GNG 1103 - Engineering Design
Design Project User and Product Manual

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Table 1. Acronyms

Acronym	Definition
3D	Three Dimensional
AI	Artificial Intelligence
BOM	Bill of Material
MMS	Morality Mavericks Simulation
NPC	Non Playable Character
UPM	User and Product Manual
VR	Virtual Reality

Table 2. Glossary

Term	Acronym	Definition
Locomotion	N/A	Ability to move from one place to another
Hierarchy	N/A	Window on the left hand side of the Unity application that contains assets in the current scene

1 Introduction

This User and Product Manual (UPM) provides the information necessary for all types of users to effectively use the Morality Mavericks Simulation (MMS) and for prototype documentation. The idea behind The Morality Mavericks Simulation was to bring awareness to autonomous robots and demonstrate a potential society if the autonomous robots were released into our society. The MMS was created in a game platform called Unity and was intended for our client, Mines Action Canada who asked us to help design a project that convinced the public that having autonomous robots in our society would be detrimental to our living. Our audience for this UPM is anyone who wishes to either use, recreate or modify the MMS. We hope our UPM will help all users from those who have a basic level of understanding to those who have a vast level of understanding about gaming technology comprehend our goals, aspirations and reasons behind this project. This UPM will walk you through the cautions and warnings one should be aware of, how we started the process of the design, the steps for executing the prototypes and final design and suggestions for improvement. It will then conclude with any documents and websites referenced in the document.

2 Overview

The main reason why we wanted to bring awareness to these autonomous robots was to emphasize the threats and serious problems they could cause such as, the dehumanization of both the victims and shooters, the invasive surveillance and the lack of accountability. To start, replacing human shooters with robotic ones will take away the human aspect of both the shooter and the victim. Having robots deciding whether or not to pull the trigger can be catastrophic as it eliminates any human emotion behind the decision. This is a very serious issue as malfunctions could happen within the software such as glitches or even hacking. In addition, humans have empathy, judgment and other emotions that could affect an overall decision of taking or saving a life. With these human emotions gone, there would be no room for mercy or sympathy. Secondly, the AI surveillance that would have to be in place in order to monitor and detect suspects would be very invasive to any civilian's privacy. As AI surveillance is much more intrusive and intense than human surveillance, constant AI monitoring could cause a compromise in people's security. Lastly, the lack of accountability that would occur with the replacement of humans would be detrimental to any victims' families and friends as there wouldn't be a physical person to blame if anything went wrong with their algorithm.

With the help of Unity, we were able to create our personal views of what we imagined an environment to look like where these autonomous robots were released into society. Our goal was to demonstrate the chaos and intimidation the robots would invoke in the world but also give a sense of hope towards the end to show that something can be done to prevent a future like this.

Problem Statement: Mines Action Canada needs a short, simple and concise video that demonstrates the potential consequences of killer robots in a livable environment that invokes a feeling of concern with a glimpse of hope in the user.

What makes our product unique is the demonstration of how stores and shops will change in a world with autonomous robots, the incorporation of the effects the robots will have on children and including a sentimental component at the end of the simulation.

There are six main features in our design listed below;

1) The robot store: We wanted to demonstrate how the stores and the products people would buy would change in a society with robotic targeting. This store contains different methods one can protect themselves from the AI targeting with the news playing in the back warning customers about the latest robotic attacks.

2) Riots: As we assumed there would be many people who would not agree with the implementation of autonomous robots roaming around their neighbourhood, we wanted to incorporate voices of the people in the form of riots and protests against the government about their decisions to let autonomous robots in their society.

3) Bordered up windows and doors: As people will be paranoid about the robots roaming their streets, they will set up extra security precautions such as boarded up windows and extra locks on doors. The bordered up windows will help prevent targeting and spying into homes.

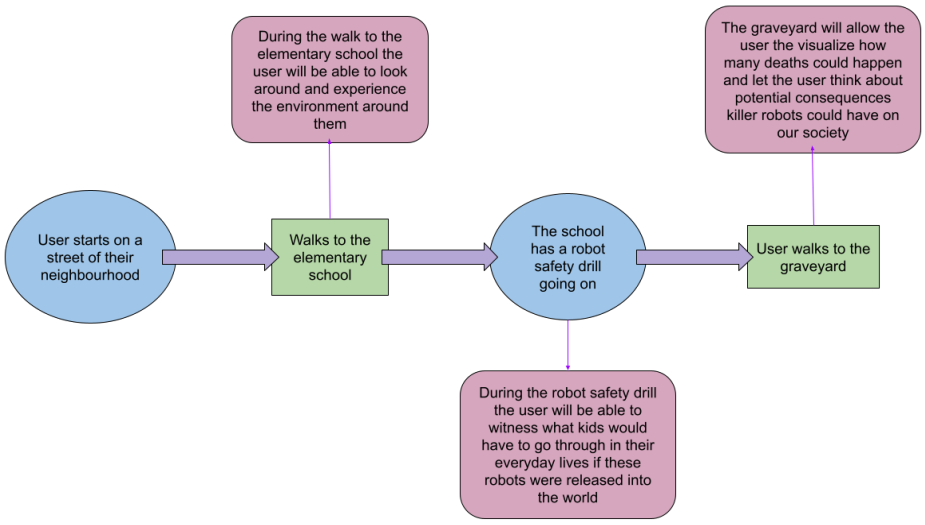
4) Posters: We wanted to include multiple posters warning and informing people about the threats of the robots and precautions they should take to keep themselves safe.

5) School safety drill: We wanted to incorporate the effect the robots will have on children, not just adults so we added a school to the simulation. The school has a robot safety drill playing on the PA system to represent a potential drill children would have to perform if a rogue robot came into their school.

6) Memorial: We thought having a sentimental section in our design would be more convincing and realistic to a realistic society. In order to include a sentimental component to the environment we decided to include a memorial where all the names of the people who have been killed will be up for display.

The main architectures in this simulation are the buildings on the road with a few NPCs protesting against the robots on the street. The buildings include the robot store, a grocery store, the school, the memorial and the apartment buildings and houses in the background.

Flow chart of our original storyline:



2.1 Conventions

There were no particular conventions used in this document.

2.2 Cautions & Warnings

As this project was all virtual there are not any major physical warnings although there is a potential risk for motion sickness. We incorporated a feature that reduces the amount of motion sickness but it can still affect the user if they are sensitive to motion. In addition there is a risk the user could feel claustrophobic while in the VR. As the VR headset is enclosed and covers most of the users face, one might feel claustrophobic while in the simulation. There are also some trigger warnings as this simulation deals with a low level of violence and chaos which could be triggering for some users.

3 Getting started

3.1 Configuration Considerations

3.1.1 Connecting The Headset

Visit the oculus website for information about downloading the oculus app as well as connecting the headset to your computer. The headset used for this experience is the Oculus

Metaquest 2. The game will require the use of both the headset and its controllers, in order to move the character.

3.1.2 System Requirements

The prototype was only tested on a windows PC, so we are not sure if it will run properly on a Macbook. Lower end laptops may run at lower frame rates, which may cause motion sickness to the user.

3.2 User Access Considerations

3.2.1 For the visually impaired: The experience may not have the same impact, as much of the game relies on visual aspects(i.e posters, protestors, overall environment). The audio will give context to what is going on, however, as it explains what the user is seeing as they walk through the game. An additional person may have to be present to move the character, as otherwise the audio will not be triggered.

3.2.2 For the hearing impaired: Unfortunately we did not have time to implement subtitles for the audio. Despite this fact, we believe that the message still gets across as the posters in the robot safety store as well as the protestors tell the user what kind of world the game takes place in, even though there is no audio.

3.2.3 Decision Makers, or people with no experience with VR: If you can, you may want to have someone explain the basic controls of the VR system. This includes looking around with the headset, and using the left joystick(the stick with a circle on top protruding from the controller). We found that we could not just hand someone the VR headset and controllers if they hadn't ever used VR or video game controllers before, as they wouldn't know how to move around the environment.

3.2.4 Faults in the design when used by the average person: We found that one issue with the game was that the player didn't always know where they were supposed to go to move on with the game. Particularly, they would either completely walk by the robot safety store, or walk inside and then not know where to go from there. It is recommended to first either show a video of the desired path, or explain where they should go before the user plays the game.

3.3 Accessing/setting up the System

3.3.1 Downloading the game

A link to download the game build can be found within the makerepo submission. Once downloaded, all you have to do is open the game application.

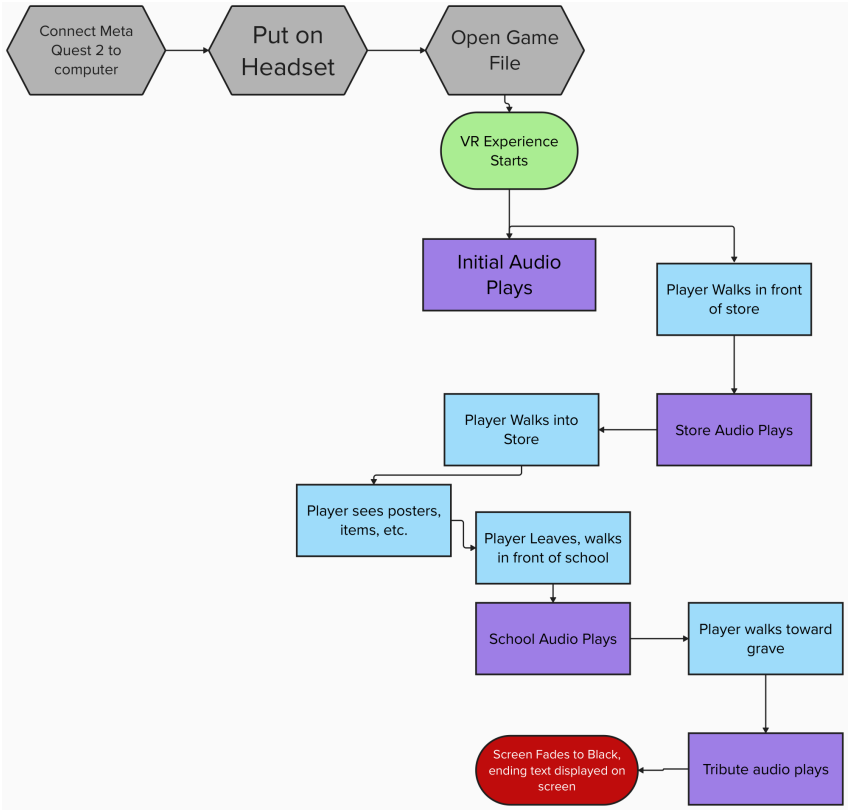
3.3.2 Starting the game

Once you have set up the Meta Quest 2 headset on your computer, you should just see the quest hub in the headset as seen:

Once you are in this hub, all you have to do is double click on the downloaded application, and the game should start and be visible within the Meta Quest 2 headset.

3.4 System Organization & Navigation

3.4.1 Flow chart of system operation:



3.4.2 Beginning of the experience

Once the game has been opened, the game will play an audio clip where the character being controlled is talking about his day at work. There will also be audio from protestors on the street. Nothing else will happen until the player moves forward toward the rest of the experience.

3.4.3 First Trigger Box - Store

When the player walks in front of the robot safety store, an audio will trigger where the narrator talks about how there is a new item. The player should then walk inside of the store.

3.4.4 Inside the Store

The player will see several items related to the killer robots. These include masks to protect yourself from facial recognition, a radar to see where the nearest robots are, and handheld radios for the public to be informed about the robots and when it is safe to be around them/ go outside. There are also posters around the store which explain each item, as well as newspapers which talk about the destruction caused by the killer robots.

3.4.5 Second Trigger Box - School

Once the player leaves the store, they will walk across the street and see more protesters as well as graffiti against the robots. They will then walk by a school, which will cause the second trigger box to play an audio clip of an alarm blaring, and an announcer on the PA sying that there is a robot safety drill.

3.4.6 Final Trigger Box - Tribute

Once the player walks by the school, they will see a headstone/tribute of the people who have been wrongfully killed by the robots. Once they walk up to it, another audio will play which explains that they have been wrongfully killed, and how he wishes something could be done about it. The screen then fades to black and text appears on the screen saying “Do you want killer robots to be a reality? #TeamHuman”.

3.5 Exiting the System

To exit the system, press the oculus logo on the right hand controller of the Quest 2 (**Figure 3.5.1)**. Then, there should be a prompt to exit the game, which you can select using your controller. Alternatively, you can press Alt+F4 on your computer, which will close the application.

Figure 3.5.1-The button with the oval shape on it in the bottom right can be used to exit the system.

4 Using the System

In our VR experience there are 3 main user functions. These functions are the VR camera, VR locomotion, and audio. The following subsections provide detailed, step-by-step instructions on how to use the various features or functions of these user functions and how they work.

4.1 VR Camera

The VR camera is how the user sees when they put on the VR headset. It allows the user to experience the environment we developed in unity in first person through the VR headset. This is how they will be able to see and actually experience the game we cultivated. When the user puts on the headset the VR camera tracks where they are, and when they turn their head or move their head up and down that movement is tracked and is then reciprocated in the game so the user could feel like they are actually in the game themselves. It also tracks if the user is moving around, and that movement is reciprocated in the game, but the user could only move in an area set up by the bounds of the VR headset, which is separate from the experience and is set when the user is setting up the system. When the user is in the game, if they move out of the bounds they set up, they won't be able to continue the experience until they go back into the bounds which they set up. The VR camera also has a sub-feature which allows snap turns of the camera.

4.1.1 Snap Turns

Using the right controller of the VR system the user has access to a feature called snap turns. When the user flicks the joystick on the right controller to the left or right the camera turns around 45 degrees to whichever direction the user flicked the joystick. This only works in the left and right directions horizontally. The purpose of this is so the user does not need to turn their body to look a certain way, in case they end up getting wrapped up in wires or something else, so this provides a safer way to turn.

4.2 VR Locomotion

To move around the environment there is a locomotion system to allow the user to walk around without having to walk around in real life so they can stay in their bounds. The locomotion system is set up to allow players to move through the environment, with colliders in place to keep the user where they are supposed to be, and to stop them from walking through objects in the game. To use this locomotion system users need to use the joystick, which is talked about in the section below.

4.2.1 Walking movement

Using the left controller the user has access to walking movement which is a part of the locomotion system. Using the joystick on the left controller the user is able to move through the environment in whichever direction they are pointing the joystick. The movement is oriented so that whichever way the camera is facing is forward, so whenever the user points the joystick forward (or up) they will move the direction they are facing. The purpose of this is so the user can move around the environment safely without having to leave the bounds they set up when setting up their VR headset.

4.3 Timeline Audio

When the user is in the VR game they will be able to hear audio which comes out at certain points. This audio is what gives the user a sense of what is going on around them, as they can hear noise from NPCs, and also the narration of the thoughts of the character which they play as they go through the experience. The audios are triggered by the user through a timeline. After the user passes through a certain point, it triggers the audio to play, so that certain audios will play at certain points in order to give the game story and make it more cohesive.

5 Troubleshooting & Support

Our VR experience has been built into a program/app from unity, so all that needs to be done to start it up. If the VR system is set up properly and the headset is on and the program is started then the program should run smoothly from the start until the finish. When the program cuts to the black screen after the experience is over the user can exit via their VR system or the task manager on their computer. There are some errors which may occur when going through the experience, and what they are and how to fix them are outlined in the next subsection.

5.1 Common Errors

One common error that may occur is when the user steps out of the playable area. When this happens they will be taken out of the VR experience and be shown their surroundings in the VR headset. To fix this the user needs to step back into the playable area they set up, and at that point they will be put back into the VR experience.

Another error that the user may experience is the app not starting up after you click it. If this is the case then the user will need to restart their device which they are trying to open the app on, and after that the app should open. If the app is not closing, then the user will need to go into the task manager on their device, and stop the app from there.

5.2 Support

In case of any unknown errors occurring which are not outlined above and support is needed please contact Andrew at ayusu090@uottawa.ca. When reporting these errors please include in detail what is going on, and why the experience isn't working, and if possible please include screenshots or pictures.

6 Product Documentation

6.1 Environment

6.1.1 Bill of Materials

Asset #	Asset Name	Link to Asset	Cost
1	Modular Low Poly Streets	https://assetstore.unity.com/packages/3d/environments/urban/modular-lowpoly-streets-free-192094	$0
2	Low Poly City Buildings	https://assetstore.unity.com/packages/3d/environments/urban/low-poly-city-buildings-256801	$20.45
4	Simple Generic Buildings - Cartoon Buildings	https://assetstore.unity.com/packages/3d/environments/simple-generic-buildings-cartoon-buildings-266743	$0
5	Church Model	https://assetstore.unity.com/packages/3d/environments/historic/church-model-110307	$0
6	Simple Drone	https://assetstore.unity.c	$0

		om/packages/3d/vehicles/air/simple-drone-190684	
7	Military camo bag	https://assetstore.unity.com/packages/3d/props/clothing/accessories/military-camo-bag-62496	$0
8	Character Pack-Lowpoly	https://assetstore.unity.com/packages/3d/characters/humanoids/character-pack-lowpoly-free-221766	$0
9	Walkie Talkie Radios	https://assetstore.unity.com/packages/3d/props/electronics/walkie-talkie-radios-245895	$0
10	Navigation Radar Console	https://assetstore.unity.com/packages/3d/props/electronics/walkie-talkie-radios-245895	$8.86
11	Low Poly Pack-Environment Lite	https://assetstore.unity.com/packages/3d/props/exterior/low-poly-pack-environment-lite-102039	$0
12	Police Car and Helicopter	https://assetstore.unity.com/packages/3d/vehicles/land/police-car-helicopter-52496	$0
13	Free Ceramic Vases	https://assetstore.unity.com/packages/3d/vegetation/flowers/free-flower-ceramic-vases-187046	$0
14	Low Poly Trees And Rocks	https://assetstore.unity.com/packages/3d/vegetation/lowpoly-trees-and-rocks-88376	$0

15	Barricade	https://assetstore.unity.com/packages/3d/props/exterior/barricade-652	$0
16	UK Terraced Houses	https://assetstore.unity.com/packages/3d/environments/urban/uk-terraced-houses-pack-free-63481	$0
17	Sci-Fi Soldier	https://assetstore.unity.com/packages/3d/characters/humanoids/sci-fi/sci-fi-soldier-29559	$0
18	Stylized Wood Texture	https://assetstore.unity.com/packages/2d/textures-materials/wood/stylized-wood-texture-153499	$0
19	Worn Wooden Planks	https://assetstore.unity.com/packages/2d/textures-materials/wood/worn-wooden-planks-54550	$0
20	Character Models	www.mixamo.com	$0
	Total		$29.31

6.1.2 Assets

To create our environment, the majority of the assets were obtained from the unity asset store. To find your desired assets, just type the description of the asset into the search bar. You can then sort by price. All assets that we used can be found in the BOM. Once you have purchased the asset, you can click “Open in Unity” to open the asset inside of your game. It will then open a window that shows you all of your assets. Click on the desired asset, then click download. Wait for it to finish, then click install.

6.1.2.1 Placing Assets

Once you have the assets that you need, you can start to create your environment. When creating your environment, remember that it should look like a regular city with modifications to show how people have changed to adapt to killer robots. In our environment, this included police cars blocking off streets from protestors, posters placed around the map, a robot safety store, a school with boarded up windows, and a tribute to people who have been killed by the autonomous weapons. The base construction of our environment was made by the modular city streets asset and the low poly city buildings. To place the roads down, simply drag and drop one into the scene window. You can then resize them however you want in the inspector window. You can then duplicate them with ctrl+D, and then merge them together by holding v, clicking on one corner of the road and dragging it to the corner of the other road. Repeat this process using the different types of roads to create the street layout of your city. This process can then be repeated with the city buildings and pavement to create a full city.

6.1.2.2 Creating Robot Safety Store

To create the robot safety store, we simply added onto the market asset that we purchased. We did this by creating four cubes, then resizing them to become walls. Then we added a roof, and some materials so that the building wasn't just white. To add a material to an object, just drag the material from the assets window to the object. We then added posters around the store. The posters are available for download on the makerepo submission. To add them into the environment, right click in the hierarchy window, create a plane, then drag and drop the image onto the plane and resize it to your liking.

6.2 VR Setup

6.2.1 Libraries

To use the Meta Quest 2 headset in unity, you must download the XR plugin management library, the oculus library, and the XR interactions library. To do this, in Unity click edit, then project settings. At the bottom you should see XR plugin management. Click on it, then click install. Once it is installed, it should look like **(Figure 6.2.1.1)**. Next, click the oculus box. This will install the oculus library. Then, click on window -> package management. In the top left corner, click on the drop down menu that says "Package: In Project", then click Unity Registry. Then, in the search box, type "XR Interaction Toolkit", and install the package that shows up. Once the package is installed, in the package manager, click on the XR interaction toolkit, then click "samples". Then, import the starter assets. Wait for them to import, then in the assets window, there should be a folder called "Samples". Open this folder, then XR Interaction Toolkit -> 2.5.2 -> Starter Assets -> Prefabs, then drag the XR Origin(XR Rig) to the hierarchy. This will

be the controller for the player. You can move this rig around in the environment to choose where you want the player to start.

6.3 Audio Triggers

One of the most important subsystems of the final prototype was the audio triggering system. This means that when the player enters a certain area, a pre-recorded audio will play. This was done using multiple collision detection scripts within unity, as well as making use of the timeline feature.

Item Name	Description	Type	Source
Meta Quest 2	VR Headset/Controllers	Equipment	Makerspace
Makerspace Laptop	Powerful Laptop that can handle the stress of unity	Equipment	Makerspace
Unity XR Plugin Manager, XR Interactions Toolkit	Libraries needed to set up VR	Library	Unity

6.3.3 Instructions

6.3.3.1 Creating the trigger box

To begin with this subsystem, the basic layout of the environment must be laid out, and the VR movement must be set up. Once this has been completed, you can start to create the trigger boxes. To start, right click in the unity hierarchy, then hover over 3D object, then click cube **(Figure 6.3.3.1)**. This should create a white cube in the environment **(Figure 6.3.3.2)**. Next, click the checkbox on the mesh render section to disable it, which will make the cube invisible **(Figure 6.3.3.3)**. Next, check the “is trigger” box on the collider of the cube. **(Figure 6.3.3.4)**

6.3.3.2 Adding the Trigger Script

Next, download the “Trigger” script from the maker repo submission. This will be used to play the audio when the player comes in contact with it. Once this is done, click “Assets” in the top left, then “Create”, then click New C# script. Then, copy and paste the

Trigger code into this script, and name the script Trigger. After this, drag and drop this script into the inspector window of the cube. **(Figure 6.3.3.5)**

6.3.3.3 Adding the Audio to the Object

Once the script is added to the trigger cube, right click in the hierarchy and click “Create Empty” **(Figure 6.3.3.6)**. Name this new object “Audio”. Then, in the inspector of this object, click “Add Component”. Then, in the search box, type “Audio Source”. Click on it to add it to the object **(Figure 6.3.3.7)**. Disable ”Play on Awake”.Then, drag and drop the audio clip that you would like to be played when the player enters the box to the area labeled “AudioClip” in the audio source **(Figure 6.3.3.8)**. Finally, navigate to your player camera, and add a tag of “Player”. Now, the desired audio should play when the player walks inside of the trigger box.

6.3.3.4 Placement of Trigger Boxes

The trigger box can now be resized and moved to the desired location.

6.3.3.5 Figures

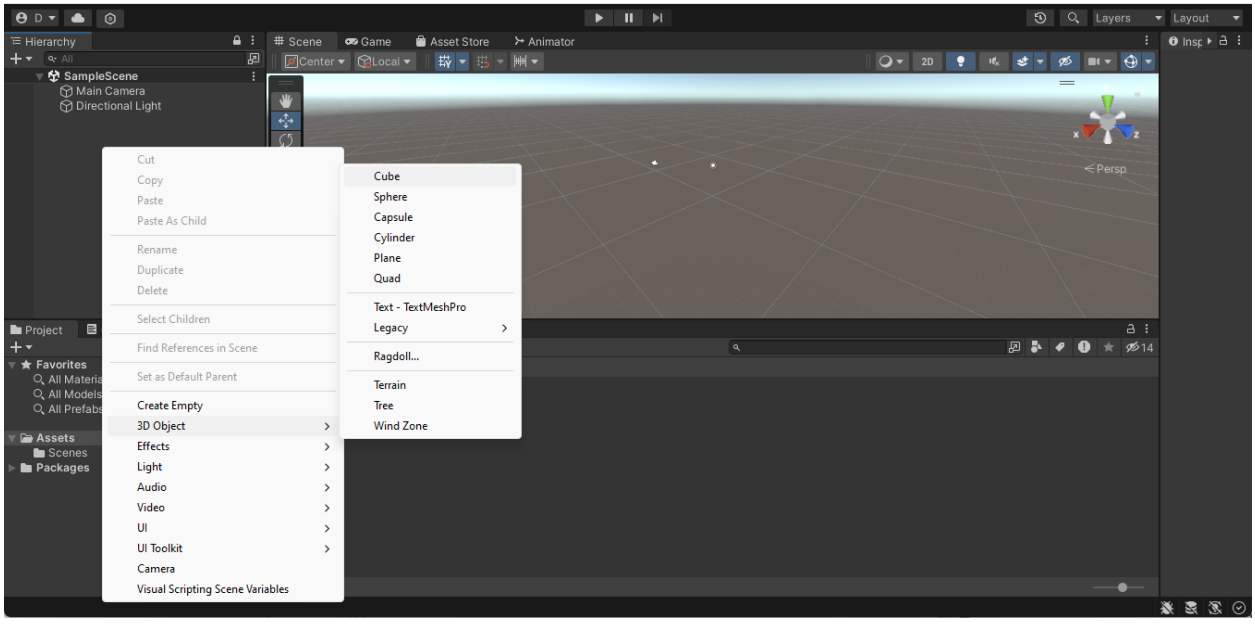


Figure 6.3.3.1

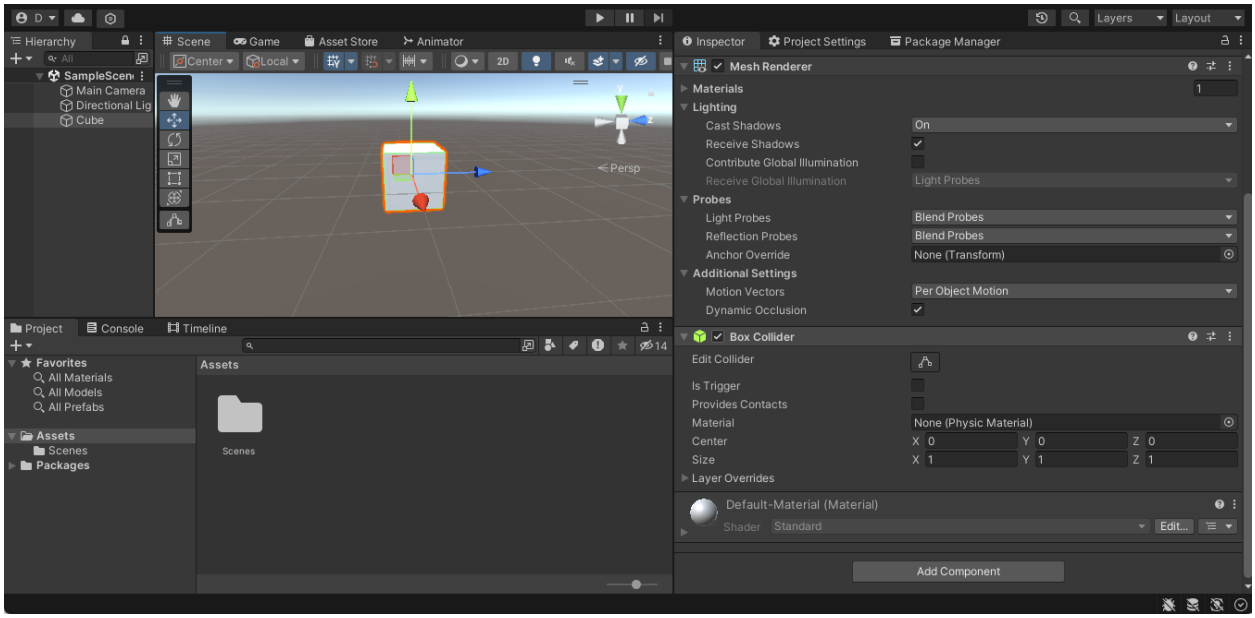
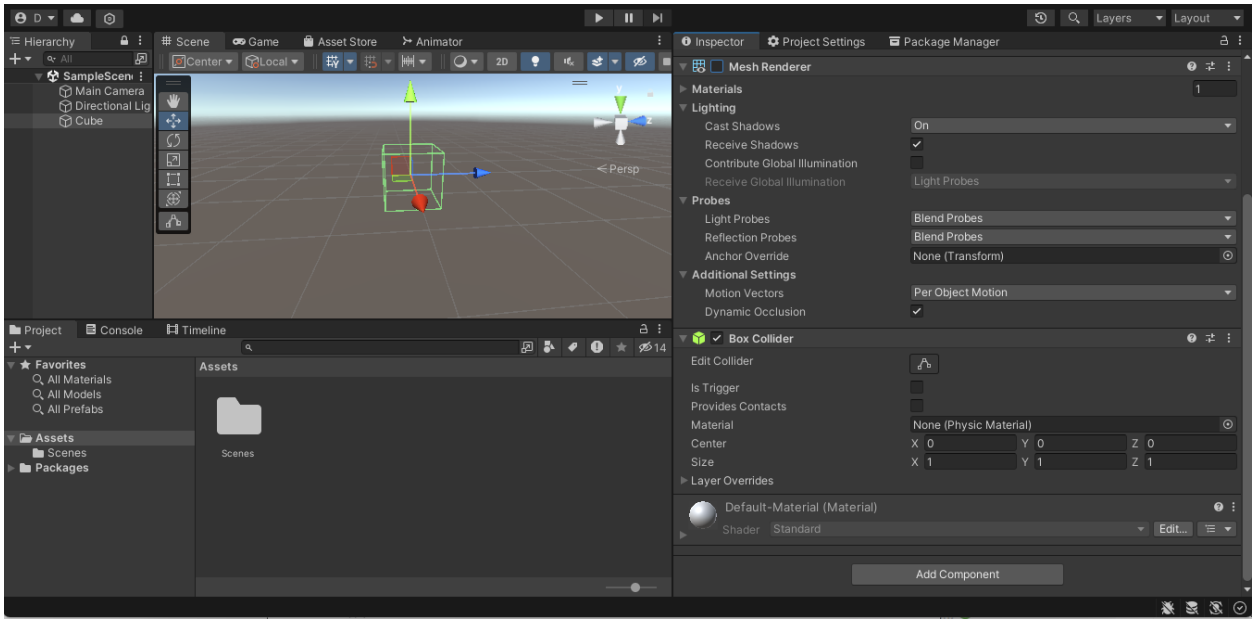


Figure 6.3.3.2



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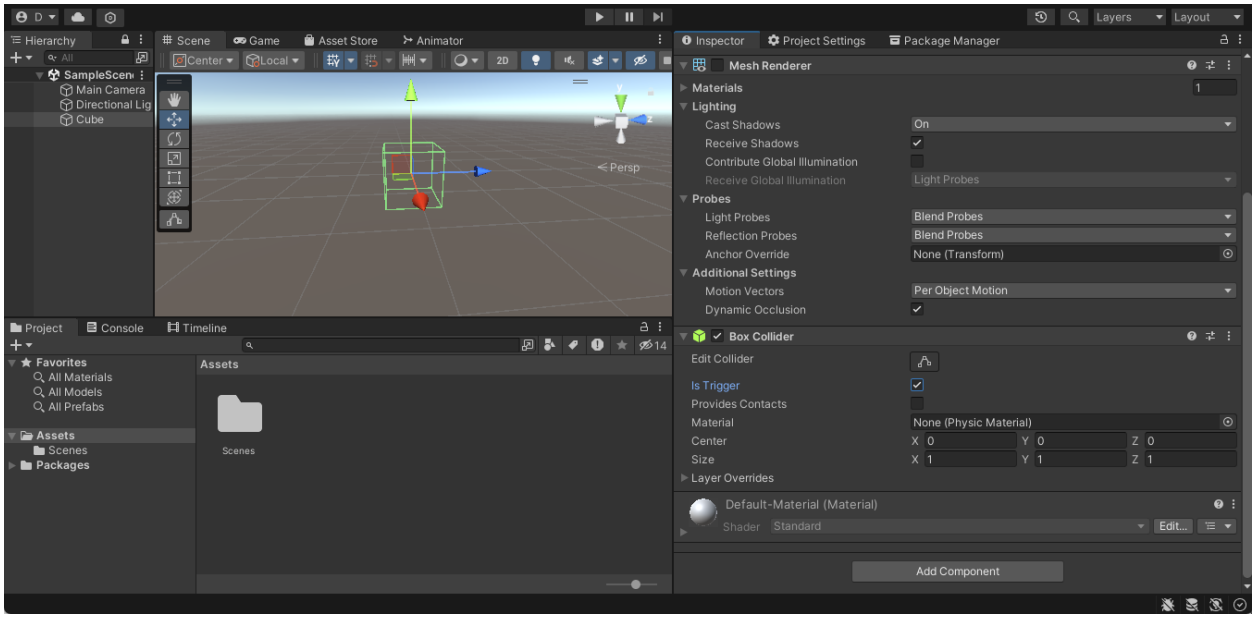


Figure 6.3.3.4

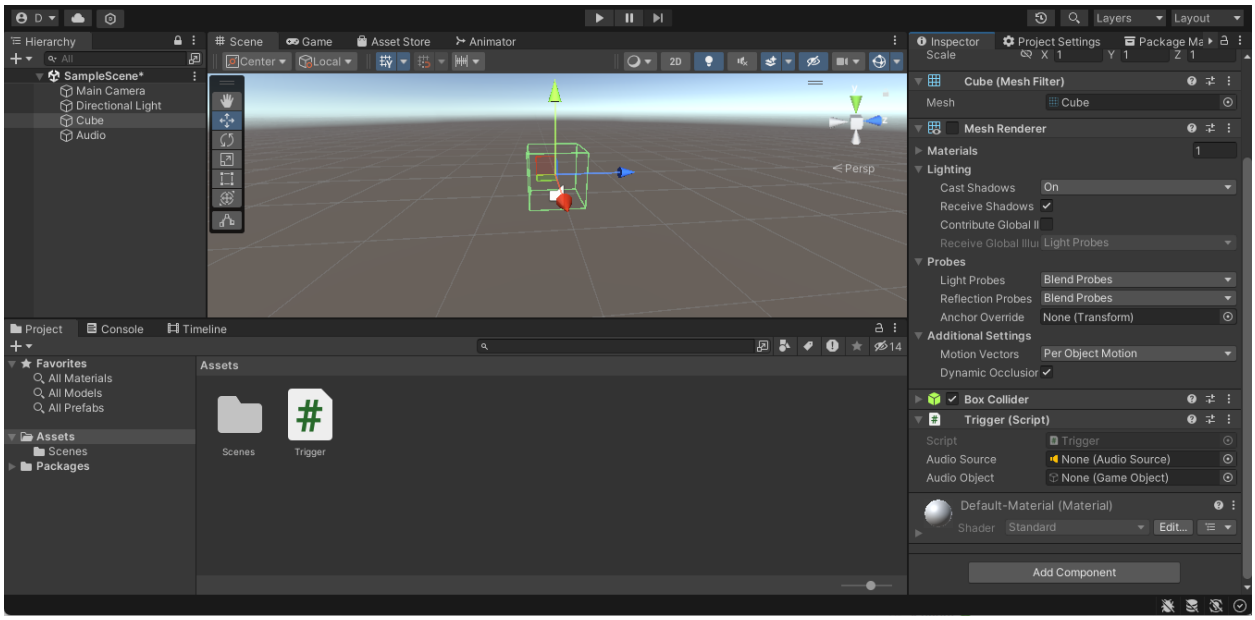
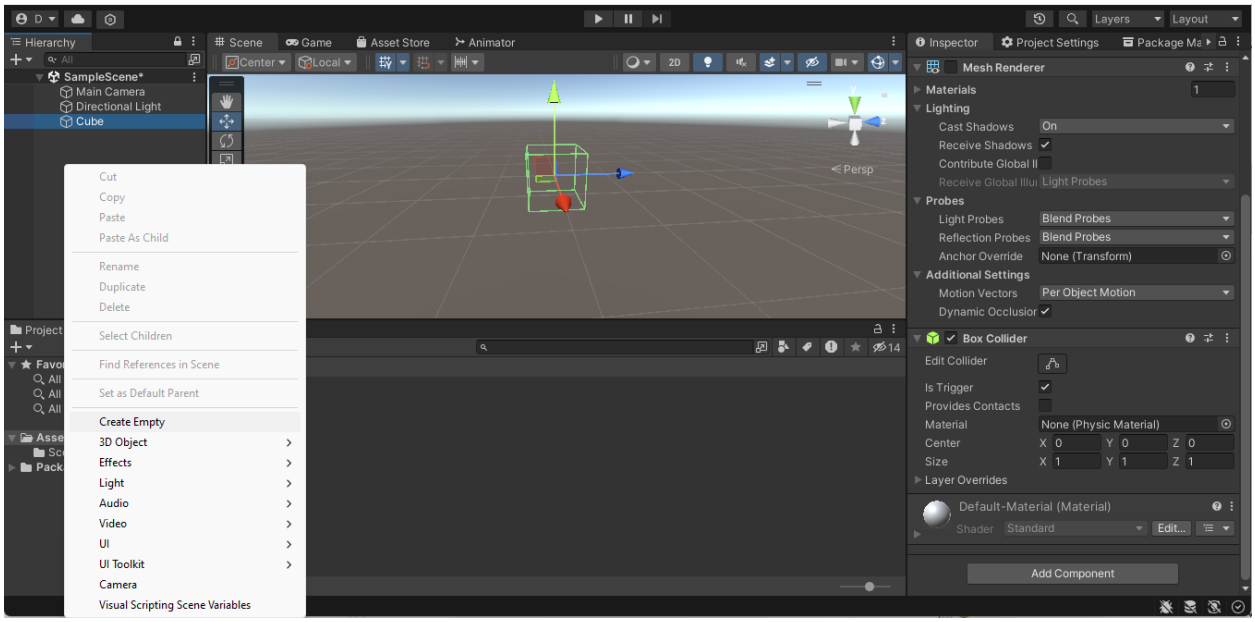


Figure 6.3.3.5


Hierarchy
SampleScene*
Main Camera
Directional Light
Cube
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Game
Asset Store
Animator
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Inspector
Project Settings
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Lighting
Cast Shadows
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Duplicate
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Set as Default Parent
Create Empty
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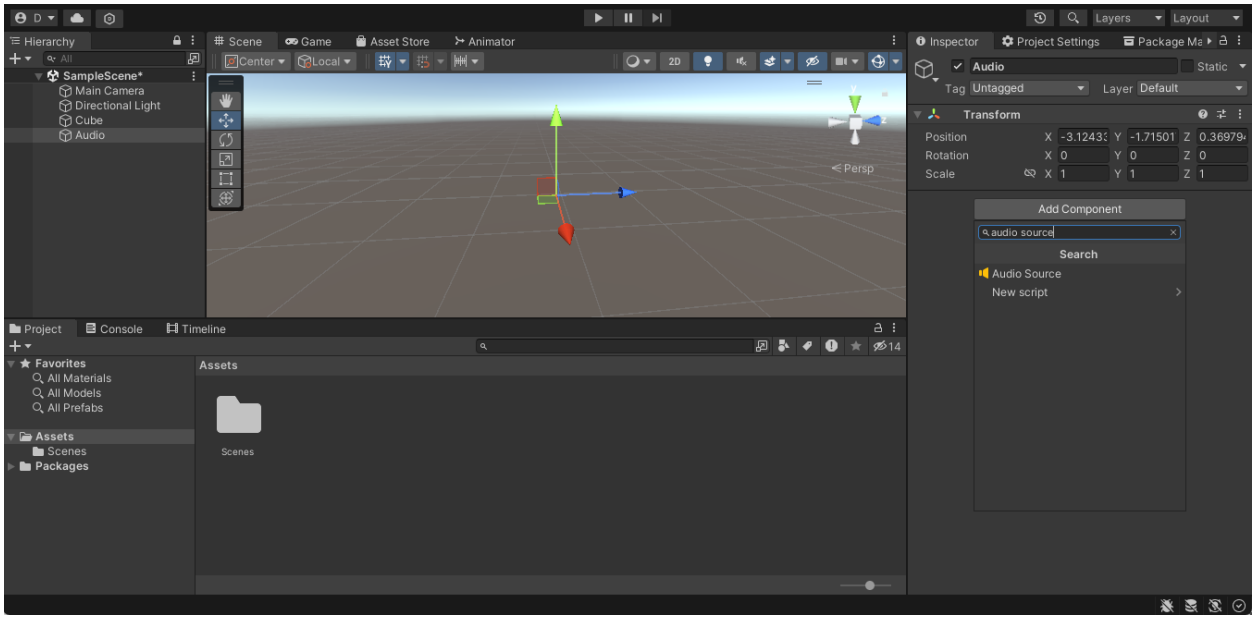
Audio
Video
UI
UI Toolkit
Camera
Visual Scripting Scene Variables

6.3.3.6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Scene
Game
Asset Store
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Persp
Inspector
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All Models
All Prefabs
Assets
Scenes
Packages

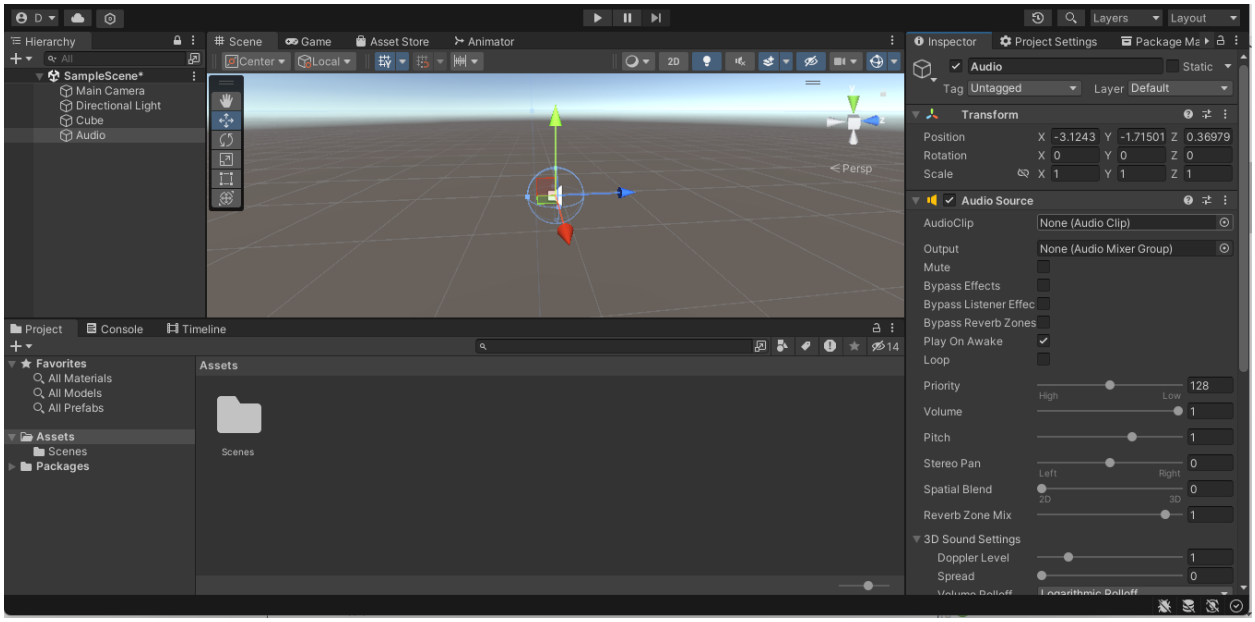

Figure 6.3.3.7

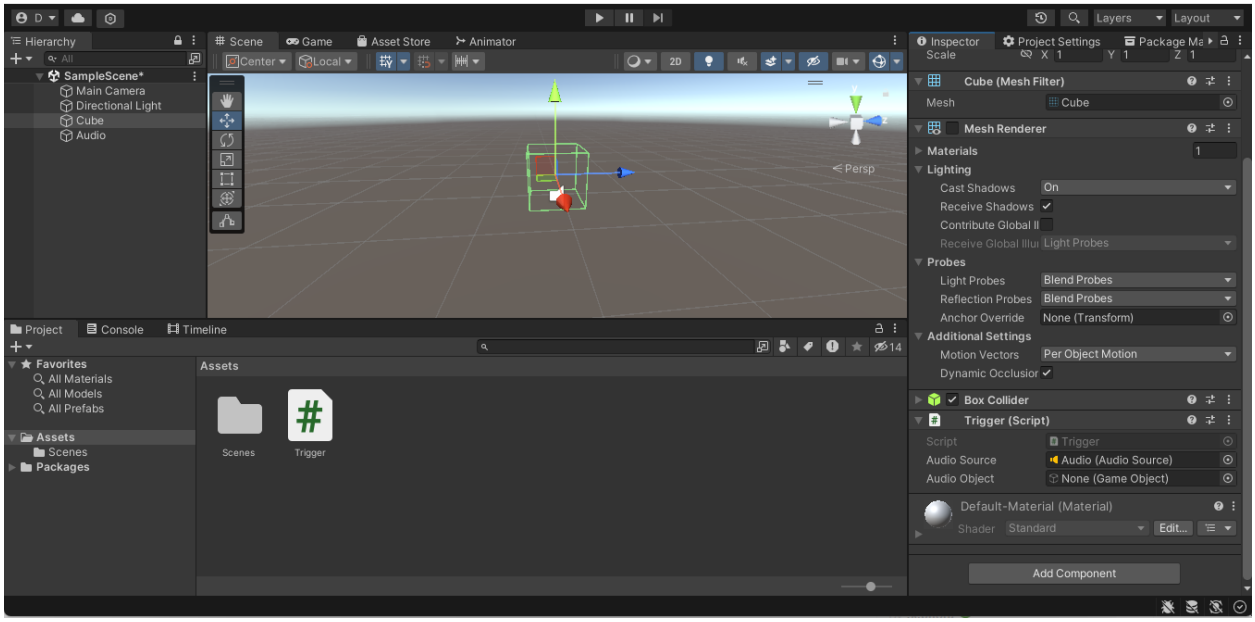

Figure 6.3.3.8

6.4 Storyline

To create the storyline, we all created our own ideas, then combined them and contrasted them to figure out what we thought would be a story that matches the client's needs. These

conceptual designs can be found in Deliverable D. We then took these ideas and showed them to the client. They gave us feedback on what they thought about our ideas, and we chose the one that they liked best.

6.4.1 Explanation of The Storyline

The story that we ended up choosing was to have the player start outside of a store in a normal looking city. They then look around and see people protesting against these new law enforcement robots. The main character then walks down the street and makes a comment to himself about a new item in the "robot safety store". Inside this store, there are masks to protect yourself against the facial recognition that the robots possess. There are also radios which are used by the public to know when it is safe to go outside without having fear of being targeted by the robots. Finally, there is a robot radar system, which shows the nearby robots. On the walls of the store there are posters which explain each item. Once the player leaves the store, they will walk in front of a school, which will then play an alarm sound over the PA with an announcer saying that there is a robot safety drill going on in the school. Finally, the player will walk in front of a tribute which has the faces of people who have been wrongfully killed by the killer robots.

6.4.2 Linking the Story to the Problem Statement

We chose this story because it showcases multiple needs that the client outlined in the first meeting. The first need being the need to show how people have adapted to autonomous weapons. This is showcased via the robot safety store. The second need was the need to invoke a sense of fear and concern in the user. This was done using both the school's robot safety drill, as well as the tribute of the people who were killed. Finally, our story shows how the public would react to the robots, via the protestors in the street.

6.5 Equipment list

Item Name	Description	Type	Source
Meta Quest 2	VR Headset/Controllers	Equipment	Makerspace
Makerspace Laptop	Powerful Laptop that can handle the stress of unity	Equipment	Makerspace
Unity (and required	Game engine used to	Software	Unity.com

libraries)	create prototypes 1,2 and 3.		
USB Key	Portable Computer Storage	Hardware	Various

6.6 Testing & Validation

Test ID	Test Objective (Why)	Description of Prototype used and of Basic Test Method (What)	Description of Results to be Recorded and how these results will be used (How)	Estimated Test duration and planned start date (When)
1	The objective of this test is to test how easy it is for the user to move and navigate around the simulation. This is important to investigate as if the user cannot move around the environment, the rest of the simulation will not be able to be experienced. The results of this test are also crucial to the finalization of the final prototype as the ability to move around the environment and observe the landmarks of our simulation are fundamental parts of the product.	Once the required VR libraries are installed, try to view the game through the headset by entering the game mode in unity with the headset on with quest link enabled. If the game does not appear, check the directions provided by oculus to ensure that your headset is properly connected. Once you can view the game, use different criteria to evaluate the effectiveness of the VR movement. Tweak parameters on the XR rig until the criteria are met.	For each repeat trial, evaluate the height of the camera, the speed of the movement, and the ease of movement around the environment. Give each of these a numerical ranking to properly document the progress made. Also record the values of the camera position/movement speed etc.	This test will most likely take more than an hour, as it takes a while to set up the Headset and to get the values to the desired number. Stop the test once you are satisfied with the results.
2	The objective of this test is to test the sound quality and the accuracy of the alignment of the sounds with the storyline and the environment setting. This test is important as our	This is a physical test to examine if the audio system in the simulation runs smoothly and properly. The sound should be audible and play the proper music and sounds and effect at the	The user will use the virtual reality headset to listen to the sound effects (or listen out loud) and evaluate if they align with the actions the character is experiencing in the simulation and if the	In order for this test to be executed, the navigation part of the simulation will have to be finished and working properly as a part of this test is to move along the environment therefore

	objective is to make the user feel a sense of unease and concern and therefore it is essential that the music and sound effects in the simulation correspond with said emotions and feelings.	corresponding moments. (e.g. the robot safety drill can be heard clearly and near the school). Specific audio sounds and packages will have to be found and purchased for this test component.	music makes them feel uncomfortable and anxious. The user will rate on a scale from 1-10 on how much they think the sound effects work with the characters actions and how much the music has an impact on their emotions. They will also be allowed to give any other feedback they feel necessary (e.g. the music that was played at the store did not align with what was being displayed).	requiring the navigation component of the simulation to be completed. The test should take around 5-10 minutes to allow the user to reflect about how the music made them feel and observe how accurately the sound effects aligned with the exterior actions. Having multiple people testing this objective would be more impactful as different people have different responses and effects to sounds and audios. If time becomes scarce it is possible to not include the extra sound effects and just incorporate music in the background.
3	This objective is to test the understandability and comprehension of the storyline and message we are trying to convey to our audience. This is a crucial test as if the results show that the storyline is not understandable we will have to change and modify our ideas and design which could set us back multiple days in our design progress.	This is a communication and comprehension test to analyse if others are able to interpret the same or similar messages we are trying to demonstrate through a virtual reality simulation. The message we are trying to get across should be easy to comprehend and understand as anything too complicated or confusing will be disregarded. This is also a de-risking test as we would like to catch any aspects that could be potentially confusing in our design before it is too late to change or modify them.	The user will follow along the storyline of the simulation (start on a street, walk to the robot safety shop, go to the school and end at the memorial) and will rate their experience on a scale from 1-10 based on how much they understood the messages we were trying to display with each landmark. (e.g. the school shows how the robots will affect our children). The user will also give any other feedback they feel needed about the messages and overall storyline (e.g. they didn't understand what the memorial was supposed to be).	As this is not a physical test, the program does not necessarily have to run perfectly but enough for the user to get the gist of the storyline. Having this in mind, the navigation part and audio should be relatively finished for this test to have its full effect. This test needs to be done as soon as possible in case the feedback we receive requires us to come up with different ideas and/or change/remove old ones. The test should only take 5-10 to give enough time for the user to experience the whole simulation, analyze, reflect on the storyline and then criticize it. A variety of

				different people should be interviewed for this test as everyone has unique perspectives and opinions therefore accumulating as many results as possible will help diversify and optimize the results.
4	The objective of this test is to test how realistic / convincing the environment is. The goal is to have a reasonable realistic environment as the more realistic a design is, the more convincing it will be. Since we are trying to convince decision makers on a very important and serious topic, we want our design to be as convincing as possible. Although the level of realism is not one of our main focuses in this project it is still an important aspect to test and receive feedback for.	This is an aesthetics test to evaluate the quality and realism of our design. The materials that are needed for this test are Unity assets but more specifically Unity assets that are are realist as possible but that are still in out budget (≅$50). These assets are essential to the test as they are what will determine the level of realism of the simulation.	Similar to the previous test, the user will go through the simulation and inspect and observe the environment to evaluate how realistic and convincing the design is. They will rate their conclusions on a scale from 1-10 based on the realism of the environment. In addition they can provide specific or general feedback that could help with our overall design. (e.g. everything was good except the store's sign).	In order for this test to be executed, the whole simulation must be close to or completely done. Components such as navigation, sound and lighting all need to be incorporated to maximize the realistic effect. Having multiple people test this objective would be preferred although it is not crucial if there is not enough time. It would not be ideal but, if need be, this test could be sacrificed as it does not directly affect the storyline. Although the realism of the environment has an impact on the , if users are still able to understand the main concept of the storyline, we can do without this test if necessary. In addition, the clients mentioned that they would rather a finished but less realistic design than an incomplete more realistic design. This test should be done relatively early on as if others do not think it is realistic enough, assets will have to be changed which could take a while to re

				code.
5	The objective of this test is to ensure the video of our simulation is around 30-60 seconds. This is an important and crucial test as the clients have made it very clear they want a short visual of our simulation as well as the actual program, as not everyone will have access to the virtual reality headset and controller on design day. Having an additional video will guarantee anyone will be able to experience our simulation regardless if a VR set is available or not.	This is a physical test as it will test the amount of time it will take to complete the whole simulation without it missing anything or feeling rushed. There are no specific materials needed for this prototype, simply a way to record the screen the user will be running and demonstrating the program on.	Unlike the previous tests, this test does not require multiple people to test or rate or provide feedback. For this test to work, one person must run through the whole simulation, making sure to stop at each landmark to simulate an actual person observing their soundings, within 30-60 seconds. The run through of the simulation should not feel rushed or tedious as either will lose the audience's interest.	All components of the design must be complete for this test to be executed properly. As the video is a demonstration of the final simulation, everything must be completed and finalized before the video is taken. The test should only take a few minutes to execute as the video will only be around 30-60 seconds. If multiple attempts are necessary the testing process will take longer although it should not take more than a few hours.

7 Conclusions and Recommendations for Future Work

If we had more time to work on our project we would add more details to the simulation and environment. Details such as the textures to make the people and objects look more realistic.We would also make it more user friendly. We would do this by having a planned path the user would follow instead of them trying to find our main landmarks in the environment. We would also include interactions the user would be able to interact with such as being able to enter and exit the stores. Something we would include in the simulation would be the children running into school during the robot safety drill. Unfortunately we have to take out this component because of time restrictions but it would have been an important aspect to the story line. In addition, if we had more time we would also have a bigger environment with more and different kinds of autonomous robots. Having a variety of robots such as drones and AI scanners would add more of a realistic

8 Bibliography

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APPENDICES

9 APPENDIX I: Design Files

All documents referenced in this document about our design are referenced below:

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Deliverable B - Needs Identification and Problem Statement	Project Deliverable B	September 30, 2023
Deliverable C - Design Criteria and Benchmarking	Project Deliverable C	October 8, 2023
Deliverable D - Conceptual Design	Project Deliverable D	October 15, 2023
Deliverable E - Project Plan and Cost Estimate	Project Deliverable E	October 29, 2023

Deliverable F - Prototype 1 and Customer Feedback	Project Deliverable F	November 5, 2023
Deliverable G - Prototype II and Customer Feedback	Project Deliverable G	November 12, 2023
Deliverable H - Prototype III and Customer Feedback	Project Deliverable H	November 26, 2023

MakerRepo Link: https://makerepo.com/danielbarker/1845