GNG1103

Design Project User and Product Manual

Troubleshooters' VR Experience Manual

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Table 1. Acronyms

Acronym	Definition
BOM	The bill of materials used in the project
UI	The way the user interacts with the VR
UPM	The user and product manual
UX	The user experience of the product
VR	images and sounds created by a computer that seem almost real to the user, who can interact with them by using sensors

Table 2. Glossary

Term	Acronym	Definition
Virtual Reality	VR	images and sounds created by a computer that seem almost real to the user, who can interact with them by using sensors
Bill Of Materials	BOM	the bill of materials used in the project
User Experience	UX	The user experience of the product

1 Introduction

This user and product manual is to give the necessary information for anyone who can use a VR device to experience our VR program about autonomous weapons. It also can be helpful for designers who are wishing to create a VR experience to raise awareness about the danger of autonomous weapons. It even can be used as a reference for any project related to VR experiences or programs that are built using Unity platform. The manual will go over the process of creating a VR experience using the Unity platform. Our product is an effective and helpful tool to deliver an educational message about a certain topic and raise awareness (about autonomous weapons in our case). It is built professionally and fits the market criteria so that it can be integrated into the market if a client wishes to do so.

2 Overview

Autonomous weapons raise several moral and ethical concerns that decision makers need to be made aware of. It is important for decision makers to start negotiations on these weapon systems before they are available to use. Politicians and diplomats still see this issue as theoretical, and they don't see how such a revolution in warfare would have a major impact on many individuals.

The target audience are politicians/decision-makers. The program aims to draw attention to the possible consequences of allowing autonomous weapons development. In some way, we hope the message that our product delivers changes decisions and saves lives.

Our product was designed with inexperienced users in mind. Control aid and player guidance is placed everywhere to ensure a smooth experience for everyone.

Our product delivers the message with clarity and provides an immersive experience for the user. User interactivity is a point of strength in that aspect as it makes the user understand the depth of the matter in hand. The user can interact with the environment and be in touch with the potential repercussions of deploying autonomous weapons on the ground.

Moreover, the storyline is a distinguishing factor of our product. The story puts the user on both sides of the problem. The user experiences an autonomous weapon attack from the point of view of a higher-up authorizing their use, then as the citizens being affected by the brutality of such decisions.

Lastly, our product has a great mechanism to test its efficiency by asking for immediate feedback from the user as soon as they finish the experience. As we seek to change the view of decision makers we want to know if they will change their mind by the end of the experience. So,

we incorporated a survey at the end of the program asking the user to make a decision on whether they would deploy these autonomous weapons. This will serve as a success measurement of our product and give an immediate result of how effective and impactful the product was on the user.

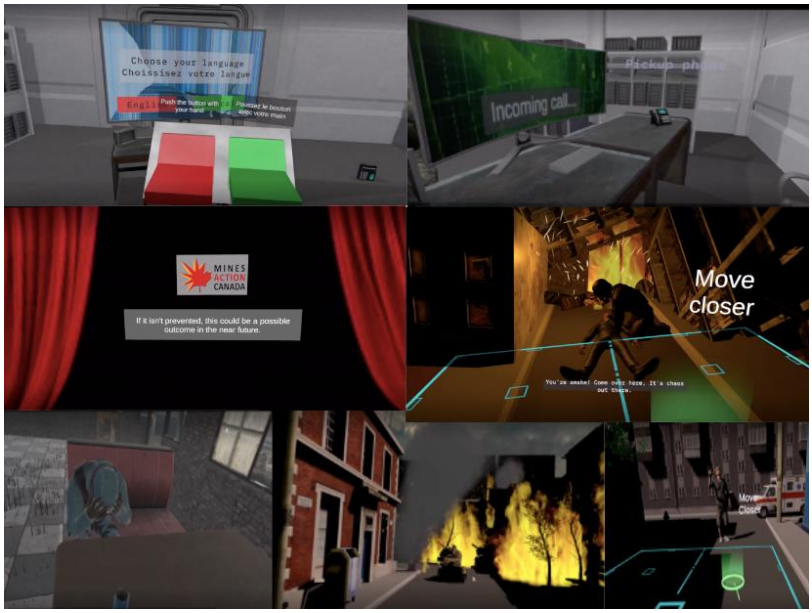

Figure 1. The final Prototype

The product is a VR experience, built using Unity3D. The product aims to raise awareness of autonomous weapons by walking the player through a possible sequence of events, leveraging the user interactivity of VR to deliver a more lasting and impactful message.

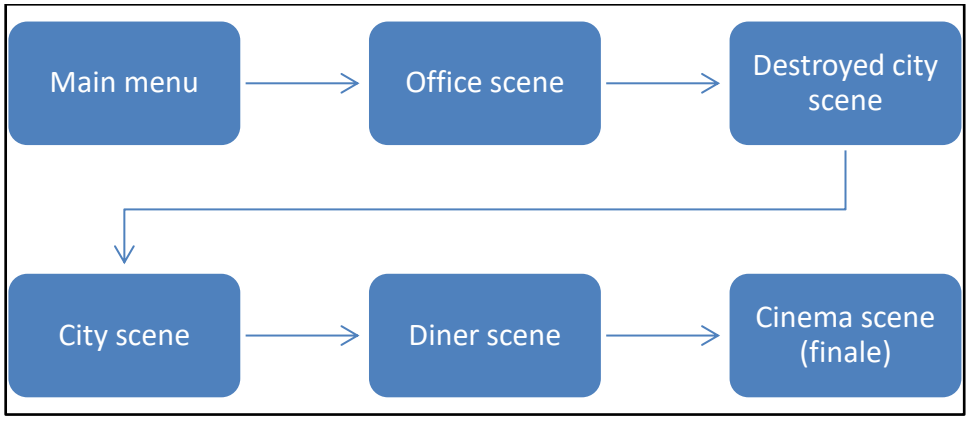

Figure 2. Block Diagram of the Product structure

2.1 Conventions

Various acronyms are used in this document. Refer to the glossary when needed.

2.2 Cautions & Warnings

- Players new to VR might experience nausea or motion sickness. If users ever experience discomfort, immediately exit the system to avoid heath issues.
- While using the VR, you should stay aware of your surroundings, so you don't bump into things.
- Be careful when imitating the motions inside of the VR not to throw the controllers by accident.
- Headaches may occur with the use of VR, ensure to takes breaks in between trials and hydrate.

3 Getting started

Figure 3. Elements of the VR set.

Figures 3 shows an HTC Vive headset (middle) with two handheld controllers (front) and two base tracking stations (back). Figure 3 also shows the PC adapter in the middle. Not shown are the two poles to mount the base tracking stations on.

Figure 4. Base station of the VR headset

Step 1:

Set up the base station so it resembles the image to the left. You will need to make sure they are screwed in tight, so they don't fall and turn them on. Place them on opposite corners of the room to ensure largest possible coverage and ensure the green light it on.

Figure 5. PC adapter

Step 2:

This is a PC adapter which should be plugged into the computer PC as well as the headset itself through the wires in the box. Ensure the HDMI cable is plugged to the GPU. Refer to the VR user manual for more specific instructions.

Figure 6. Elements worn by the user

Step 3:

The game uses SteamVR for VR interaction, and thus should be calibrated for room mode through SteamVR.

Put the headset to your eyes and tighten the straps around your head as necessary. Tighten the wrist straps on the controller around your wrist. Ensure player height is well calibrated.

3.1 Configuration Considerations

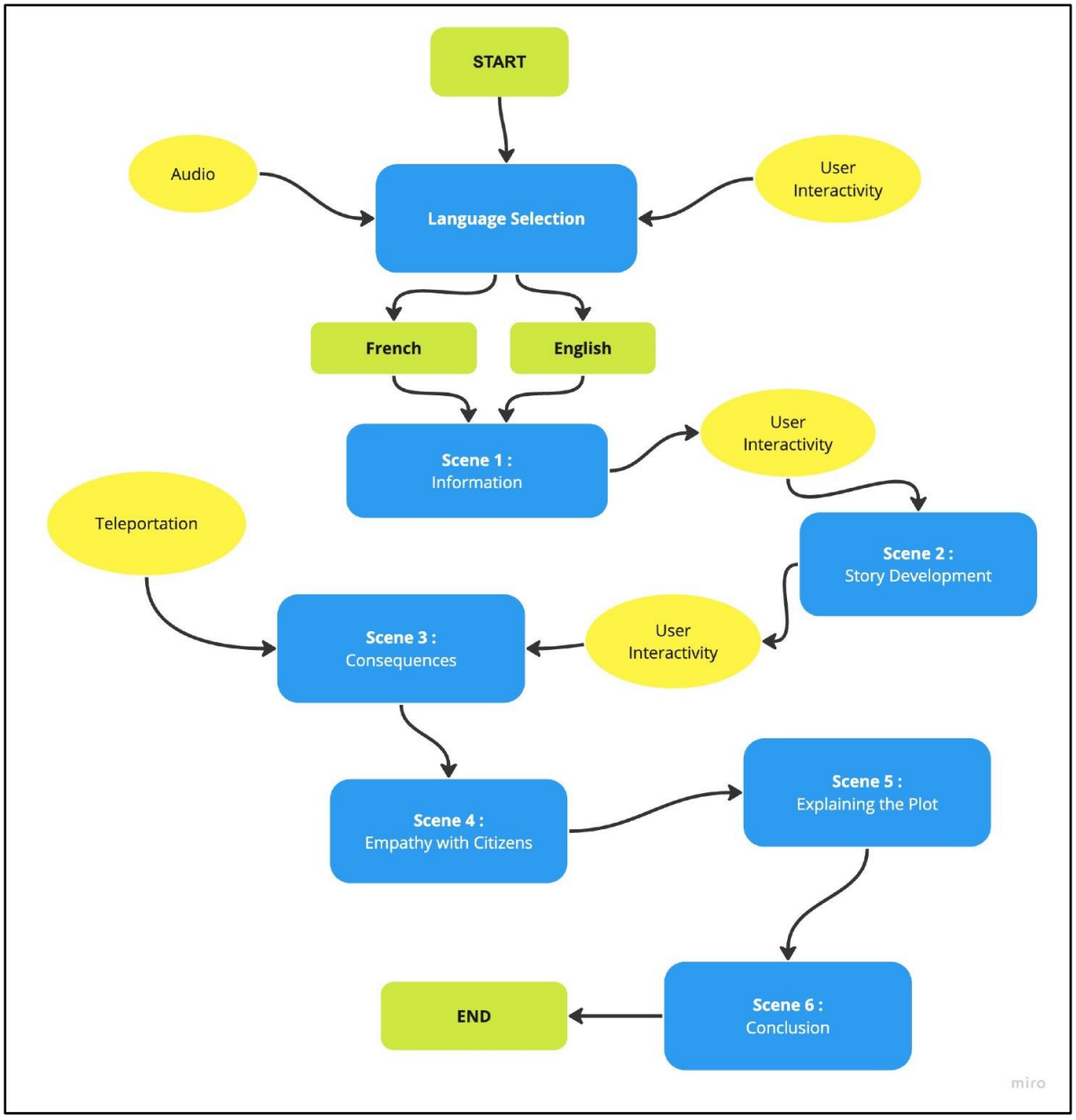

Figure 7. VR Experience Flowchart

In this flow chart, the three different colors represent three different elements of the game; the blue boxes being each scene and their corresponding title, the yellow is the UI in each scene and the green is the basic skeleton of the experience. Where the yellow user interactivity bridges the gap between the scenes is where the scene change is dependent on the user performing some sort of action to keep the experience going. While teleportation is incorporated into each scene, the ones

where teleportation is specified in a yellow circle are the ones where teleportation is used to keep the storyline going. Audio is present in each scene but is especially present in the first couple of scenes.

3.2 User Access Considerations

Users with visual impairments will not be able to experience the visual effects, however, the soundtrack and audio will provide users with the instructional information as well as the background information regarding autonomous weapons in the beginning scenes. Users will still be able to experience the storyline as all dialogue is recorded and provide a brief description of what is occurring.

Users who are hard of hearing will still be able to experience the experience as it has subtitles and technical instructions written in. All the dialogue is written out so the user can read along, and the restriction will not limit them from getting the message of the experience.

Government officials and diplomats would also be using our VR experience, a restriction for this group would be the space they have available for them to use it. Although we incorporated teleportation to reduce the amount of movement for the user, the set-up of the VR itself needs about 9m^3 of space for the monitors. Another restriction beyond physical space would be people getting in the way of the monitors. This causes an issue as the monitors would not be able to pick up the user or the actions that they are doing if an obstruction (person or object) is in the way. This would be a probable outcome with government officials as they would most likely be using a VR system at conventions or in places with many people around.

The final group of users that would be using VR would be students. With all their excitement surrounding the functionality of VR, they may neglect to pay attention to the background information in the first scene and consequently miss the point of the experience. With our trials during design day, we noticed that many students who tried it ended up engulfed in the teleportation, the user interactivity and the visual effects of the scenes which resulted in confusion as to why certain scenes were happening. Consequently, we had to explain the storyline a lot more than we initially thought we would have to ensure the users were getting what they were supposed to get out of the experience.

3.3 Accessing/setting up the System

1. Download the system – the only possible option is grabbing the binaries from the MakerRepo, as the build assets are too large to share and contain licensed material.
2. Set up the VR -- The two tracking stations must be set up diagonally and afar from each other. Connect the headset to the computer with the cords and PC adapter from the box. Ensure the HDMI cable is plugged to the GPU. This will connect the computer to the headset through the PC adapter.
3. How to wear it – Put the goggles around your eyes first then adjust the straps around your head as necessary. Once you have the goggles on you will not be able to see and that could be an issue, which is why it is important to have another person with you to help. Have this other person hand you the remotes, ensuring they are turned on by

holding down the button in the center until it is green. Adjust the wrist straps as necessary.

4. Running the game binary should automatically launch SteamVR and setup the controls.

Precautions: The VR must be set up in an open space with no tripping hazards or obstacles. Ensure the VR is well calibrated and centered to the middle of the room. If any other questions arise, refer to the VR manual for calibration instructions.

3.4 System Organization & Navigation

All internal workings of the system are hidden away from the player and should not need any interaction. Nevertheless, a description of their operation is shown below

3.4.1 Physical components

A VR headset with positional tracking and at least one controller is needed to start the system. Pressing the circular button allows 'teleporting', pressing the back triggers allows grabbing.

3.4.2 Language

The main menu scene asks for language at the beginning. Internally, a static global Boolean is set in LanguageControls.cs (see appendix for source code) to indicate to all subsystems the language chosen. All other subsystems read this global variable and act accordingly.

3.4.3 Audio system

The audio subsystem relates to the animation subsystem. There exist two timelines per scene, one for each language. The animations played are identical, but the timings and voice lines played are different. A per-scene script selects which timeline to enable/disable based on the global language option.

3.4.4 Subtitles

All text is managed by TextTypewriter.cs. It interacts with subtitle UI elements and displays subtitles according to language chosen. Tooltips and other non-dynamics texts are managed by TextReplacer.cs

3.4.5 Character animations

All character animations are synced with audio and player movement. Eve

3.5 Exiting the System

Reaching the end screen should exit the system. Otherwise, pressing ALT-F4 is the only other way to prematurely exit the system.

4 Using the System

4.1 Main menu

The first scene (called the 'main menu') contains a podium with two hover buttons in the middle of the scene. A screen in front displays a message and instructions. Choosing a language here sets the display language for the rest of the program. Most custom scripting and complexity come from supporting what is almost two different versions of the program.

4.2 First scene

The player is placed in an office. A soldier walks in, then a phone ringing plays. Grabbing the phone on the desk begins the scene transition.

4.3 Second/Third Scene

Both scenes are triggered by approaching a character and entering a specified trigger area. Entering said trigger area plays a timeline depending on language chosen. Tooltips on the scene indicate where to go.

4.3.1 Third scene special trigger

In the third scene, after the player approaches the trigger area, the system waits until the player turns around before starting the particle effects and scene switch sequence. This is to ensure the player does not miss the action.

4.4 Fourth scene (Diner scene)

The player simply waits and listen to the story explanation until the scene transition begins.

4.5 Fifth scene (Cinema scene)

The player watches a final message on the theatre projection and waits until the game exits.

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

Some bugs are present in the final built, due to deadlines preventing us from fixing them. None of them affect the overall progression of the experience but may raise some questions when playing.

1. The main menu buttons are disable when both the audio and text are still being written/read. They might appear broken, especially when played without earphones.
2. The game does not wait for the user's opinion after finishing the main menu message.
3. In the city scene, after the tank appears all particle effects may disappear before the scene fades to black.
4. The user might be placed in a position outside the play area, causing the view camera to clip through geometry.

5.2 Special Considerations

There's an unfortunately large amount of unused code and files, some of them might be referenced by others despite being inactive. However, the build process should strip them out of the final executable.
Note that tall players might have difficulty reaching the buttons on the podium.

5.3 Maintenance

No maintenance needed on the software part of the system. Refer to the VR headset's user manual for instructions on hardware maintenance.

5.4 Support

For technical support/questions you can contact the university for contact information of any of the team members.

6 Product Documentation

This section of the report focuses on the project's documentation, which includes how each individual feature of the VR experience was developed in Unity and how they were integrated in the software.

All prototypes were built with Unity3D, a cross-platform game engine. Most assets were imported from the Unity Asset Store to. Voice lines were recorded by team members.

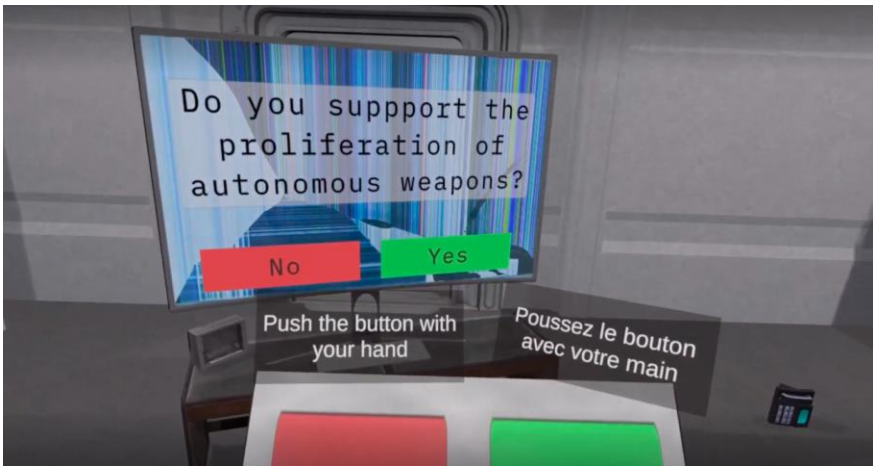

Figure 8. Main Menu

All text displayed uses built in Unity UI elements, with custom scripts described in Section 5, to manage display language and text timing. The buttons used in the first scene use built in Steam VR Hover buttons scripts, showing initial VR interactivity.

The first scene that appears upon starting the VR experience is the main menu screen. In this scene, the user is asked to choose their preferred language (English or French). Once the language is chosen, a brief overview on how to use certain features is presented. These instructions include how to user the controllers, the buttons, etc. UI buttons were incorporated in most scenes, where it allowed the user to interact within the experience. Once the buttons are pressed, it triggers a next

dialogue or a transition to a next scene. For instance, represented in the figure below, at the end of the first scene, the user is asked a yes or no question related to whether they support autonomous weapons. The user would have to match their response to the question by pushing the button that matches the colour shown on the screen.

The other scenes consist of the player interacting with the environment to start an event or show a specific message. All scenes have voice acting, are subtitled, and are self contained to stay within the required time limit.

Custom scripts were critical to the success of this prototype. Animation timing, subtitles, audio timing all used custom scripts specific to each event. A link to the source code repository is attached below.

6.1 Assets

6.1.1 BOM (Bill of Materials)

Table 3. Bill Of Materials

Part #	Part Name	Description	Quantity	Unit Cost	Extended Cost
1	Personal computers	Provided by team members and university	5	NA	NA
2	Unity	3D game engine. Student/Personal edition used	5	NA	NA
3	HTC Vive	VR set, provided by university	1	NA	NA
4	Unity Asset: Apocalyptic Wasteland	Unity Asset https://assetstore.unity.com/packages/3d/environments/urban/apocalyptic-wasteland-105051	1	$20.60	$20.60
5	Unity Asset: Ambulance	https://assetstore.unity.com/packages/3d/vehicles/land/ambulance-70313	1	$0.00	$0.00
6	Unity Asset:	https://assetstore.unity.com/packages/3d/environments/roadways/low-poly-road-pack-67288	1	$0.00	$0.00

	Broken Vector- Low poly road pack				
7	Unity Asset: Building Apartment	https://assetstore.unity.com/packages/3d/environments/building-apartment-80004	1	$0.00	$0.00
8	Unity Asset: Destroyed_city	https://assetstore.unity.com/packages/3d/environments/sci-fi/destroyed-city-free-6459	1	$0.00	$0.00
9	Font: IBM_Plex_Mono	Font https://fonts.google.com/specimen/IBM+Plex+Mono	1	$0.00	$0.00
10	Unity Asset: Low Poly Soldiers_demo	https://assetstore.unity.com/packages/3d/characters/low-poly-soldiers-demo-73611	1	$0.00	$0.00
11	Unity Asset: Pavement Textures Pack	https://assetstore.unity.com/packages/2d/textures-materials/roads/yughues-free-pavement-materials-12952	1	$0.00	$0.00
12	Unity Asset: LowPolyOffice	https://assetstore.unity.com/packages/3d/characters/low-poly-office-pack-characters-props-119386	1	$0.00	$0.00
13	Unity Asset: Rune Assets- Simple Urban Buildings	https://assetstore.unity.com/packages/3d/environments/urban/simple-urban-buildings-pack-1-33563	1	$0.00	$0.00
14	Unity Asset: Rune Assets-Road Blocker	https://assetstore.unity.com/packages/3d/props/exterior/road-blocker-663	1	$0.00	$0.00
15	Unity Asset: Russian_buildings	https://assetstore.unity.com/packages/3d/environments/urban/russian-buildings-pack-113375	1	$0.00	$0.00
16	Unity Asset: ScifiOfficeLite	https://assetstore.unity.com/packages/3d/environments/sci-fi/free-sci-fi-office-pack-195067	1	$0.00	$0.00
17	Unity Asset: Sky Series Freebie	https://assetstore.unity.com/packages/2d/textures-materials/sky/skybox-series-free-103633	1	$0.00	$0.00
18	Unity Asset: Small Tank	https://assetstore.unity.com/packages/3d/vehicles/land/small-tank-186792	1	$0.00	$0.00
19	Unity Asset: VRCinemaForMobile	https://assetstore.unity.com/packages/3d/props/interior/vr-cinema-for-mobile-150120	1	$0.00	$0.00
				Total	**$22.60**

6.1.2 Equipment list

Table 4. Equipment List

Item name	Description	Type	Prototype #	Source
HTC Vive	The VR set to test the program	Equipment	1,2,3	Maker Lab
Testing area	The lab space needed to test the VR	Safe empty space	1,2,3	Maker Lab
Test computers	Powerful test computers	Equipment	1,2,3	Maker Lab
Unity SteamVR Plugin	VR integration with Unity	Library		Valve

6.1.3 Instructions

Install Unity 2021.3.19 LTS. Ensure ILL2CPP module and MSVC tools are installed with the editor. To get a good starting point, it is important to start collecting and gathering different assets to use for scenes. The project uses various assets (prices range) which can be purchased from the Unity Asset Store. Our BOM indicates exactly which assets we used for our project, and we identified each of their cost. For each of our prototypes, we included all of the subsystems that we had determined from our conceptual design. Our team separated our conceptual design into the following 5 subsystems:

1) Storyline

The storyline was one of the most important aspects of our design product. It is what we deliver through our product, hence it had to be captivating and emotional while remaining under 5 minutes. The storyline had to be impartial and thus not refer to any real-world entity. It had to be short, concise, and clearly demonstrate the ethical issues of autonomous weapons. It could not be too graphic or violent as we wanted to avoid scaring users and detrimentally affecting the central message given.

2) Control Scheme

Our client chose virtual reality as a storytelling medium. It allows users to possibly influence event and give the scenarios proposed a larger impact. We aimed for a small range of motion as our target users - Canadian Parliamentarians and politicians - most likely do not have much experience with VR applications. The user is prompted for an action to advance the storyline, or to make a decision and branch out the storyline. Movement is mostly via teleportation or button clicking, as opposed to continuous motion like other VR games. Essentially, we incorporated this method to avoid triggering motion sickness in sensitive people.

3) Art Style and Accessibility

We avoided depicting scenes in a stereotypical or unrealistic fashion, but still took artistic liberty when necessary. Nevertheless, the art style had to be modern to near future, not science-fiction. No quick motion is present, no violent imagery, and no flashing lights.

4) User interactivity

Our solution involves user interaction to move the story. Some degree of user-interactivity is written into the story to take advantage of VR features and create a sense of cause-and-effect. The VR headset used – an HTC Vive – consists of a head mounted display and two hand tracking controllers.

5) Audio

Sound effects are used throughout to provide a greater immersive experience. Voice acting and dialogue is bilingual. The audio also plays a big role in the emotional aspect of our product. This subsystem is essential to our final product as it ensures the user fully understands our goal and the message from Mines Action Canada regarding autonomous weapons. A voice over can help to answer any questions, give useful information, and guide the user through the experience, ensuring the user gets the most immersive experience out of our virtual reality design.

6.2 Testing & Validation

The final prototype included our past two prototypes; however, we enhanced and improved them to get an overall better final product. This prototype was divided into different categories, which consisted of numerous tests. The test objectives were as followed:

1) Audio checking
2) Movement checking
3) User interactivity
4) NPC motion/ model animations
5) Script/dialogue
6) Transitions
7) Scene settings
8) Play testing.

Represented in the table below are a series of test we did during our prototyping phase. For each test, we provided a description, the results obtained, as well as an estimate of their timeline.

Table 5. Prototype Testing Plan

Test#	Test Objective (why)	Description (what)	Results (how)	Estimated Test duration (when)
1	Scene settings	Scene implementation, asset integration	Realistic, captivating and storytelling	3 hr
2	Model Animations	Sequencing animations correctly	Realistic and captivating interactions	3 hr
3	Camera Angles	Ensuring player vision is focused where needed	Find the best perspectives that showcase scenes	1 hr
4	Control Scheme	Method to interact with game	Measuring ease of use and learning	3 hr
5	Audio	Sound effects, ambience	Clear, captivating, bilingual	1 hr
6	User Interactivity	Integrating scene flow with VR	Teleportation method; encourages user participation	3 hr

7 Conclusions and Recommendations for Future Work

In conclusion, the development of this VR game has been a valuable learning experience for our team. We have gained a deeper understanding of the importance of the iterative design process. One of the most important lessons we have learned is that starting the prototypes early for a software type project is crucial because a lot of time is needed for testing a debugging. This will allow for identifying and addressing key design flaws and improve the overall user experience.

In terms of future work, we believe that there are several avenues that future teams could pursue to built on our work. The most productive route would be to develop the user feedback by conducting more extensive testing. Our group was not able to focus on getting user feedback as the game itself took most of our time.

If we had more time to work on our final version of the experience, we would focus on developing the storyline. We originally had a longer storyline that incorporated 2 flashbacks and multiple scenes that would have immersed the player much better into the cause of the game. Due to lack of time the story was cut to become extremely short and simple for the sake of meeting deadlines while still producing a full story.

Overall, we are extremely proud of the work and team effort that we poured into this project, and we believe, if further developed properly, it could have a significant impact on decision makers.

APPENDICES

8 APPENDIX I: Design Files

Table 6. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Source Code	https://github.com/PencilAmazing/GNG1103	
Maker Repo	https://makerepo.com/Joumana/1605.gng1103-f31-troubleshooters	