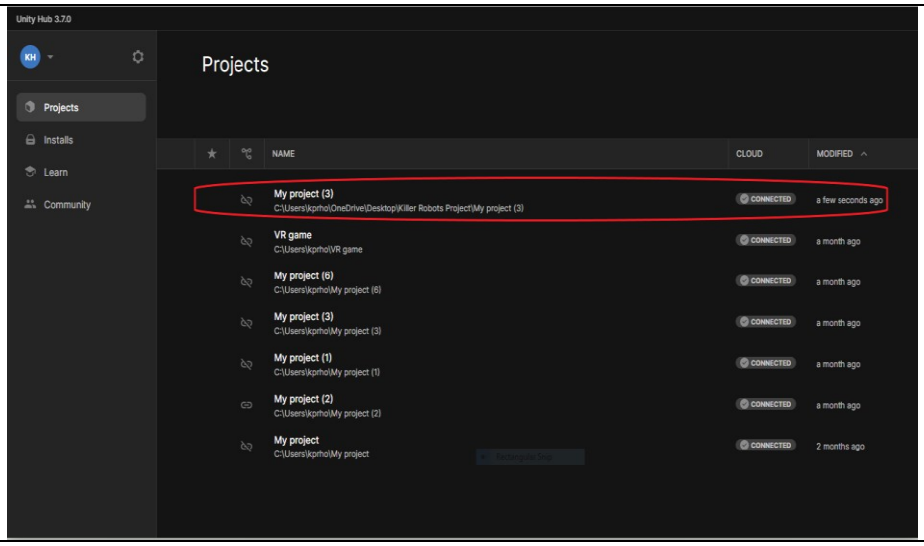
Prior to setting up the VR to your computer, ensure you have complete the following steps for the setup to function properly and for your own safety.

3.1.1 Table 4 | Preparing the Oculus and Computer Setup

Computer A suitable computer to adequately operate the VR experience	
Oculus VR Headset An Oculus VR headset ready to use for the full VR experience	
HDMI Cable An HDMI cable to connect the VR headset to the computer	
Free/Open Environment Ensure you are in an open area to prevent injuries	

After acquiring all the necessary tools, you are now able to begin the setup.

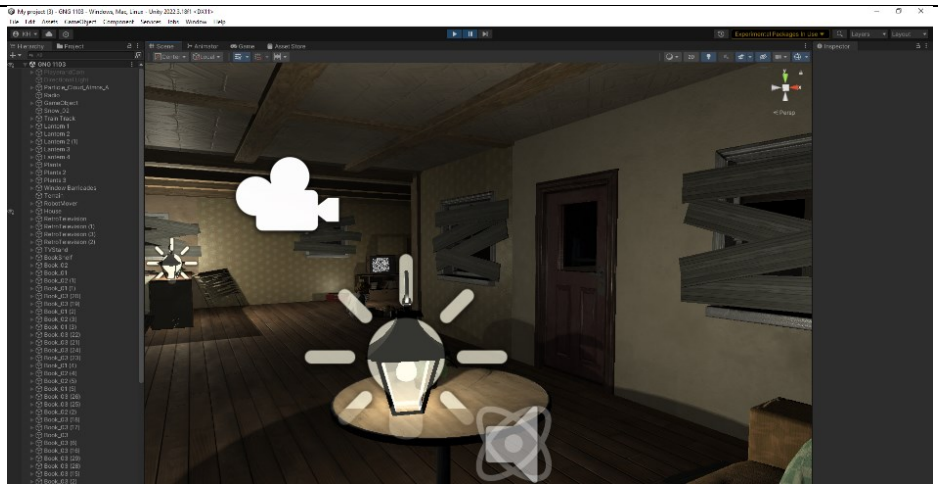
3.1.2 Table 5 | Connecting the Oculus Headset to the Computer

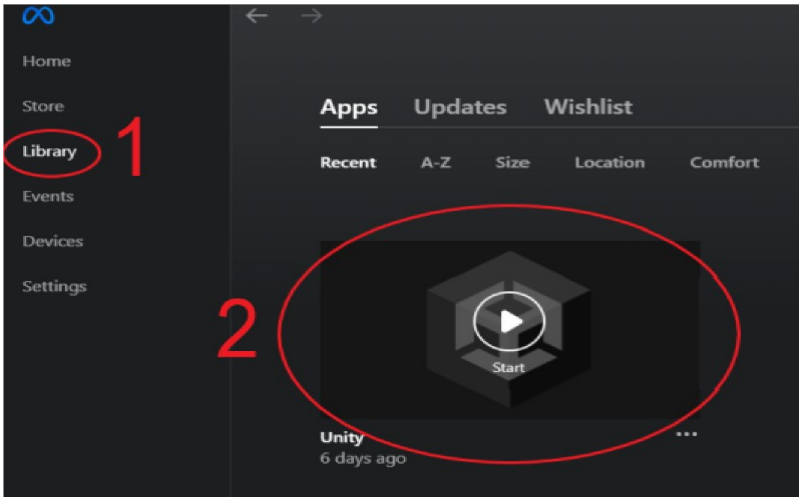
Step 1 Begin by connecting the VR headset to the computer using the HDMI cable.	
Step 2 Download the Unity Software with our game files and the Oculus app.	+ Unity
Step 3 Run the game in Unity by going to projects, then double clicking on the folder named “My project (3)”.	

Step 4

After Unity opens it should look like setup 4.

Run the Oculus app, click on library, then press start on the Unity game shown in setup 5.





Step 5

Adjust the Oculus VR headset to your head by manipulating the straps for a secure fit.

Step 6 Finally, click on the play icon in unity at the top middle of the screen and enjoy. Additionally, be sure to adjust the volume accordingly by clicking on the +/- button on the headset.	

Due to time constraints, a main menu could not be setup so the only way to experience the game is to simply just wear the VR headset and the main screen is the environment itself. During the presentation, group members had to manually restart and end the experience due to some bugs in the system which did not indicate that the experience had ended. The only way to fix this is to program a simple main screen with a start and help/rules button.

3.2 Configuration Considerations

3.2.1 Figure 9 | Flowchart of the Timing of Events

This flowchart explains the layout of our story and what the viewer will get to experience. The Green represents the beginning and end of the experience, the Yellow represents the time intervals, which notable events take place, the Blue represents the physical element, such as movement or sound, during that time interval, and the Purple represents the specific point in the plot.

3.3 User Access Considerations

3.3.1 Mobility Issues

We have designed our game to accommodate to those with mobility issues. The movement area is limited, primarily so there is no excessive movement, and it is more of a visual experience. Furthermore, the viewing area is situated in the center of the action, where you are able to see all the important events during the experience.

3.3.2 Visual Impairment

Our game is dialogue focused so that users with visual impairments can hear and understand what happens within the experience. Unfortunately, there are some details that they could miss such as the child walking or the robot approaching the door; however, the radio clearly outlines the issue and the severity of our target message, which is our primary focus.

3.3.3 Age

The experience was targeted towards age groups varying from teenagers to adults. With that being said, people under this age group could also participate in the experience. Each scene was constructed with the intention of making it suitable for all ages, however, there is use of a gunshot sound effect, which might be unsettling for some audiences.

3.3.4 Other Considerations

We have made the message clear and concise for anyone with difficulties regarding attention or learning abilities. Additionally, we have taken into account different cultural backgrounds, ensuring to avoid religions, locations, racism, social implications, hate speech, and more.

Our game prioritizes accessibility for users with various needs and preferences. Overall, our commitment to inclusivity and sensitivity ensures that our game offers an engaging and enjoyable experience for all users.

3.4 Accessing/setting up the System

1 To obtain the system, the sole method is to download the Unity data files from Maker Repo under our group's repository. This is because the build assets are excessively large for distribution, include proprietary material, and must be uploaded into unity in order to be played in VR.

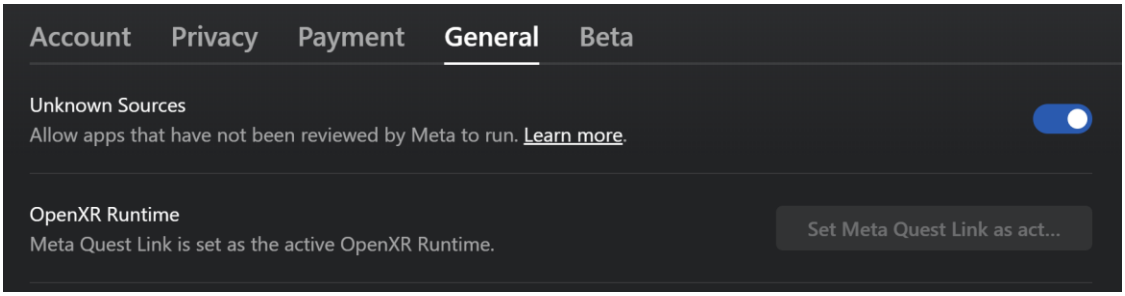
2 After downloading the entire ZIP file containing the Unity world file, open the Unity Hub software then click the 'Add' Button and find the file you just downloaded to open it. This should load the group's VR game.

3 To configure the VR setup, download the Oculus Software accessible through Meta's Website and download the version that matches your specific Oculus model. For the purpose of the equipment offered in the GNG 1103 lab, we will be using the Quest 2. Install all files once downloaded.

4 Connect the VR to the computer via the designated cable and complete the setup by following the instructions prompted by the software.

5 Enable access to any unknown source on the Oculus software by going to Settings → General and clicking the first button from the top. Then activate OpenXR Runtime by choosing the Meta Quest Link.

3.4.1 Figure 10 | General Settings to Activate when using Oculus



Now if you try to run the unity game, it will connect to the VR headset with full interactivity.

6 For proper wear, first place the goggles over your eyes before adjusting the head straps for a comfortable fit. Since visibility will be obstructed with the goggles on, it is advisable to have assistance. The assistant should hand you the controllers, which can be activated by pressing and holding the center button until it turns green, and then adjust the wrist straps as needed.

Precautions: Ensure the VR setup is in a spacious area clear of any hazards or obstructions. The system should be accurately calibrated and aligned with the center of the room. For additional calibration guidance, consult the VR manual.

Furthermore, if the VR headset has a password, ensure that the code is known in case the VR shuts down unexpectedly.

3.5 System Organization & Navigation

3.5.1 Physical Components

The VR headset along with the controllers allow the user to start/stop the VR system. Moreover, when moving around, the user needs to hold the controllers so game can track the player movement.

3.5.2 Language

The language chosen for our game is English. We originally intended to include French subtitles to accommodate for any French speakers, however, due to time constrains we were unable to add them. Ensure your audio is turned on and connected to a set of speakers to hear the language in the game.

3.5.3 Audio Systems

The Audio Systems are present within the code of the Unity game, and act according to a pre-set timeline. There are a total of 3 audio files:

1) Radio Dialogue + Frequency Distortion + Robot Radio Feedback Interference

2) Character Dialogue between Father & Son (Script)

3) Ambient Noises (Floorboards Creaking, Weather, Footsteps.)

Each audio file is present within certain props inside the game as an audio source to bring realism to how they sound in the VR game. For instance, the Radio audio file plays directly from the Radio asset, and therefore, gets louder when approaching it and vice versa. Likewise, the character dialogue resides inside both characters and the ambient noises are placed within the walls to make it appear as if the sounds are coming from the house itself.

Each audio file is synchronized as they act on pre-determined time intervals that were edited within an audio editor. For instance, when character dialogue ends at the 18 second mark, the radio audio file will play separately at the 20 second mark, all while the ambient noises continuously plays.

3.5.1 Figure 11 | Audio Source & File

3.1.2 Character Animations

There are 2 characters that are animated: the child and the robot. These animations follow a timeline that matches the audio and the movement scripts. The robot's animations are it walking forward. The child's animations are it listening to music and moving in accordance, turning its head to the side, turning it facing the ground, standing up, turning to the right, walking, turning to the left, and then walking again, this time going outside to the robot and stopping right before it. The robot animations stop when it reaches the house, while the child's animations all last for predetermined amounts of time to match the story.

3.1.3 Exiting the System

When the gunshot is heard at the end, the game will automatically turn off by itself and return to the Unity game development screen. To exit the system completely, close the Unity game on the computer along with the Unity hub, unplug the headset cable from both the headset and the computer, and turn off the VR by clicking the oval power button on the right hand side of the headset.

4 Using the System

Due to the lack of a main screen, the system only consists of the viewer wearing the VR headset and viewing the experience from an outside perspective without any interactivity with the characters in the game/story.

4.1.2 Main Menu

As mentioned before, a main menu was not planned at the start of the game. Currently, the main menu is the main menu of the VR headset and a group member needs to manually start the game. Ideally, the main menu would have been a simple welcome window with a start and help button.

4.1.3 First scene

The story doesn't involve "scenes" but the storyline is being divided into 3 parts. The first "scene" includes a brief talk between the child and the father indicating a family. The child asks about food to which the father replies about having only a limited amount of options hinting about the apocalyptic world with a scarcity of resources. As you look around the house, the poor maintenance of appliances and walls can be noticed. When you look out of the window, you can see snow falling along with trees visible which shows that the family's house is located in the middle of the forest.

4.1.4 Second scene

The second scene abruptly begins when the radio, the only piece of technology remaining in the house, turns on as it intercepts a signal from the government warning all people in a certain area to seek shelter if they are ex-militia personnel, as an autonomous humanoid soldier has received a bug in their system that begins to target these people. As the the man in the radio continues on, pleading civilians to stay patient with their progress, the radio becomes distorted as the character realizes that the robot is approaching and is intercepting the radio. While hearing the robot begin to speak through the radio, you frantically examine your house for things to do to protect your family.

4.1.5 Final scene

As the radio broadcast dies out, you move towards to door to investigate the blinking red light. Upon noticing the light, the child is curious as well. He walks over to the door and goes outside. In the storyline, the child has had very limited interactions with humans besides his mother and father. This does not allow him to distinguish between humans and robots. During these events, the father does not notice his child missing and after a couple seconds, a gunshot is heard outside the house indicating something terrible occurred. This marks the end of the experience and leaves the interpretation of the final event to the viewers (even though the message is clear and only has one meaning, the group avoided any violence being shown in the experience).

5 Troubleshooting & Support

There are not any bugs in the code that cause any major issues for the user experience, however, there can be a few minor things that appear upon use, but they can be fixed quite easily by following the procedures below.

Error Messages or Behaviors

An error message that affected us during design day was that the Oculus 2 headset could not connect with Unity. We fixed this by restarting the Oculus headset and untangling the cable that connected the laptop and the headset. There are also warnings about certain parts of assets not being found but those have not caused any hindrance to the experience.

Special Considerations

The two potential issues that remains that could be considered for troubleshooting are first, that depending on the frame rate, the movements and animation of the child will not match, and the door will not open at the right moment. These can be fixed on location by changing the timers on the movement of the child as well as the time it takes for the animations to happen. A more permanent fix could be found, such as linking everything to timers, although timers are the second issue, as the timer keeps on running even when the experience is paused.

Maintenance

To maintain the virtual simulation, testing it before any presentation is necessary as the frame rate needs to be at a certain level to have the animations match the timers and each other, as well as to identify any problem that might have arisen due to sharing the project or a faulty save file.

Support

For any questions or if technical support is needed, the university can be contacted to ask for the contact information of the team members, or feel free to contact any of the members of Team 14 who contributed to the project. The emails are listed below:

droso096@uottawa.ca

rshar201@uottawa.ca

bdega087@uottawa.ca

mstla062@uottawa.ca

khong019@uottawa.ca

6 Product Documentation

In order to better document the development process of the VR experience, it has been divided into 5 crucial subsystems which are as follows: Storyline, Control Scheme, Art style, User interactivity, and Audio. In the following section each of these subsystems are explained in thorough detail alongside examples of how our VR experience implemented each of these subsystems.

6.1 Assets Used

6.1.1 Table 6 | Bill of Materials (BOM)

Item Number	Description	Quantity	Store	Price (CAD)
#1	House Model with Interior	1	Unity Asset Store	$25
#2	Smartphone Model	1	TurboSquid	Free
#2	Radio Model	1	Unity Asset Store	Free
#4	Gunshot Sound Effect	1	Unity Asset Store	Free
#5	Autonomous Weapon Model	1	TurboSquid	Free
#6	Gas Lantern Model	1	Unity Asset Store	Free
#7	Newspaper Model	1	TurboSquid	Free
#8	Book Stack Model	1	TurboSquid	Free
#9	Realistic Young Kid Model	1	Unity Asset Store	$19
#10	Animation Script Walking | Playing | Sitting	3	Mixamo	Free
#11	Unity	1	-	Free
#12	Microsoft Visual Studio	1	-	Free
#13	Oculus	1	-	Free
#14	Blender	1	-	Free
Total	-	-	-	**$44**

6.1.2 Table 7 | Equipment List

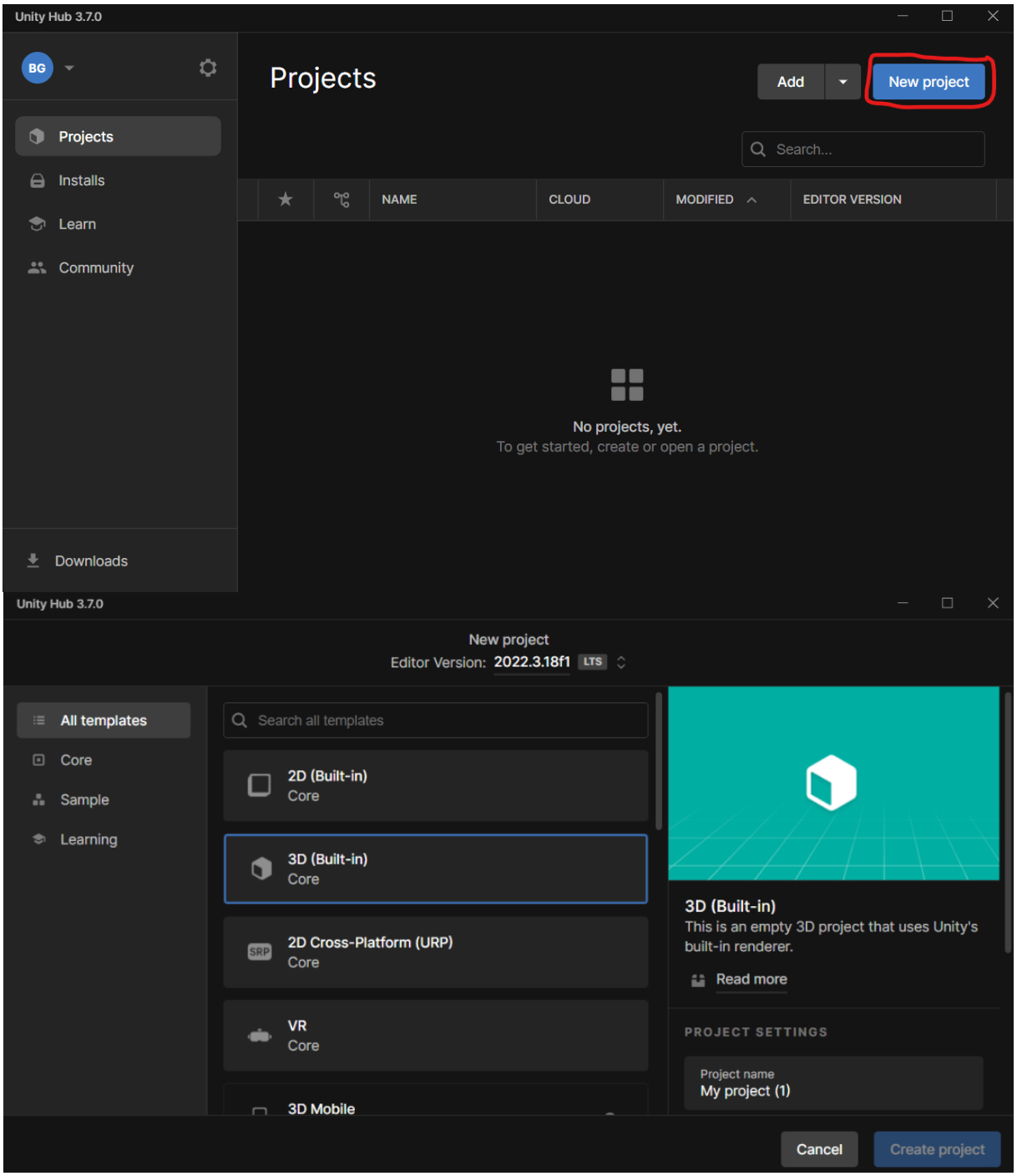
The following table references all the equipment needed for the setup to work along with their functionality.

Equipment	Description
Quest 2 Headset	Current Generation of Meta's Oculus headset. Used to allow the user to interact freely and realistically in our game environment.
PC	Computer must be strong enough to run the VR experience and have a graphics card that is compatible with running VR. (Laptop or Computer must have Dedicated Graphics Card)
Quest 2 Glasses Spacer	Allows users to wear glasses under the VR headset.
USB-C Cable	Connects the VR headset to the computer to run the experience smoothly.

Instructions

Start by installing and opening the newest version of unity.
Once opened create a new 3D environment by clicking new project then selecting 3D (Built-in).

6.1.3 Figure 12 |Project Hub Display



- Before any work can be done towards building the VR experience, A great deal of care must be put into creating a moving storyline to hold the attention of your users, this will be foundational for the rest of the design process.

- Once a story has been decided, the next step is to build the environment in which the experience will take place. Search for or create assets that fit your emotional theming and ensure that any set pieces (i.e. buildings, props, non-playable characters) are present in the environment.

- Next, implement the story into the environment by coding in interactions between the user and the world. These interactions can be as simple as listening to audio or as complex as directly interacting with the game world by moving objects.

- Implementing audio to a VR experience is not required however it can serve to invest your audience in the game world. Music can effectively set the tone of the story, and voice acting can cause your audience to grow attached to characters in the story.

- Finally, movement and VR compatibility must be added to allow users to fully explore the world that you have created. The control scheme must be curated to the experience that you intend to give, picking the wrong one may harm user investment.

Testing & Validation

There were numerous tests for the prototype. However, most of them were done right after changes to the prototype to verify if the solution worked, and if it did not, more changes were made, followed by another test. The major recurring issue was the relationship between the NPCs and the surrounding terrain. This was caused by sizes and locations of the colliders on the NPCs, the coordinates of the NPCs that caused them to go to locations that they were not supposed to go to, such as walking into walls or in the sky, or the position of the asset changing with the animation, causing a modification to the elevation of the asset. The solutions to these problems were found by making parent objects for these assets that can follow the movement scripts, as well as the root motion settings of the assets and animations.

6.2 Storyline

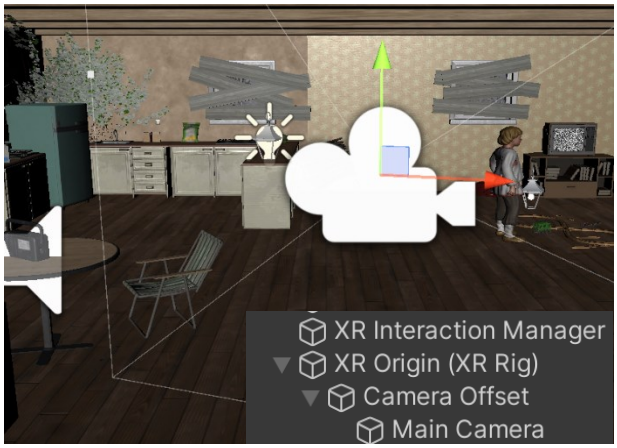
The story of the game takes place in an apocalyptic home, where an ex-militia soldier lives in isolation from the rest of society as he fears the danger of autonomous weapons. He lives with his wife in son in this dystopian household, where no technology is seen to be found (other than the rubble of broken TVs and household appliances) as he believes technology is no longer to be trusted other than the radio, which acts as his only method of communication to the outside world. After the introduction of autonomous weapons, the father has hidden the truth of the situation to his son, who innocently believes this is how life now is. However, upon receiving an emergency alert issued to those with a background of being a registered militia soldier by the government as there had been a mistake in the programming of the robots (yet again) that they're now targeting people of this description as they've mistakenly identified them as enemy conspirator. After hearing this through the radio, the father looks outside his door to see an autonomous weapon (in this case, a humanoid soldier with a turret mounted on his shoulder) walking towards the home. The father looks around the house, and puts up barricades as he does so, while the radio starts receiving distorted feedback and faint crying and robotic noises – signifying that the robot is approaching and interfering his radio signal. Then suddenly, the father hears the door open. As he turns around, he sees his son run out screaming, "Hey we have a visitor!". Then as the son goes close to the robot, the screen goes black and a gun-shot sound effect goes off, implying that the kid has been shot despite the lack of hostility.

6.1.4 Figure 13 |Conceptual Storyline Images

6.1 Control Scheme

In order to fully immerse the user in the experience the control scheme that was used was tracked to the gyroscope in the VR headset. This way the user movements in the real world directly correlate to their movements in the experience. No additional code was required to implement VR controls.

6.1.14 Figure 14 | VR Camera Settings & Script



For testing purposes, a mouse and keyboard control scheme was also implemented however it is not used when viewing the experience using a VR headset. This control scheme was implemented using VBA scripts which can be found in Appendix II. Player Movement Script |Camera Movement Scripts

6.1.15 Figure 15 | Keyboard & Mouse Settings & Script

6.2 Art Style and Accessibility

After discussing our theme and world visuals, we decided to minimalize the amount of paid assets used to have a more original and authentic environment. The base terrain was made from scratch using free assets in Unity. We sculpted and painted the terrain to match our intended visual, a snowy environment. To enhance our domain, we added weather effects such as snow, wind, moving clouds, etc. We agreed upon a house and child figure that resonated with our snowy atmosphere and rustic feel, which were both paid assets. Ultimately, we achieved our visual goal using our knowledge and skills, while limiting the amount of paid assets.

6.2.14 Figure 16 | Outside Environment

6.3 User Interactivity

Interactivity was not required by our clients; however, we realised that adding interactivity to the VR experience would allow users to immerse themselves fully in the world leading to a greater emotional impact and as a result, our message being better understood. The decided method of user interactivity was to implement the ability for users to board up the windows around the house as the robot approached. Not only did this allow to user to better explore the house, but it also got them emotionally invested since they felt that they were at fault for what happened to the child.

6.4 Audio

Audio plays a crucial role in enhancing immersion within our experience, especially since our group aims to capture the emotions of the user by making them feel as if they are in the situation themselves. As VR graphics alone cannot simulate the feeling of realism, audio must be precise and as accurate as possible to the real world for the experience to feel more 'believable', especially to those who have never used VR. Therefore, our group delicately uses a mix of dialogue and ambient noise to achieve this immersion. For one, ambient noise plays a vital role in immersion by creating a rich, believable environment that engages the senses, drawing the user deeper into the experience. It subtly fills the background with life-like sounds that mirror reality or enhance the thematic setting of a virtual world, making the user feel as if they are truly part of that space. By providing auditory cues that complement visual elements, such as the floorboards creaking when walking or the radio becoming distorted when the robot intercepts its signals represents this. Furthermore, ambient noise adds depth and dimension to our video game, making our virtual environment more convincing and engaging and thereby significantly enhancing the overall sense of presence within our virtual space.

On the other hand, voice acting and dialogue significantly enhances the narrative of our game by imbuing it with emotional depth and realism. It creates a closer connection to the characters and story in our VR experience, making the game more immersive and engaging. Through the nuances of voice, players gain a deeper understanding and emotional attachment to the virtual world, elevating the storytelling to a more impactful level.

It is important to note that our video game can only run in English and is therefore monolingual.

7 Conclusions and Recommendations for Future Work

Our group's project, "Echoes of Tomorrow," is a testament to the potential of virtual reality (VR) as a medium for conveying important societal messages, specifically the ethical implications of autonomous weaponry. Through our innovative VR experience, we aimed to immerse users in a narrative that highlights the consequences of deploying AI-powered weapons, fostering awareness and sparking conversation on this critical issue through the use of emotional engagement.

Our journey through this project has been one of extensive learning and adaptation. As new engineering students with little knowledge in product development, we meticulously navigated through the various stages of the engineering design process, from identifying client needs and developing functional requirements to brainstorming, prototyping, and testing. Each phase was instrumental in refining our prototype, ensuring it met both our educational objectives and user accessibility standards.

However, given the ambitious scope of our project, certain aspects were left unexplored due to time constraints and a lack of experience in product development. Should we have more time, our focus would be on enhancing user interactivity within the VR environment as our feedback from design day stated we lacked in that department of our experience. Our narrative-driven approach was applauded by our clients in effectively conveying the message, but by allowing users to interact more dynamically with the story elements, we could have created an even more engaging and immersive experience. Additionally, we would prioritize developing a multilingual interface to make our project accessible to a broader audience, further amplifying its impact and matching our accessibility standards.

Another important avenue for future work would be the integration of adaptive difficulty levels or scenarios based on user feedback, enabling the experience to be tailored to different audiences more effectively. This could involve varying the narrative complexity or the emotional intensity of certain scenes to cater to a wider range of sensitivities and backgrounds.

For future groups wishing to build upon our work, we recommend focusing on these areas:

Enhancing Interactivity

Explore ways to make the VR experience more interactive, allowing users to influence the narrative or outcome based on their decisions within the VR world.

Multilingual Support

Develop a multilingual interface to cater to non-English speakers, thereby increasing accessibility and impact.

Adaptive Content

Implement adaptive difficulty levels or scenarios to tailor the experience more closely to the user's preferences or sensitivities.

Further Testing and Feedback

Continuously test the VR experience with diverse groups to gather comprehensive feedback, allowing for further refinement and improvement.

In conclusion, "Echoes of Tomorrow" stands as a foundational project that marries technology with social awareness. We opened the door to further exploration and innovation in using VR as a powerful tool for education and change, and our hope is that future work will continue to build upon this foundation, leveraging emerging technologies to create even more compelling narratives that challenge, educate, and inspire.

8 Bibliography

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APPENDICES

9 APPENDIX I: Design Files

For the group to reach this stage of final conception, the group carefully worked its way through several portions of the design process to achieve a proper and successful solutions. In the referenced table, all portions of the engineering design phase are listed below, split into various deliverables which tackles different aspects of this process, along with the video that our group had submitted and the game files to play “Echoes of Tomorrow”.

9.1.1 Table 8 | Design Files & Deliverables

Document Name	Document Location and/or URL	Issuance Date
Deliverable A - Team Contract and Project Management Template	Deliverable A	January 21
Deliverable B - Needs Identification and Problem Statement	Deliverable B	January 28
Deliverable C - Design Criteria	Deliverable C	February 4
Deliverable D - Conceptual Design	Deliverable D	February 11
Deliverable E - Project Plan and Cost Estimate	Deliverable E	February 25
Deliverable F - Prototype I and Customer Feedback	Deliverable F	March 3
Deliverable G - Prototype II and Customer Feedback	Deliverable G	March 10
Deliverable H - Prototype III and Customer Feedback	Deliverable H	March 24
Deliverable I - Design Day Presentation Material	Deliverable I - Design Day Presentation Deliverable I - Script and Relevant Work	April 4
Deliverable J - Project Presentations	Deliverable J - Presentation.pptx	March 14
Final Video	Final Video Submission	April 4
Unity Files (Download)	Unity Folder	April 4

10 APPENDIX II: Other Resources

10.1 References used for the Creation of "Echoes of Tomorrow"

The following links are all tutorials or references that our group had used to finish the third prototype of our project:

Mesh Colliders: https://youtu.be/Q88f4u9mKqQ?si=Q-cxWDM8kCes5FMx

Colliders & Hitboxes: https://youtu.be/mkErt53EEFY?si=-VPusjktbVUCBSsm

Fixing Missing Particles: https://youtu.be/yvLsGuZodaQ?si=MOJtCaf-zKJuzqI1

Fixing FPS in Unity: https://youtu.be/DoHPx5RQ7P4?si=OU4DYw5OCsPYeE6U

Frame Rate Limit: https://youtu.be/P5PQV0SW0pI?si=GivoOOd7HjtxYKU3

Adding Audio & Sound effects: https://youtu.be/N8whM1GjH4w?si=bl5EB8cJEc-f1LYd

The song we chose to use in our game for Prototype III:
https://youtu.be/6ozWxuWtQq4?si=LuPe1qJjH_S7JUB2

How to Animate Characters in Unity 3D: https://youtu.be/vApG8aYD5aI?si=ZpFixhpfThgwMA88

Unity Timeline Animation: https://youtu.be/RRMMnwWZH10?si=dclvn5GAcAAHDKNk

10.2 Trello Links

The following links were used to help organize our team in conducting activities and tasks on time. To refer to how our group had accomplished our tasks in a certain time frame, refer to the Trello links below to understand when we did certain tasks and who took that responsibility.

Note that Trello is a scheduling website that allows multiple users to edit a bulletin board of tasks.

Group Tasks:
https://trello.com/invite/b/BVQUyzOo/ATTIffa561593f1eb68dd5f7bae366d91099C0403DE3/gng1103-group-14

Group Deliverable Progress:
https://trello.com/invite/b/nBKqHlud/ATTIedb77cf20bf59f8d9431a337a519c81e59084991/gng1103-project

10.1 Keyboard Controls Script for Player Movement

The following script allows for a model to move around in 3D space when implemented into a Unity C# script. Refer to the tutorial link above to understand how to implement it.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using TMPro;

public class PlayerMovement : MonoBehaviour
{
    [Header("Movement")]
    public float moveSpeed;

    public float groundDrag;

    public float jumpForce;
    public float jumpCooldown;
    public float airMultiplier;
    bool readyToJump;

    [HideInInspector] public float walkSpeed;
    [HideInInspector] public float sprintSpeed;

    [Header("Keybinds")]
    public KeyCode jumpKey = KeyCode.Space;

    [Header("Ground Check")]
    public float playerHeight;
    public LayerMask whatIsGround;
    bool grounded;

    public Transform orientation;

    float horizontalInput;
    float verticalInput;

    Vector3 moveDirection;

    Rigidbody rb;

    private void Start()
    {
        rb = GetComponent<Rigidbody>();
```

```
        rb.freezeRotation = true;

        readyToJump = true;
    }

    private void Update()
    {
        // ground check
        grounded = Physics.Raycast(transform.position, Vector3.down, playerHeight
* 0.5f + 0.3f, whatIsGround);

        MyInput();
        SpeedControl();

        // handle drag
        if (grounded)
            rb.drag = groundDrag;
        else
            rb.drag = 0;
    }

    private void FixedUpdate()
    {
        MovePlayer();
    }

    private void MyInput()
    {
        horizontalInput = Input.GetAxisRaw("Horizontal");
        verticalInput = Input.GetAxisRaw("Vertical");

        // when to jump
        if(Input.GetKey(jumpKey) && readyToJump && grounded)
        {
            readyToJump = false;

            Jump();

            Invoke(nameof(ResetJump), jumpCooldown);
        }
    }

    private void MovePlayer()
    {
```

```
        // calculate movement direction
        moveDirection = orientation.forward * verticalInput + orientation.right *
horizontalInput;

        // on ground
        if(grounded)
            rb.AddForce(moveDirection.normalized * moveSpeed * 10f,
ForceMode.Force);

        // in air
        else if(!grounded)
            rb.AddForce(moveDirection.normalized * moveSpeed * 10f *
airMultiplier, ForceMode.Force);
    }

    private void SpeedControl()
    {
        Vector3 flatVel = new Vector3(rb.velocity.x, 0f, rb.velocity.z);

        // limit velocity if needed
        if(flatVel.magnitude > moveSpeed)
        {
            Vector3 limitedVel = flatVel.normalized * moveSpeed;
            rb.velocity = new Vector3(limitedVel.x, rb.velocity.y, limitedVel.z);
        }
    }

    private void Jump()
    {
        // reset y velocity
        rb.velocity = new Vector3(rb.velocity.x, 0f, rb.velocity.z);

        rb.AddForce(transform.up * jumpForce, ForceMode.Impulse);
    }
    private void ResetJump()
    {
        readyToJump = true;
    }
}
```

10.2 Mouse Controls Script for Camera Movement:

The following script allows for a camera to be moved around around in 3D space when implemented into a Unity C# script. Refer to the tutorial link above to understand how to implement it.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class PlayerCam : MonoBehaviour
{
    public float sensX;
    public float sensY;

    public Transform orientation;

    float xRotation;
    float yRotation;

    private void Start()
    {
        Cursor.lockState = CursorLockMode.Locked;
        Cursor.visible = false;

    }

    private void Update()
    {
        float mouseX = Input.GetAxisRaw("Mouse X") * Time.deltaTime * sensX;
        float mouseY = Input.GetAxisRaw("Mouse Y") * Time.deltaTime * sensY;

        yRotation += mouseX;
        xRotation -= mouseY;
        xRotation = Mathf.Clamp(xRotation, -90f, 90f);

        transform.rotation = Quaternion.Euler(xRotation, yRotation, 0);
        orientation.rotation = Quaternion.Euler(0, yRotation, 0);
    }
}
```

10.3 Update Camera Position Script for Camera Movement:

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class NewBehaviourScript : MonoBehaviour
{
    public Transform cameraPosition;
    private void Update()
    {
      transform.position = cameraPosition.position;
    }
}
```