Project Deliverable C - Conceptual Design and Project Plan

GNG 2101 Group A4.4

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Table of Contents

1. Introduction

For the this deliverable, we discussed as a group the core functionality of our project and broke it down into sub-functions and sub-systems. Each member has then come up with at least 3 product concept for some of the components of the core functionality. Out of these product concepts, we chose several that we would implement in our final product. Finally, our ideas will be presented to our client for our second meeting and gain insight on the concepts we came up with.

2. Functional Decomposition

To deliver a product that aligns best with our client's needs, we must first break down our project's core functionality and consider all the possible components in creating it. After discussing our project and considering the creation of a virtual reality video game, we divided our project into three sub-systems: Storyline, Technology and Resources. For each sub-system, we then divided them into sub-functions. First, storyline focuses on what the experience will deliver. For example, who is this experience targeted towards? What will the experience tell? How will it be told? How will the user interact with the experience? Secondly, the technology used for the creation of our product. What device will the experience be played? What kind of engine are we using to create it? What languages? Finally, a crucial component of game development are the resources that will be put into the game as well as the resources needed to run it. Here, we think about the assets needed, such as graphics, audios and animations. We must also consider if we are looking for free or paid materials while ensuring copyrights. Moreover, we must consider what systems our client has available and ensure it meets with our product's minimum requirements.
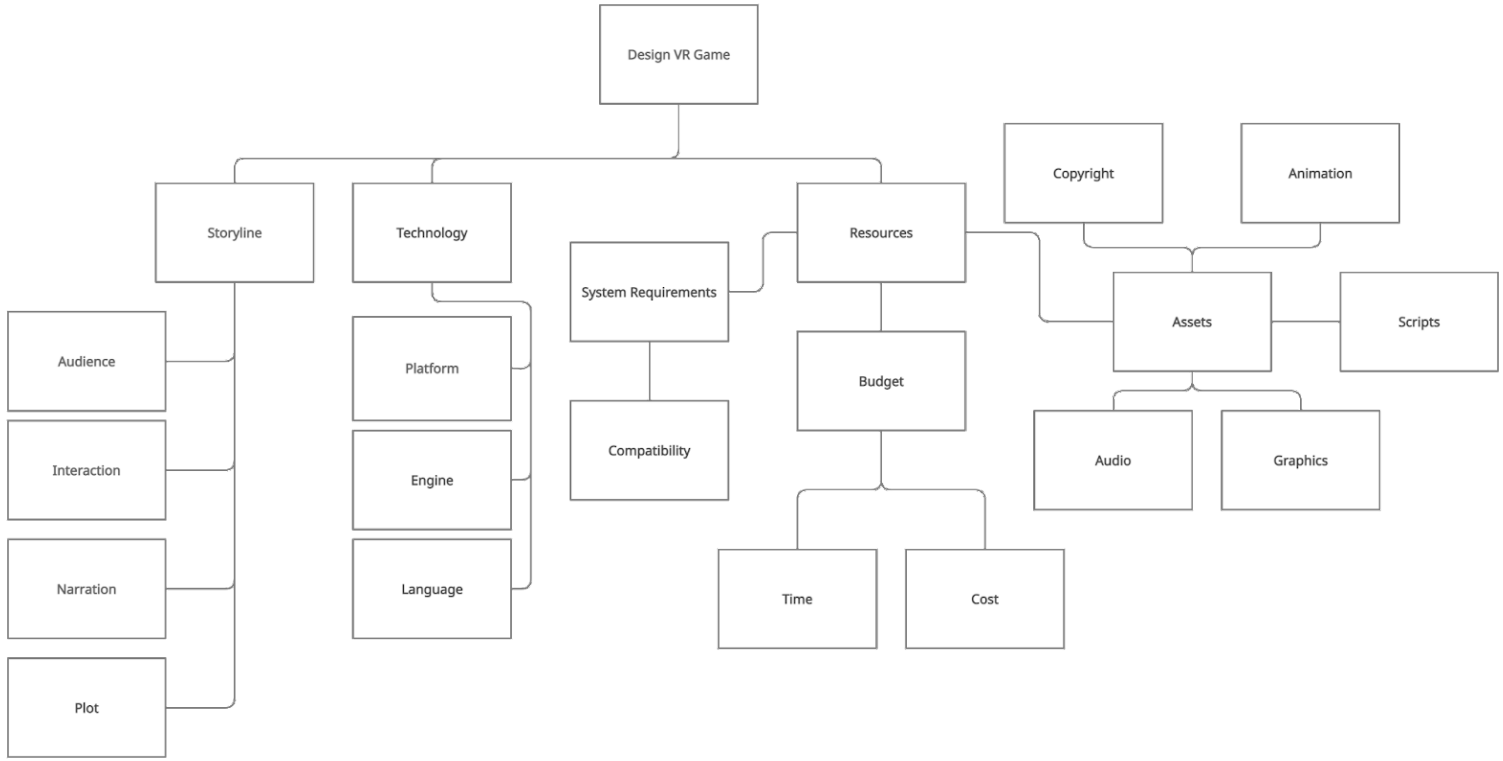
Figure 1. Function Decomposition Diagram

3. Product Concepts

After breaking down our product's core functionality, each member of the team provided 3 different concepts for the mentioned sub-functions and/or sub-systems mentioned above. We then analyzed each concept based on our target specifications, providing metrics to better critique the concept.

3.1 Mostafa's Concepts

Deciding how the story is portrayed is one of the first steps in creating a video game, as many limitations must be considered, such as immersiveness, resources and aesthetics.

Two Dimensional: The experience uses flat graphics and does not contain any three-dimensional geometry.

Figure 2. Two Dimensional Video Game

Pros:
1. Frame rate friendly. A two dimensional game does not require a lot of resources to run it as it the graphics are simple. This means your day-to-day computer can allocate less resources while maintaining at least 100 frames per second (fps) (Game Debate, 2021). Our specified ideal value is at least 90FPS.
2. Loading time is short. Since simple and relatively small assets are already rendered on download, the game loads very quickly. After

simulating several different kind of 2D games (i.e. *Geometry Dash*, *Pummel Party*, *Rayman Legends*), the average loading time from the moment the game was executed was 8 seconds, which is much less than our target loading time of 80 seconds.

3. Memory and File size is minimum. As mentioned earlier, little resources are needed to run 2D games. For file size, the range can be as little as 200MB to 6GB. Depending on the size of the game, we can easily target less than 4GB. As for memory size, we are targeting <8GB of RAM, two dimensional games only need up to 2GB. These specifications were taken from *Doki Doki Literature Club*, a small story game, and *Rayman Legends*, a bigger story game.

4. Development cost is cheap. Simple assets mean less money spent. Game engine Unity offers thousands of free graphic, audio and animation assets for 2D game development. They also have paid assets for only 4.99USD$, which is less than 7$. Our ideal development cost is under 50$.

Although two dimensional games meet most of our target specifications, it lacks the idea of immersiveness. Since it is 2D, it is difficult to have the user put themselves in the shoes of the character, thus making it difficult to use VR. Furthermore, 2D games can last anywhere between 20 minutes (i.e. *missed messages*) to countless hours depending on the story. Since we are targeting a story length of approximately 12 minutes, we would need to condense a lot of story material with simple assets, making the game less immersful and rushed.

Three Dimensional: The experience uses three-dimensional geometry.

Figure 3. Three Dimensional Video Game

When it comes to three dimensional video games, the user is much more immersed into the story as they can feel like they are the character. Therefore, the implication of virtual reality is feasible. When it comes to how much resources a system needs, it all comes down to how many assets were used in the game. Since 3D games require 3D geometry, then more resourceful and complicated assets are needed. However, since we are looking to make a game that lasts roughly 12 minutes, we won't need to load a lot of assets. Thus, your average 3D story game of that length does not require much resources and can at 100FPS, need 4GB of RAM and 2GB of storage. Furthermore, the loading time is averaged under 20 seconds. The game *A Story About My Uncle*, a 3D story video game, was simulated and used as benchmarking.

With that being said, bigger 3D projects can be quite resourceful. High end 3D games would need powerful gaming computers to run at 60FPS and 12GB of RAM. They also often need at least 25GB of storage. Naturally, higher end games would also cost more as you would often need to buy higher quality assets. 3D games imply that the user can explore more and view more, more stuff to see mean more assets, which means bigger file size, more RAM needed and longer loading times than 2D games.

Closed Ending Story: The plot has a beginning and end. It could have different ending depending on the user's input throughout the experience.

Figure 4. Different Endings Figure

Designing a story with one or multiple endings is a great way in keeping the user engaged in the story as it motivates them to finish the experience and even replay it to view the other endings. In turn, the user will spend more time as the character and show greater signs of empathy. Creating an ending also gives structure to the game which can help minimize unnecessary bugs and make the overall backend more structured. This can thus enhance the overall frame rate, the memory needed and the file size. Furthermore, since we already know the kind of ending we want, we can already target the assets needed, which can help mitigate the development cost. On the other hand, creating an ending limits the user to "free play" and experience the game as they wish. Multiple endings can also make the duration of the game quite long. It also takes much more time to develop, more assets to potentially buy and more resources need to run it.

Success Criteria (1-5, 5 being best)	Two Dimensional	Three Dimensional	Closed Ending Story
Interactive	3	5	4
User friendly	5	4	5
Develops empathy	3	5	5
Experience is accurate	3	5	4
Tells a story	4	5	5
Total	18	24	23

Target Specifications	Two Dimensional	Three Dimensional	Closed Ending Story
Frame rate	>100FPS	Dependent on assets and device	Dependent on assets and device
Loading time	<8s	Dependent on assets and device	Dependent on assets and device
Memory	<4GB	<12GB	Dependent on assets
File size	<6GB	~2GB	Dependent on assets
Development cost	<7$ (Dependent on assets)	<7$ (Dependent on assets)	Dependent on assets

Duration	< 12 min	<20	Dependent on type of gameplay and assets

3.2 Shaylin's Concepts

Concept 1 Day in the life of a veteran (VR game where a user will have to complete tasks a veteran enduring PTSD and mental illness has to) Example:
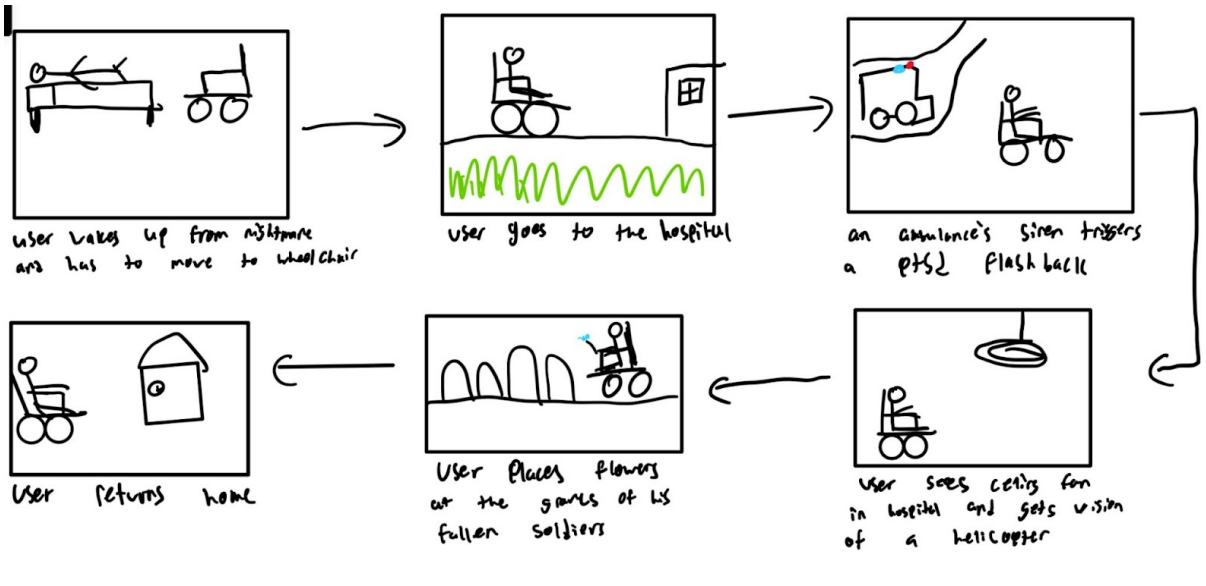

Figure 5. Day in the Life Concept

In this concept, the user will experience a day in a veteran's shoes. In this immersive experience, the user will closely follow a storyline of a veteran completing everyday tasks. The day may start with the user waking up from a nightmare, to experiencing events that trigger PTSD episodes, to visiting the graves of his fallen friends and comrades.

Developing a game that follows a storyline comes with many benefits. Since we the developers can control the story, we have the ability to create an interactive story that will allow the user to empathize with veterans. Secondly since the user will be closely following a story, the game would be user friendly as explicit instructions can be developed. Moreover, through creating a story, we can ensure that the experience is accurate to what many veterans undergo as we can conduct research on how to create an accurate experience.

Concept 2 Explore an open world as a veteran (Users can see how the world looks from the perspective of a veteran and certain events may trigger a PTSD episode)
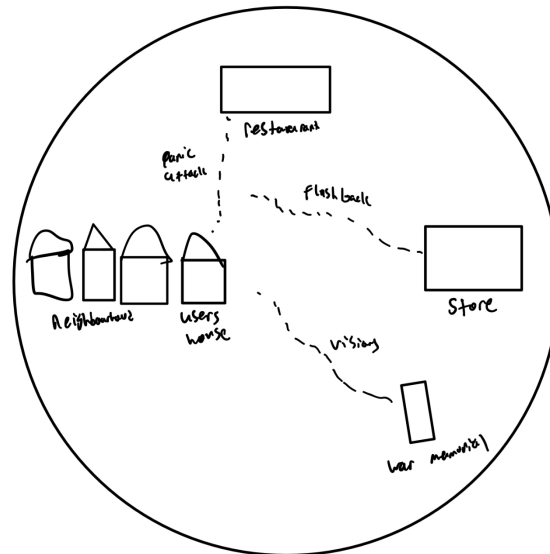
Example:

Figure 6. Open World Concept

In this concept, the user will be able to explore the world as a veteran. The user will be able move around an open world such as walking down streets and going to restaurants and store. As the user explores the world they will come across events that cause PTSD episodes such as visions or flashbacks. For example, as the user walks to the store, a loud car may pass by triggering a flashback of a veteran's past such as a battlefield.

Developing an open world game comes with many benefits and drawbacks. Considering the developers do not have full control over what the user experiences, there is variability of what the user will see. The benefit of this aspect is that each time the user plays the game, they will receive a unique experience. The drawback is that since they are not following a storyline, it may be more challenging to develop an empathizing experience when the user plays. Moreover, as there is no storyline with a clear set of instructions, the game may not be as user friendly as the user will be responsible for their experience.

Concept 3 PTSD simulator (User will experience what it is like to experience PTSD and mental illness such as flashbacks and nightmares)
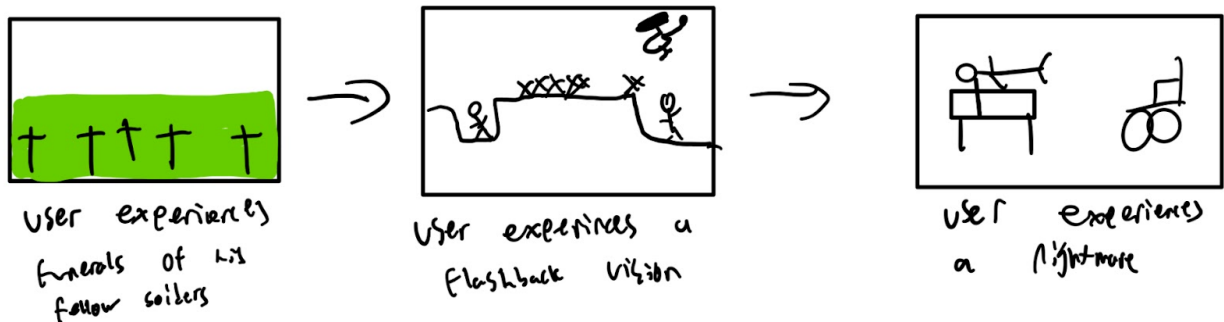
Example:

Figure 7. PTSD Simulator Concept

In this concept, the user will experience what it is like to have PTSD. In this immersive game, the user will see nightmares and flashbacks of war and sadness that a veteran would encounter.

This concept, although simple, comes with many drawbacks. Since the user will just witness flashbacks and nightmares without a story, it may lack interaction and will lack the ability to build empathy. In addition, it may be difficult to develop an accurate experience of flashbacks and nightmares as these experiences vary for each individual and may not be what veterans experience.

Success Criteria (1-5, 5 being best)	Concept 1	Concept 2	Concept 3
Idea	Day in the life of a veteran (VR game where a user will have to complete tasks a veteran enduring PTSD and mental illness has to)	Explore an open world as a veteran (Users can see how the world looks from the perspective of a veteran and certain events may trigger a PTSD episode)	PTSD simulator (User will experience what it is like to experience PTSD and mental illness such as flashbacks and nightmares)
Interactive	4	4	2
User friendly	4	2	3
Develops empathy	5	4	4
Experience is accurate	4	3	2

Tells a story	5	1	1
Total	22	14	12

Target Specifications	Concept 1 - Day in the life of a veteran	Concept 2 - Open world	Concept 3 - PTSD simulator
Frame rate	Dependant on device	Dependant on device	Dependant on device
Loading time	<5s (dependent on device)	<20 s (dependent on device)	<5s (dependent on device)
File size	1 GB	6 GB	1 GB
Development cost	unknown	unknown	unknown
Duration	< 15 min	Unlimited (can use anytime for as long as the user desires)	< 10 min

3.3 Engy's Concepts

Concept #1:
- Interactive VR game where the user will lay in bed and experience different PTSD triggers that veterans may experience as they go through general daily tasks.
    - The user will go through an entire night from the perspective of a veteran. The user will begin in a very serene and calming environment with minimal noise and light, simply an overhead fan running to keep the room cool. The user will then fall into a slumber and the screen view goes completely dark, simulating sleep. Next, the user is awakened on a battlefield and is experiencing PTSD that was triggered by the fan. That fan serves as a reminder of helicopter wings. The light and noise are loud and chaotic, simulating the authentic experience.
    - The advantages of creating a storyline such as this one is that the developers are able to control the lights and sound effects to create an accurate and authentic experience. Another advantage of this is that the user is able to truly empathize with veterans who are unable to have healthy sleep hygiene due to their traumatic experiences and lack of mental health services provided to veterans.

Example:

user begins in bed, time is   user screen goes black,   user is awaken, ceiling fan
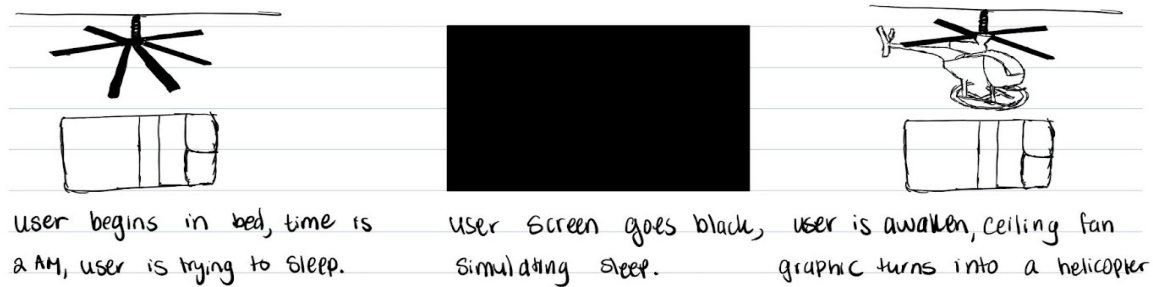2 AM, user is trying to sleep.   simulating sleep.   graphic turns into a helicopter

Figure 8: Sleep hygiene effect simulation

Concept #2:
- Interactive VR game where users will need to complete tasks such as collecting cans, resource gathering, etc… The user will live as a homeless veteran and will attempt to get a bed in the homeless shelter, but will need to complete the task list before unlocking that function.
    - The user will go through an attempt to be granted a bed in a homeless shelter for veterans through the eyes of a veteran with a physical disability. This will be an interactive experience in which the user must get around and complete tasks before "unlocking" access to the homeless shelter. Some of these tasks could be collecting cans, finding supplies to survive the night, finding food, etc… Once the user has gone through the task list and faced the challenges that would have been faced by a veteran, only then will they be allowed access to the bed in the overrun shelter.
    - The advantages of creating a storyline such as this one is that it is extremely interactive and user friendly, it will be an entire experience of exploring and completing tasks, rather than just witnessing what will happen. Another advantage of this is that we can portray how little veterans who have fought for our country receive for their service. Once they are injured and out of commission, they must fend for themselves. This will allow the user to both see the process of getting into the shelter as well as seeing the poor conditions of the shelter.
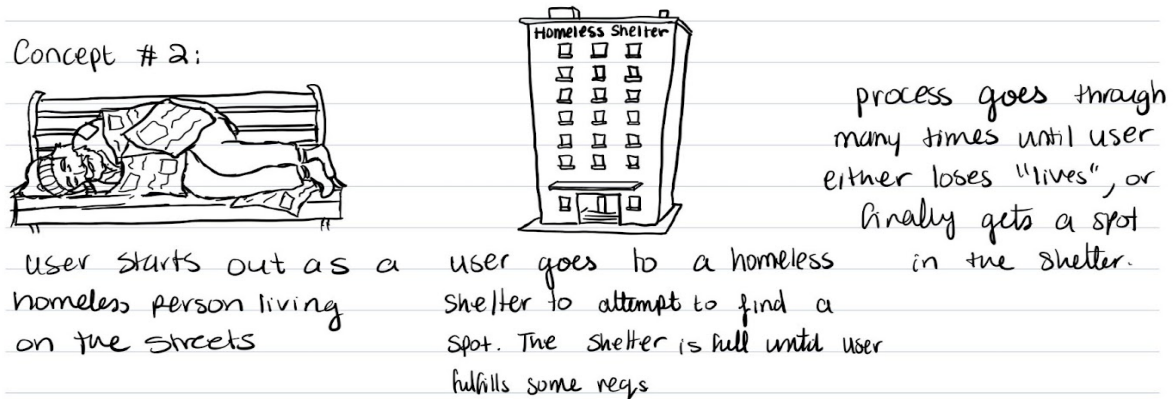
Example:

Figure 9: Homeless Shelter Game Simulator

Concept #3:
- VR game where users will experience how everyday events that bring us joy may negatively impact a veteran that has PTSD. Users will start out in a fun celebration where there are fireworks, the fireworks sound and visual will be transformed into a warzone battlefield.
    - The user will go through a simulator that visualizes an everyday fun experience for the average person as the treacherous event a veteran may experience. The user will be going to an event where everyone is celebrating and having a fun time. The user's vision and hearing are distorted and there is ringing. Once the part of the event where fireworks begin is out, the user experiences an episode, the lights and noise being a trigger. The area gets completely transformed from a big celebration to a warzone battlefield.
    - The advantages of creating a storyline such as this one is that it is extremely useful to build empathy and to help users understand how a fun and exciting day can be completely traumatic and isolating to a veteran. It also shows how alone it feels to experience the world in that way, as the celebration will go on completely normally without anyone knowing what the user is going through

Example:
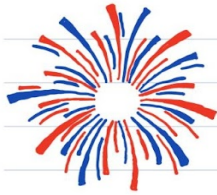
user starts out in a celebration with fireworks, everything seems okay.

create voice distortions and ringing.

Scene turns into a battle field simulating a warzone.

Figure 10: Firework PTSD trigger Simulation

Success Criteria (1-5, 5 being best)	Concept 1	Concept 2	Concept 3
Idea	Interactive VR game where the user will lay in bed and experience different PTSD triggers that veterans may experience as they go through general daily tasks.	Interactive VR game where users will need to complete tasks such as collecting cans, resource gathering, etc… The user will live as a homeless veteran and will attempt to get a bed in the homeless shelter, but will need to complete the task list before unlocking that function.	VR game where users will experience how everyday events that bring us joy may negatively impact a veteran that has PTSD. Users will start out in a fun celebration where there are fireworks, the fireworks sound and visual will be transformed into a warzone battlefield.
Interactive	4	5	3
User friendly	4	5	4
Develops empathy	4	5	4
Experience is accurate	4	5 - real story	5 - real story
Tells a story	4	5	5
Total	20	25	21

Target Specifications	Concept 1	Concept 2	Concept 3
Frame rate	Dependant on device	Dependant on device	Dependant on device
Loading time	<10s (dependent on device)	<10s (dependent on device)	<10s (dependent on device)
File size	1 GB	1 GB	1 GB
Development cost	unknown	unknown	unknown
Duration	< 10 min	< 10 min	< 10 min

3.4 Vivek's Concepts

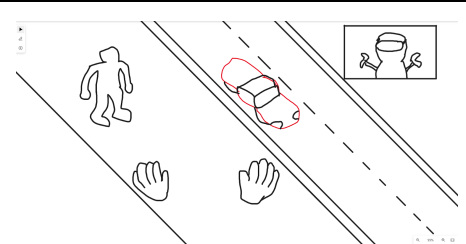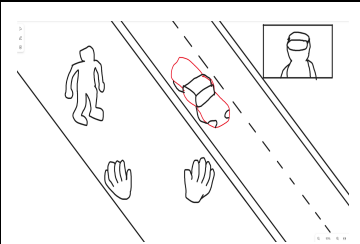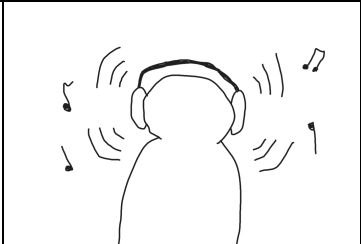| Concept	Augmented Reality	360 video	Minecraft game
Story/ description	Users will be able to use their mobile device to get an idea of how a veteran suffering from PTSD might perceive everyday objects. For example, a regular helicopter would be converted into an attack helicopter, large vehicles would be converted into military vehicles like tanks, hand held devices like phones might be converted into firearms, etc	Compilation of some of the experiences many veterans have had to go through. Different settings, starting with the battle field, then the hospital, then therapy sessions, etc.	A custom server where the user can go through experiences many veterans have had to go through (similar to the 360 video idea). The user will have full freedom to explore the terrain and complete certain objectives to get to the next nevel.
Application type	Mobile Application	360 video available	Minecraft server
Required Technology	The augmented reality conversions would be done via an AI that detects these objects. A specific tool that we could use is Vuforia, which is a mobile AR development tool which uses "computer vision	For this immersive experience we would simply scrape the internet for 360 videos we could compile to fit our storyline. To accomplish this by using Adobe tools	For this immersive experience we would use Minecraft to create a custom server. We would also download Minecraft modifications to

	technology to recognize and track planar images and 3D objects in real time."	to create and refine immersive videos.	make the game appear more realistic.
Visualization		https://www.youtube.com/watch?v=xuVHe-0r-BE Similar example	

Success Criteria (1-5, 5 being best)	Augmented Reality	360 video	Minecraft game
Interactive	4	2	2
User friendly	4	4	3
Develops empathy	2	4	1
Experience is accurate	3	5	1
Tells a story	1	2	4
Total	14	17	11

Target Specifications	Augmented Reality	360 video	Minecraft game
Frame rate	Dependant on device	30 fps	Up to 144fps (dependant on device)
Loading time	<5s (dependent on device)	<5s (dependent on device)	Servers on average take about 1-3 minutes to start up
File size	1 GB	five-minute 360 video with a bitrate of 150Mbps would clock in at around 5.5GB	1 GB
Development cost	unknown	$0 (just compile videos)	$0 (just create a minecraft server

			hosted at home)
Duration	Unlimited (can use anytime for as long as the user desires)	About 10 minute video compilation	Will take approximately 20 minutes to complete all tasks

3.5 Teddy's Concepts

Concept	Virtual Reality	VR Video	3D Audio
Story/Description	Users will be put in the perspective of a military veteran returning from war and trying to adjust to regular life, where they will face PTSD challenges a real veteran may face. Examples include city noises becoming war and gun noises, large cars turning into trucks and tanks, etc.	Similar to virtual reality story however rather than making user face and solve challenges, the video shows users what it feels like for a veteran to face such experiences among others	The user is played a 3D surround sound audio of a veteran going about there day (waking up, getting dressed, etc) however alongside that they will also listen to the sounds of flashbacks one might face triggered by the daily noise one might hear
Application Type	Virtual Reality (Oculus, HTC, etc.)	Video	Audio
Required Technology	This version would be done via a a VR Headset where the user can control the veterans arms and inbteract with objects	This version would be done via a Mobile Device where the video would play in VR mode and the user would place the mobile device within a VR mobile headset	This version would be done via noise cancelling headphones and a mobile device or laptop which would play the audio for the user to experience
Visualization			

Success Criteria (1-5, 5 being best)	Virtual Reality	VR Video	3D Audio

Interactive	5	3	1
User friendly	5	4	4
Develops empathy	4	4	3
Experience is accurate	3	5	2
Tells a story	4	5	3
Total	21	21	13

3.6 Rafael's Concepts

Concept 1: Affordable VR

This concept will consist of a 3D video where users will be able to turn their heads around in 360° and visualize the experience of veterans during their day-to-day lives. Users will experience 3D effects when held up to their eyes. Users will require a Google Cardboard, with cardboard-certified viewers starting from CA$10, and will be able to experience the game using their mobile phone.
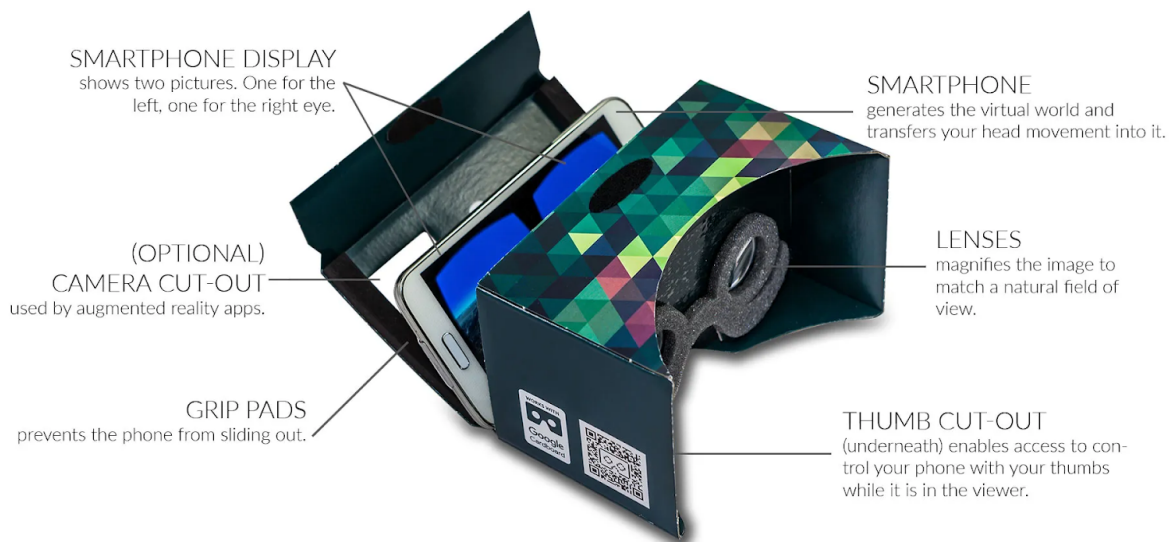

Figure 11: Google Cardboard VR Headset

Concept 2: Mixed Reality

Mixed Reality (MR) is enhanced Augmented Reality (AR) that merges the real world and virtual world. This is different to AR as it creates a physical environment that does not exist, whereas MR uses the real world to create a new environment where

19

physical and digital objects co-exist. MR combines both virtual and real elements. The virtual components of MR interact with the real world, which makes the user experience more authentic.

This concept will utilize the Microsoft Hololens MR headset, which will enable users to change their environmental input and perception. Environmental inputs capture objects, surfaces, boundaries, ambient lighting and sound, and physical locations. Users will be able to experience the day-to-day lives of veterans through an enhanced perception of reality. This means while in the 'real world', they will be able interact with objects and the environment in the perspective of a veteran, experiencing the perception that they would.

Figure 12: Microsoft Hololens MR Headset

Concept 3: Real Story VR
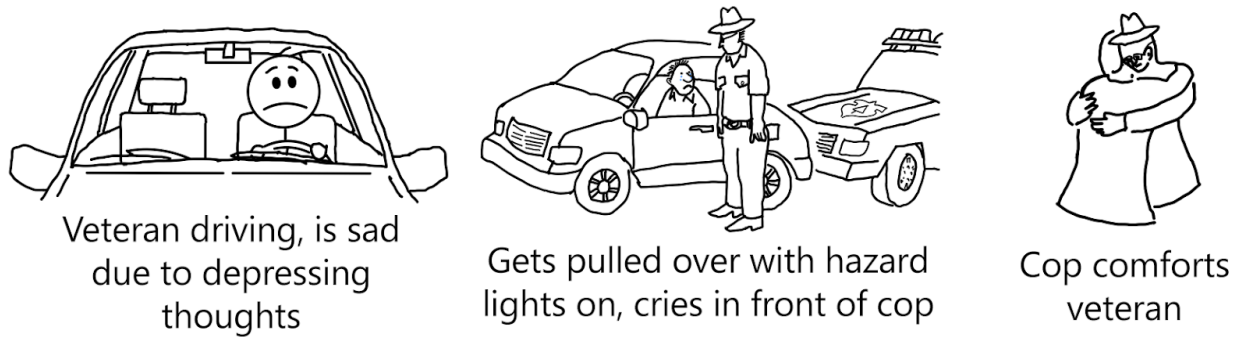

<div align="center">Figure 13: Real Story VR Example</div>

VR game where users will experience the negative emotions that a veteran goes through in their day-to-day life. In this game, the user will have a POV perspective of a veteran as they have their depressing thoughts due to PTSD from war. The user will experience first-hand what veterans went through and the experiences that accumulated to such a level of distress and anguish and how this affects their daily life. In the end, they will be pulled over by a traffic cop where the cop tries to comfort the veteran through their time of distress. This story is adapted from a real-world situation where a veteran in distress was pulled over by state police in Connecticut [6].

This version will require a VR headset and will be interacted through VR controllers, by controlling movement and interacting with people and objects. This will be done using consumer VR headsets like the Meta Quest 2.

Success Criteria (1-5, 5 being best)	Affordable VR	Mixed Reality	Real Story VR
Interactive	3	3	4
User friendly	4	4	4
Develops empathy	3	2	5
Experience is accurate	3	2	5
Tells a story	3	1	5
Total	16	12	23

Target Specifications	Affordable VR	Mixed Reality	Real Story VR
Frame rate	Dependent on device	60 FPS	Dependent on device
Loading time	<5s (dependent on device)	<5s	<5s (dependent on device)
File size	5 GB	5 GB	10 GB
Development cost	$0	$0	$0
Duration	12 minutes	Unlimited	15 minutes

4. Group Design Concept

For our group design concept, we decided to incorporate the following concepts:
- Closed ending storyline
- Day-in-the-life plot
- PTSD trigger events
- Three dimensional gameplay
- VR interactive gameplay

The most important aspect to maintain in our product is the immersiveness of the experience and its ability to foster empathy from the user. Creating a day-in-the-life closed ending storyline which implements VR allows the user to better put themselves in the shoes of the main character. From a more technical viewpoint, creating a structured story allows us to spend less money and time on creating the game and focus on mitigating unnecessary resources and bugs. Although three dimensional gameplay can become difficult to create and run, Unity is a beginner friendly game engine that facilitates the creation of 3D game development thanks to its codeless physics engine and its large selection of assets. Putting everything together, we decided on the following design:
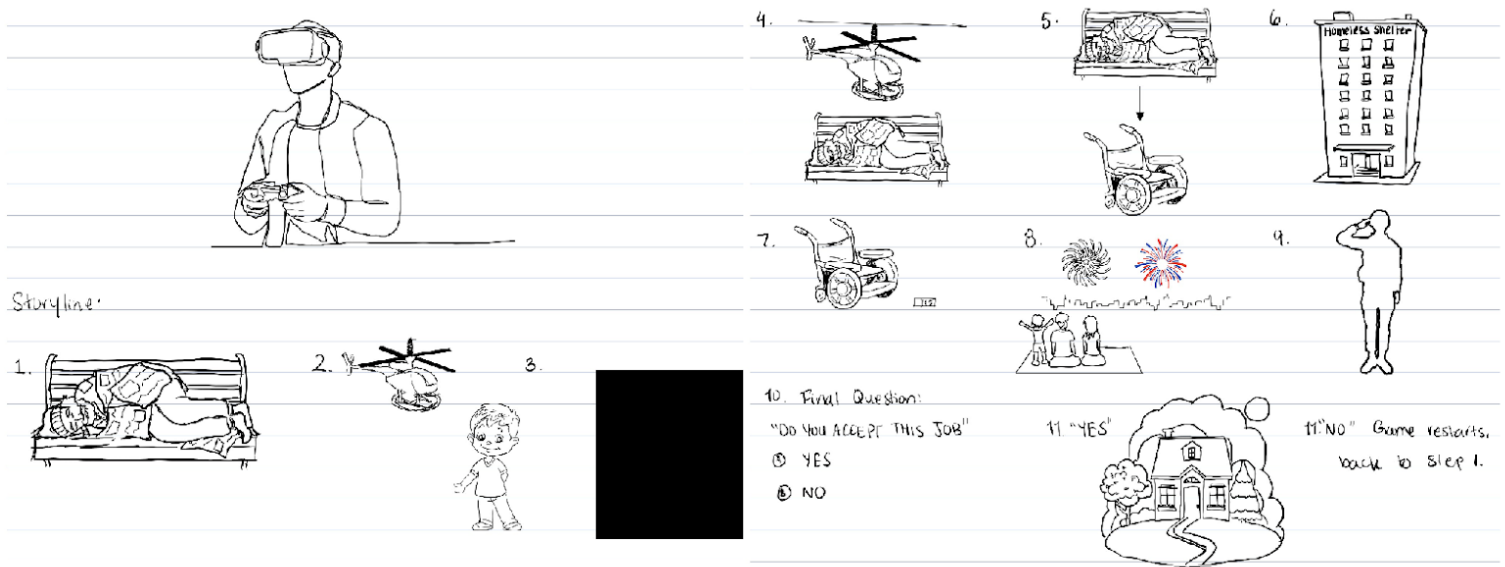
Story

1. Sleeping on a park bench and sees a little boy playing with a toy airplane
2. Black screen - goes to sleep
3. Wakes up with helicopter vision
4. Has to move from park bench to wheelchair to escape the vision
5. Goes to a homeless shelter and is denied
6. He finds $5 and has to choose between paying for medication or food (maybe: future feature where the user gains an ability)
7. Goes through a park and there's an event
8. Fireworks at the event that causes flashbacks (screaming, gunshots, etc.)
9. End game
   a. Next morning
   b. Gets a job offer from a veteran help program (shows the importance of government programs to help the community)
   c. If user accepts:
      i. Affords an apartment
      ii. Receives a prosthetic
      iii. Happy ending...
   d. Else: Game Restarts

Figure #14. Group Design Concept Sketch

Although Unity is a user friendly game engine for new developers, the main language used is C#. Previously our team has mostly worked with web development languages such as HTML, CSS and JavaScipt as well as object oriented languages like Java and Python. Thus, we would need to take some time to learn C# in order to code our game. Furthermore, if we choose to create a complicated story with multiple endings, we will have to implement many more assets that might exceed our ideal target specifications, notably the frame rate, the memory need, the file size and the loading time. Furthermore, creating a 3D game

23

would require much more resources than a 2D game, meaning we might have to spend more money on getting quality easy to render assets. Lastly, while we have full control over the duration of the game, we also need to budget the time we can allocate in the creation of it. Game development is not a task that can be done overnight, thus creating realistic and productive deadlines are crucial. When it comes to story based games, it's very common to change the development of the plot. We would need to come up with a couple of prototypes to show our client our progress and have our final deliverable ready a week before our product submission in order to tweak any last minute changes.

5. Conclusion

By using functional decomposition to break down the components of our products, we were able to design each function to target specific customer needs. This allowed us to ideate and conceptualize meaningful concepts that pertained to all the components discovered via our Function Decomposition Diagram. We not only created numerous product concepts, but also analyzed each by using target specification set in project deliverable B to identify the best ones. Deciding on VR day in the life of a veteran concept (via majority vote as specified in project deliverable A team contract), the concept that best covered our customer needs, target specifications and functional decomposition, we developed a group design concept. This not only provided a better understanding of how the product will function (via the sketch), but also led to a deeper analysis of its benefits and drawbacks going forward. Following this process is crucial as it ensures that customer needs are met and concepts are focused on solving the main issue (helping people gain empathy for veterans).

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