Håvard Hvoslef Kvalnes

Immersive Interface in Virtual Reality

Master's thesis in Interaction Design
Supervisor: Frode Volden
Co-supervisor: Tor Gjøsæter, Ilder AS

June 2021

Master's thesis

NTNU
Norwegian University of
Science and Technology

Håvard Hvoslef Kvalnes

Immersive Interface in Virtual Reality

NTNU
Norwegian University of
Science and Technology

Immersive Interface in Virtual Reality

Håvard Hvoslef Kvalnes

Abstract

This project investigated to which degree traditional interface should be altered to create as immersive an experience as possible in a virtual reality (VR) environment, more specifically in first person shooter (FPS) games. The aim was to give the player as much in-game information as they required, while still creating an immersive experience for them. To do this, prototypes were created where the participant were placed in a VR shooting range, and different ways of displaying the ammunition status to the user were tested. A phenomenological study was conducted by observing the participants, and conducting unstructured interviews to understand their point of view when testing the prototypes. In addition to the phenomenological study, a content analysis on state-of-the-art VR FPS games was done to investigate how the most acclaimed games do the same. The result of the project is guidelines for immersive interface in VR that game designers and developers can use in their design and development stages for VR applications.

Samandrag

I dette studiet undersøkte me i kva stor grad tradisjonelt brukargrensesnitt bør endrast for å skapa ein så innlevande oppleving som mogleg i virtuell røyndom (VR). Meir spesifikt såg studien på førsteperson skytespel (FPS). Målet var å gje spelaren så mykje informasjon dei trong i spelet, samtidig som det gjekk minst mogleg ut over innlevinga deira. For å få til dette vart det produsert prototypar der deltakaren var plassert i ein skytebane i VR og testa forskjellige variantar ein kunne vise status på ammunisjon til brukaren. Det vart gjennomført ein fenomenologisk studie ved hjelp av observasjon av deltakarane og ustrukturerte intervju for å forstå deira synspunkt når dei prøvde prototypane. I tillegg til den fenomenologiske studien vart det gjort ein analyse av eksisterande VR FPS-spel for å sjå korleis dei mest kjende spela gjer det same. Resultatet av dette prosjektet er nokre retningslinjer som speldesignarar og -utviklarar kan nytte seg av i design- og utviklingsfasa for å skape eitt brukargrensesnitt som gjev mest mogleg kjensle av innleving i sine VR-applikasjonar.

Preface

Supervisor from NTNU has been Frode Volden from the Faculty of Architecture and Design. In addition, Tor Gjøsæter from Ilder AS has acted as co-supervisor.

Thank you to my colleagues at Ilder, who have been very helpful when aid has been requested. A special thank you to Dag Bjørnar Hollund, who helped out immensely during the prototype development.

A thank you is also merited to my former coworkers at Sydvest and Byrået Sydvest, who have supported me during my first years of this master programme.

Thanks to Stord Pistolklubb and Norske Reserveoffiserers Forbund avd. Sunnhordland for allowing us to perform a field study and providing us with the equipment and expertise needed.

And finally, a big thank you to my friends, my family and my wife for unprecedented support throughout.

Contents

Figures

Tables

Acronyms

AR Augmented Reality. 50

CR Cinematic Reality. 1

FPS First Person Shooter. iii, v, 1, 2, 19, 45, 46

HUD Head-Up Display. 1

MR Mixed Reality. 1, 50

NSD Norsk Senter for Forskningsdata. 25

NTNU Norges teknisk-naturvitenskapelige universitet. vii

UI User Interface. xiii, xv, 9–11, 15, 16, 29, 31, 32, 35, 37, 39, 40, 42, 43, 45–50

VR Virtual Reality. iii, v, xiii, 1–3, 5, 6, 8, 15, 16, 19–21, 23, 26, 30–32, 35, 36, 39, 43–47, 49

XR Cross Reality. 1, 50

Chapter 1

Introduction

With increasing popularity of Virtual Reality (VR) headsets, both in commercial and household markets, it has become increasingly important to create interfaces within this environment that is intuitive and easy to understand.

VR has only recently become popular for the masses. Established practices for designing for 2D surfaces might not be applicable in the VR environments, and interaction designers might need to think differently when designing for VR. The VR headsets does not simply provide the user with a 3D screen in front of them. Instead it provides a surrounding, immersive 3D environment in which the user is placed in the center—allowing them to move their field of view 360 degrees in all directions. This can create some challenges for the interface design, but also new opportunities that the 2D surfaces can't provide.

This thesis will be focusing on games for VR—more specifically First Person Shooter (FPS) games. Traditionally, these games display vital information the player requires using a Head-Up Display (HUD); like the player's health, ammunition remaining, which weapons they have in their arsenal, a map and so on. This is an area with room for improvement, while at the same time have a decent amount of games on the market today allowing for a good data sample. This study aims to research to which degree the traditional interface must be altered to create as immersive an experience as possible in a VR environment.

The gaming industry is massive, with over 120 billion dollars made in revenue in 2019, and is expected to continue growing (Takahashi 2020). XR (Cross Reality, includes VR, Mixed Reality (MR) and Cinematic Reality (CR)) revenue climbed 26% to 6.3 billion dollars in 2019, much helped by the introduction of new standalone headsets like the Oculus Quest. These accounted for 49% of VR shipments and were able to bring VR gaming to a more mainstream audience.

According to a user survey done by Valve/Steam in September 2020, owners of the popular gaming platform Steam, 1,88% of their roughly 100 million active users own a VR headset (Valve/Steam 2020b). This accounts to approximately 1,88 million users.

1.1 Problem statement

Immersion is one of the main qualities of a VR experience (Yoon et al. 2010) (Buttussi and Chittaro 2018), hence game developers often seek to strike a balance between providing the player with gameplay supporting information as well as immersive gameplay aspects. Establishing this balance is required to create a meaningful and immersive gaming experience (Shelstad and Chaparro 2017). It has been shown that immersive VR versions of a game can subjectively be preferred to a non-VR version despite a decrease in performance due to more realistic aiming mechanisms (Lugrin et al. 2013).

Research has been done on how to increase player immersion in FPS games (Fagerholt and Lorentzon 2009). However, most of this research was done before VR became popularized, so there is currently a lack of research within this specific environment.

> **How can an immersive experience be created while still providing the player the required in-game information?**

To answer this problem statement, existing interface design within FPS games today will be analyzed. Furthermore some prototypes showing different ways to provide information to the player will be created, and by user-testing these prototypes the aim is to create a set of guidelines on how to create immersive interface design for VR games.

1.1.1 How to measure immersion

Immersion is a word commonly used by gamers and reviewers alike, mostly referring to which extent the player feels connected to the character they are controlling in the game, and how they feel they are involved in the game world.

Measuring immersion brings with it some complexity and difficulty, but research done by Charlene Jennett et al suggests that immersion can be measured subjectively (through questionnaires) as well as objectively (through task completion time, eye movements) (Jennett et al. 2008). In this study we will measure immersion subjectively by gathering data through performing interviews after user testing of my prototypes.

1.1.2 Research questions

To help provide an answer to the problem statement, this thesis will also be taking these research questions into account:

> **How does diegetic, non-diegetic and spatial user interfaces affect perceived immersion in virtual reality?**

How does traditional interface display for displaying remaining ammunition work in VR games compared to on a 2D screen?

Chapter 2

History of Virtual Reality

2.1 What is Virtual Reality?

Cory Mitchell has made a good definition of Virtual Reality (Mitchell 2020):

- Virtual Reality (VR) creates an immersive artificial world that can seem quite real, via the use of technology.
- Through a Virtual Reality viewer, users can look up, down, or any which way, as if they were actually there.

2.2 The evolution of Virtual Reality

The idea of wanting to immerse oneself in another world is not something new. The first stereoscope was invented in 1832 by Sir Charles Wheatstone and was first presented to the Royal College of London in 1838 (Brewster 1856). It was an important invention which could prove that the human brain processes two individual images (one from each eye) and combines them to form a single perceived 3D image. This was one of the earliest, if not the earliest, peek into artificial 3D worlds.

Virtual Reality-like elements have also been referenced in early popular culture; in 1935, science fiction author Stanley Weinbaum wrote a short story called Pygmalion's Spectacles. In this fictional short story, the main character meets a professor who invents a pair of goggles that allowed him to view a movie with sight, sound, taste, smell and touch (Poetker 2019).

Building off the stereoscope principle, the View-Master was patented back in 1939. It is still being produced today and have been part of many young children's toys while growing up. It allowed the user to view small images in what appeared to be a large size when being held up against their eyes and gave them the feeling of watching the images up close. Popular images were exotic animals and landscapes.

The Sensorama, invented in 1956 by Morton Heilig, simulated the experience of being "in" a movie by placing the user on a chair in front of the device, and having them place their hands inside the device and their head within a box-like contraption on the front. The machine had a stereoscopic color display, fans, odor emitters and a motional chair. It simulated the experience of driving a motorcycle through the streets of New York, complete with simulated noise and smells of the city. The first head-mounted display device, called the Telesphere Mask, was
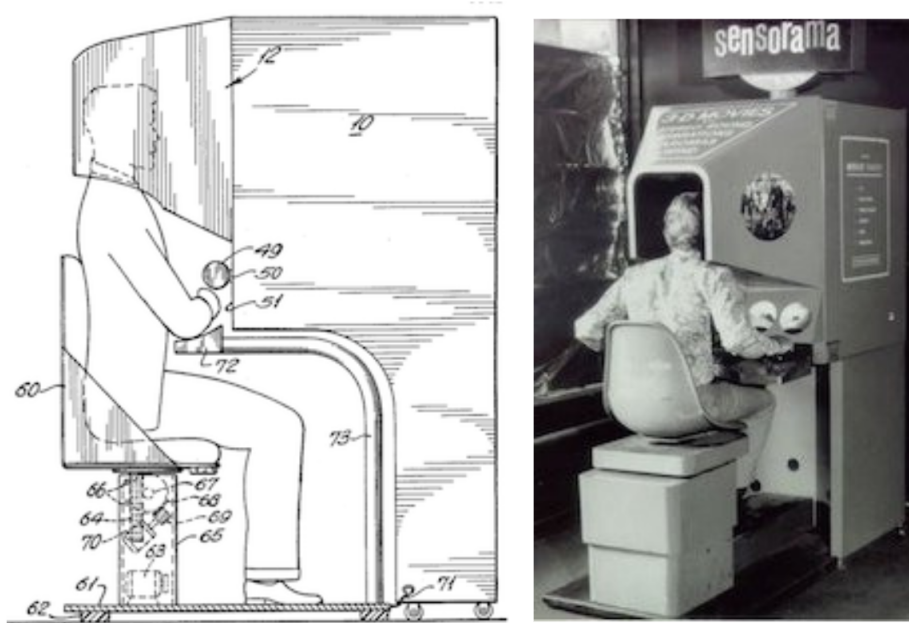
Figure 2.1: A user enjoying the Sensorama experience

created in 1961 by Comeau and Bryan, two Philco Corporation engineers. The device had two displays, one for each screen, and a magnetic tracking device. It was the first motion tracking device ever created and was primarily used to move a remote camera and look around the environment without the user having to physically be there. NASA Ames Research Center used a Virtual Reality Environment Workstation which combined a head-mounted device with gloves to enable haptic interaction in the mid-1980s. The term "Virtual Reality" was coined in 1987 by researcher Jaron Lanier.

2.3 Virtual Reality in gaming and households

The first Virtual Reality arcade game was launched in 1991 by the Virtuality Group and allowed the users to wear a pair of Virtual Reality goggles to play immersive games in real-time. Nintendo launched the first portable VR gaming console, the
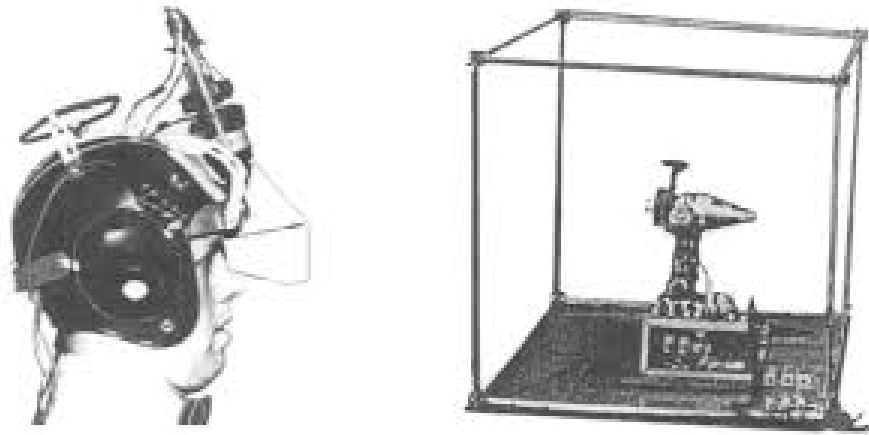
Figure 2.2: The Telesphere Mask

Figure 2.3: The first virtual reality arcade games.

Nintendo Virtual Boy, in 1995. It was the first portable device to display VR and 3D graphics but was ultimately a flop due to the lack of colored graphics (it could only display black and red), poor support and a hefty price tag.

Virtual Reality in gaming would not really re-surface until the Oculus Rift prototype was launched in 2010, which started Virtual Reality's journey to becoming a more mainstream gaming device that could appeal to everyone. Although the Oculus Rift required a desktop computer to run the games for it, the amount of detail provided was unparalleled up until that point.

In 2019, the Oculus Quest was released—a standalone headset which no longer required the wired connection to a powerful desktop computer to run its games. This, as well as a lower price tag, has allowed VR gaming to enter the household market at a larger extent than ever before.

Figure 2.4: The Oculus Quest headset and controllers.

Chapter 3

Types of interfaces and immersion

3.1 Interfaces

User Interface in games are usually divided into four categories as shown in table 3.1 (Fagerholt and Lorentzon 2009):

		In the game space?	
		No	Yes
In game story?	No	Non-diegetic	Spatial
	Yes	Meta	Diegetic

Table 3.1: Types of Interfaces in relation to game space and story

3.1.1 Non-diegetic User Interface

Non-diegetic UI is typically used for menu elements, map overlays or other elements that provides the player with information that is not part of the game world, nor as a part of the game story.

The traditional way of displaying ammunition status in games played on a flat display is by having a non-diegetic UI element in the bottom right corner of the screen (Figure 3.1).

3.1.2 Diegetic User Interface

Diegetic UI is interface elements that are both part of the game world, but also ties in with the game story. This means that the element is not only visible to the player, but also to the player character in-game and other characters present within the game world.

Figure 3.1: Traditional Non-Diegetic User Interface with ammunition status in bottom right as seen in Half-Life 2.

This kind of UI is frequently used in simulator games like the Euro Truck Simulator series or the Microsoft Flight Simulator series. There, the player can read the information through realistic looking dashboard or cockpit elements, just as one would in reality. It is also used in e.g., survival games like Firewatch, where the player navigates using a diegetic map and compass which the player character is holding in its hands (Figure 3.2).

Figure 3.2: Diegetic User Interface as seen in the Firewatch game.

3.1.3   Spatial User Interface

Spatial UI differs from diegetic UI in that it is not visible to any characters in-game, but only to the player viewing the game through a display. That means that the interface element is still a part of the game world and can move around in the world independently of the camera viewport, but it is not interactable or visible by anyone within the game world (Figure 3.3).

Figure 3.3: Spatial User Interface as seen in Need For Speed: Pro Street. Notice the green arrows on the tarmac displaying the optimal way to approach the curve to the user.

3.1.4   Meta User Interface

Meta UI is not present within the game world per se but is provided to the user through the game story. The player receives the information from something or someone within the game world, e.g. through verbal or written story line, but the information is not visible to anyone else within the game world.

3.2   Immersion

You can see the term immersion being used when describing video games, but as a descriptive term it is rather illusive. Immersion means something different

for each individual. While one player claim they had an immersive experience when the hours flew by in a game, another might consider a high level of realism to be the reason why they felt immersed. If you ask either one of them if they found the video game they were playing to be immersive, their answer would be "Yes". If you then told them that you were working on a video game which would be very immersive, they would have two different mental models on what your video game will be like.

3.2.1 The immersive fallacy

The idea of the more realistic a game is, the more immersive it is, is known as *The immersive fallacy*, referenced by Katie Salen and Eric Zimmerman in the book *Rules of Play* (pg. 450-451).

> *"The immersive fallacy is the idea that the pleasure of a media experience lies in its ability to sensually transport the participant into an illusory, simulated reality. According to the immersive fallacy, this reality is so complete that ideally the frame falls away so that the player truly believes that he or she is part of an imaginary world."*

But, as the player who felt hours flying by while playing a 2D top-down game called Stardew Valley will testify to, the simulation of reality on its own is not enough, maybe not even required, to create an immersive experience.

3.2.2 The flow state

Realistic graphics and a simulator experience might increase the immersion in one way, but is certainly not the correct way to go for every game. But, if you create a too realistic experience, the player might get bored, find it too hard or not really see the point in playing the game.

Mihaly Csikszentmihalyi is a psychologist who described the *flow state* to be a state in which the challenge presented to you matches the skill you posess (Csikszentmihalyi 2002). If the difficulty is too low, it leads to boredom. If the difficulty is too high, the user feels anxious instead. The real world is usally difficult. Not everyone can drive a racecar. Play top-level football. Climb a mountain. A game is a place where people can find an escape from this real world. Where they can live out their dreams. Experience a different life. But if game developers were to belive that a game must be immersive to be good, and that it must be realistic to be immersive, then we would end up with games that look and feel like the real world but end up being near impossible to *play*.

3.2.3 Categories of immersion

In the project report *Categorizing Immersive Interaction Design in Video Games*, Håvard Hvoslef Kvalnes analysed existing games with a high level of immersion
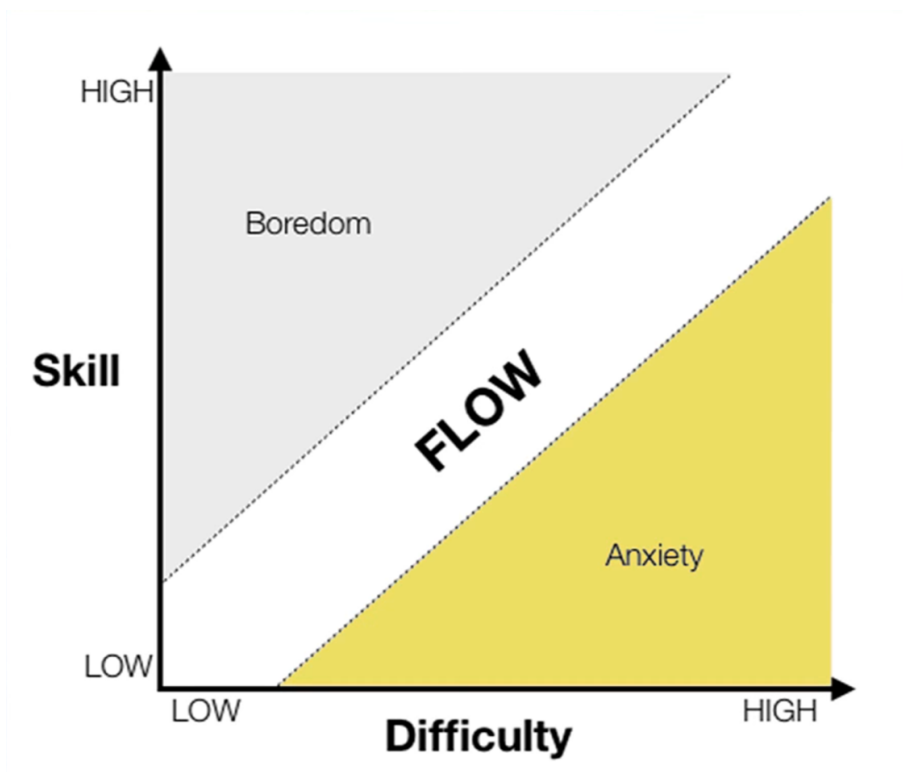
Figure 3.4: The flow state.

and interviewed several gamers on what their definition of immersion was. The result of the project was five categories of immersion which can be used to analyse your game's immersion (Kvalnes 2020) (Appendix A):

Environmental immersion

Does the game world feel believable? Does it have a consistent look and feel throughout? This category applies to everything the player can interact with to the game physics. The game developers need to create a believable game world/universe, where the same rules apply throughout.

Engaging immersion

A game with competitive and/or social aspect to it usually score high on engaging immersion. In these games, it is especially important to keep the player in the flow state.

Realistic immersion

If your game is either simulating the real world like Microsoft Flight Simulator or using real-life data as a base to allow your players to take their turn on a well-known real-life concept like in Football Manager, then your game will score high on realistic immersion.

Interactive immersion

This applies to the user's direct interaction with the game. It can be how well the game control scheme is, how the menus are laid out and how the user interface affect their experience. Do the player get the required information at the time they want/need it?

Driven immersion

By good use of an in-game story, set goals and/or achievements to make the user progress in your game, you will have a high level of driven immersion. It can be a story which the player relates to, or it can be a set of achievements that make the player want to go just... one... more... turn.

Immersion categories used in this project

For this project, where we are testing different user interfaces for providing the player with required information in a first person shooter, we are taking a closer look on three of the immersion categories: Environmental, Realistic and Interactive immersion.

Chapter 4

State of the art games in Virtual Reality

4.1 Half-Life: Alyx

Half-Life: Alyx is a game created by Valve Corporation and is one of the highest selling VR games. The game is set in a science fiction futuristic environment and is played in a first-person perspective (Valve/Steam 2020a).

By having the game take place in a futuristic environment, the developers are freer to come up with UI solutions that can differ from what is realistically possible to date. They take advantage of this by providing the player with two gloves that connects with the player character and can read their vital information. A display on the left glove provides the player with health information. The ammunition information is displayed through a digital display directly on the weapon's shaft.

These interface elements are diegetic, as they are on the gun and glove themselves and not as an extra interface layer on top only visible to the player.

One interesting thing that Half-Life: Alyx does, though, is that when you're playing it wearing your headset connected to your desktop computer, a more traditional 16:9 video stream is displayed on the desktop's screen (Figure 4.2). On this video stream, the health and ammunition information are displayed using non-diegetic UI as one traditionally would on such a medium. It is possible this decision was made so that the players of Half-Life: Alyx could more easily share their gameplay through a live stream or recorded session with an audience watching it on traditional flat displays while still getting the information they would like to see while watching the stream/recording.

4.2 Onward

Onward claim that they want you to "Become fully immersed in the firefight!" (Coatsink/Steam 2020). They try to combine military simulation with gameplay.

15

(a) Five bullets in the magazine.

(b) Three bullets left. Notice the color change.

(c) Empty magazine.

Figure 4.1: The Diegetic UI of Half-Life: Alyx.

Figure 4.2: The stream-friendly interface of Half-Life: Alyx with Non-Diegetic UI in addition to the in-game Diegetic UI. These additional Non-Diegetic elements are not visible for the player using the VR headset.

Thus, they provide no visual indication of ammunition nor health to the player. This is by far the most realistic approach, but does most realistic equal most immersive?

The player is required to have a certain knowledge of magazine capacity and required to count the number of bullets they shoot as they move along in the game to ensure they don't run out of bullets at a crucial time. This can be stressful, but an interesting game mechanic.

By doing it this way, one can assume that it would be harder for the "every day" casual gamer to remain in the flow state while playing this game, but that might not their target audience. They target the more hard-core players who are looking for the most realistic experience as possible, and this provides them with a much more believable and realistic experience than they would get with UI elements that would not be there in the equivalent real-world scenario.

Chapter 5

Methods

This Master Thesis aims to answer the question "How can an immersive experience be created while still giving the player the required in-game information?".

To answer this question, a qualitative study was conducted to greater understand what creates an immersive experience in VR. "State of the art" FPS VR games that are on the market today was analyzed, and their design solutions compared with each other. High-fidelity prototypes was created to test different design proposals with a selected group of testers, and in-depth interviews with the testers was performed during the tests to gain a subjective measurement of the immersion.

5.1 Research through Design

This project is based on Research through Design (RtD), a methodology much used within the field of Interaction Design (Zimmerman et al. 2007).

The term Research through Design was first introduced by Christopher Frayling in the article" Research in Art and Design" in 1993 (Frayling 1993). In the article, Frayling writes about *Research into art and design*, *Research through art and design* and *Research for art and design*.

Others have since based their work on Frayling's article. Pieter Jan Stappers and Elisa Giaccardi writes in their chapter "Research through Design" in *The Encyclopedia of Human-Computer Interaction, 2nd Ed.* that "Research and design are closely related, but different. Both are intentional activities with the goal of creating something new. Yet they differ in the way they are (typically) conducted, and the values by which their outcomes are (typically) judged."

By doing design as a part of doing research, one can give people the possibility to engage with a product in a way they would not normally do in a research project. They can interact with a prototype and become observable test subjects

through the design. In addition to this, the designer who have created the prototype will have faced both opportunities and constraints, with implications of theoretical goals and constructs, and the confrontations between these and the real world. By going through that design process, the designer will have already gained valuable insight by dealing with the real-world obstacles involved in creating the prototype itself.

5.1.1 Prototyping as a method

The prototypes created in this project are of vital importance for the end result. Measuring immersion without a prototype, but e.g. concepts written out on paper or screen instead, would not really be of any value, as the users would have to imagine themselves how the experience would feel like. Giving them prototypes to test ensures that the testing was done within the VR environment in which we wanted the user to be immersed.

In the process of creating these prototypes, I as the designer was challenged in making the bridge between the product and its users the best as possible. It required to an even greater extent to take into account the constraints that are within the VR technology, instead of coming up with a "best-case" scenario that might be difficult or even impossible to realistically implement. This in turn ensures that the result of the research is of value for the industry today rather than a futuristic vision.

Fundamental principles of prototyping

Prototyping is an activity with the purpose of creating a sample or a model to test a concept or a process. It should enhance the qualities that the designers are testing, while still maintaining the understanding of the entire product for the user testing it. The prototype should be created in the simplest and most efficient way while still ensuring that you can measure and analyze the design principles that you are testing.

Advantages and disadvantages

To be able to test something in the VR environment of which we are trying to understand the level of immersion in is crucial. We will not get the same results if we had tested this on paper or on a traditional 2D screen instead of a prototype using a VR headset.

The control I as the host of the test has over the VR headset is limited compared to having a controlled test on a regular computer. This can be a disadvantage, and I had to ensure that I did some "test-tests" before doing the actual user tests so that I was comfortable with the level of control over the VR headset that I got, and that found the best way of performing the tests.

Challenges

The greatest challenge in this project was to actually create the prototypes to such a level that the difference in immersion can be perceived. If the users had reported no difference in immersion in the initial prototypes, those findings would have been used to iterate and try to make a second set of prototypes.

To ensure a swift and efficient prototyping process, a pre-built shooting range asset for the Unity game engine was purchased. This was then be altered in terms of how to display ammunition left in the gun. This ensures that the only aspect that changed in the different prototypes was the way ammunition is displayed. By using a pre-built asset as a starting point, it allowed to skip initial development time setup and configuration and the effort was then rather spent on shedding light on the research questions.

5.1.2   Content analysis

A content analysis is a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes or biases (Leedy and Ormrod 2015, page 275-276). This thesis includes a short content analysis on state-of-the-art games in the VR market today, analyzing how they choose to display vital information for their users. The analysis is presented in chapter 4.

State-of-the-art games

Onward is a game that boasts to be "the most realistic combat experience available in gaming today" (Coatsink/Steam 2020). It is created to be a military simulator game, and I will use this as an example of a game that aims to be as realistic as possible in their quest for an immersive VR experience.

Half-Life: Alyx does not try to be realistic in terms of our current world and universe, but is rather a science fiction game where the player is fighting a selection of different alien spieces using a variety of modern more-or-less realistic weapons (Valve/Steam 2020a). This is developed by one of the largest game developers in the world, and will be used as a reference to what the largest game developer studios do in their VR games today.

5.2   Analytic methods

5.2.1   Phenomenological study

A phenomenological study is a study that attemts to understand people's perceptions and perspectives relative to a particular situation (Leedy and Ormrod 2015, p.273-274). It is used to answer the question *What is it like to experience such-and-such*, which is exactly what we aimed to understand from our users in this project.

Techniques from a phenomenological study was used to study the users that are testing the prototypes created.

Interviews

The aim was to get a grip on the level of immersion that the users experience while testing my prototypes, so we had to be able to go in depth to really understand how each individual user felt. To understand each individual, unstructured interviews was performed based on the way Baxter, Courage and Caine describe it:

An unstructured interview is the most similar to normal conversation. The interviewer will begin with general goals but will allow the participant to go into each point with as much or as little detail and in the order he or she desires (Baxter et al. 2015, p. 222)

By performing unstructured interviews, the user was given the ability to go more into detail in their answers. Simultaneously, the interviewer could ask follow-up questions if needed and get precisely the information that they required. To guide both the interviewer and the test subject, the subjects was asked to rate each prototype from 1-10 in three different categories of immersion. The number itself acted more of a help for the subjects to reflect on their answers and thus provide better qualitative data rather than provide quantitative data.

The data received from the interviews was analyzed using an affinity diagram. This method is often used to identify trends and themes in the data by grouping them together (ibid., p. 253). The goal was to identify what made one prototype more immersive than the others.

Field study

In addition to the interviews and surveys to try and understand the user's perspective in the digital world, we visited a shooting range to get a physical look and feel to what it is like to hold and shoot a hand-held pistol. The physical aspect of the experience of firing, reloading and wielding a pistol was taken into consideration to see if there were any elements that could be brought into the digital world. In particular, we aimed to investigate whether the gun had any differences in sound or visuals when the gun was fully loaded compared to nearly empty; e.g. if you could see a difference in the muzzle flash or the sound is different. This visit was video taped in additions to notes taken during the visit, so that the recordings could be analyzed afterwards. The findings from the field study are presented in chapter 7.

Advantages and disadvantages

Interviews give qualitative data and provides the opportunity to go more in-depth than a survey alone would. It was very important that the questions asked are of

relevance and provide the study with the insight it requires, to ensure that the data collected was of high enough quality to be used for analysis.

Visiting a gun range provides physical experience with the subject at hand, which in turn provides valuable insight to the actual concept of firing and wielding a gun. It was interesting to see whether any of it could be transferred to the digital world and if the physical feeling could be replicated in any way.

Challenges

For a phenomenological study to be effective, it is imperative that the researcher must try to suspend any preconceived notions or personal experiences that they might have on the subject. They must take care during the interviews to not be influenced by what they believe they "hear" the participants saying, and not ask leading questions that give me that answers that they *want* rather than the ones they need.

Gathering a representative collection of users that have the time to test the prototypes as well as take part in lengthy interviews like this will be of great importance to the project. The participants should preferably have experience with VR games before, so that it is not the "VR experience" itself they are reacting to, but rather the prototypes. At the very least, they should have experience with games in general.

Should Covid-19 restrictions be in place during the planned prototype testing period, we would not be able to allow the participants to test on a shared VR headset. We ould then be dependant on finding users who own a VR headset of their own, and be able to ship my prototypes to them. Performing the user testing from a distance would also be a challenge, as we would no longer be in control of what the participant was seeing or doing in their VR headset.

Chapter 6

Ethical and legal considerations

6.1 General research ethical guidelines

The project followed the general research ethical guidelines by De Nasjonale Forskningsetiske Komiteene in this project (komiteene 2020).

6.2 Norsk Senter for Forskningsdata (NSD)

The project was registered on Norsk Senter for Forskningsdata (NSD) and followed their guidelines on how to collect, store and use the data. The data collected does not have any clear identifying features other than their age, gender and profession. Still, NSD recommended that the data collected was of internal confidentiality and must be protected with access control so that it was not accessible by everyone.

NSD facilitated for making a data management plan in line with requirements of The Research Council of Norway, the EU etc.

6.3 GDPR

All participants whom I collected personal identifying data from read and signed a consent form when they took part in the project. In the process of handing them the consent form, they were informed of the project and how the collected data was intended to be used. They were all be given the opportunity to withdraw from the project at any time, and all data collected from them will be deleted on their request. They are also entitled to receive any data collected of them on request.

6.4   Ethics regarding Virtual Reality and First Person Shooters

Video games, including first person shooter games, have been highly debated on how much they influence the thoughts and minds of the persons playing them. There are studies that claim that violent video games can increase aggressive behavior and delinquency (Anderson and Dill 2000), and studies that have studied the morality and behaviour of the players in games (Sicart 2009).

As this project performed tests on users in Virtual Reality, we also considered how the VR experience could affect the users (Kenwright 2018). They could have previous bad experiences with firearms which can cause an unwanted testing experience when placed in the gun range environment of our prototypes. If the user has never tested Virtual Reality before, then it is also impossible to know exactly how they will react when trying it for the first time. Nausea and headaches are not unheard of when playing in Virtual Reality (LaViola 2000), so to prevent this as much as we can we kept the tests as short as possible, in addition to not choosing test subjects known to feel such side-effects of Virtual Reality.

Chapter 7

Field study

The purpose of the field study was to research whether the gun provided any visual, audible or other hints to the user on how much ammunition was remaining in the magazine while being used. Possible hints could be that the muzzle flash was noticeably different with a full magazine versus a nearly empty magazine, the sound could be different, the recoil noticeably different or something else.

The field study was conducted at the locales of Stord Pistolklubb (Stord Pistol Club), and every shot was videotaped to be analyzed afterwards. In addition, an interview was conducted with two representatives from the pistol club to ask their experiences with handling a gun and if they were noticing any clues when they were firing the gun.

A total of three guns were used in this study: two competition handguns with .22 caliber and one 9 mm Glock 17 handgun. The choice of guns was not up to us, as we had to make do with the guns the pistol club could provide and lend to us for the occasion. Testing two different caliber guns, however, did provide some difference in the perceived results when firing the guns.

The Glock 17 has, as the name suggests, a capacity of 17 bullets in the magazine. Each bullet weighs in at approximately 8,04 grams, meaning a weight difference of 136,68 grams between a full and an empty magazine. The two competition guns had a magazine capacity of ten, and bullets weighing approximately 2,6 grams – a difference of only 26 grams.

7.1 Field study findings

7.1.1 Visual indications

The Glock 17 magazine has numbered witness holes at the back to visually indicate how many bullets are left in the magazine. It does lack indication for bullets number 2 and 3, though (Figure 7.1).
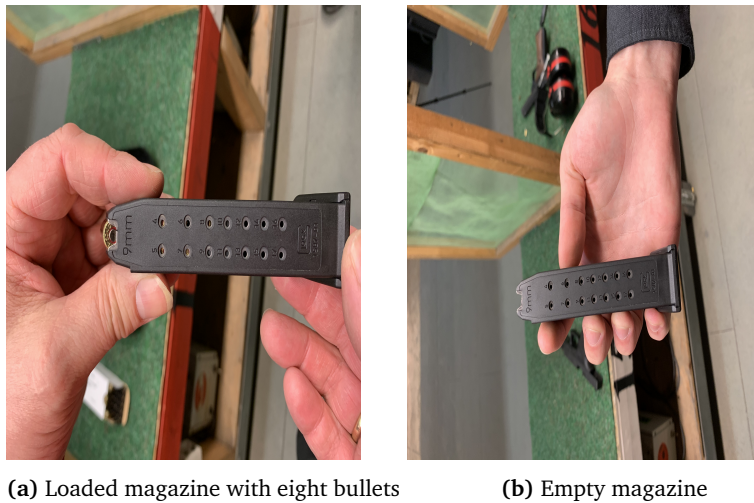
(a) Loaded magazine with eight bullets   **(b)** Empty magazine

Figure 7.1: Glock 17 magazine

The competition guns did not have any visual indication of how many bullets were in the magazine.

Once the last bullet is fired, the slider of the gun remains in the back position. This is a clear visual indication that there are no more bullets left in the magazine.

The fact that no bullet is fired if you try to fire an empty magazine is also a visual indication that the magazine and chamber is empty.

7.1.2   Audible indications

There was no difference in the audio between the first and final shot with the gun, as shown in figure 7.2.

If trying to fire again after the final bullet was fired, a "click" sound from the hammer indicates that the gun is indeed empty.

7.1.3   Other noticeable observations

When firing, the arms are constantly tiring. If the shooter does not lower his gun between the shots, it gets progressively harder to keep the aim steady.

Once the final bullet is fired and the slider remains in the back position, the weight distribution of the gun changes significantly.

The difference between a fully loaded Glock and an empty Glock was noticeable, but when firing a Glock from full to empty, the difference occurs gradually. In addition to your arm getting more tired, it was not noticeable for an amateur shooter that the gun became lighter for each shot.

(a) The audio waves of the first shot, right and left channel (stereo).
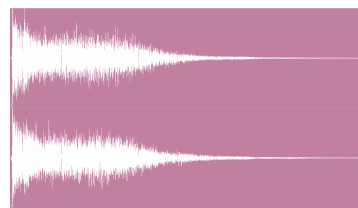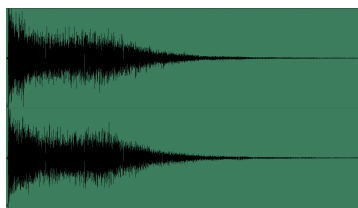
(b) The audio waves of the last shot, right and left channel (stereo).
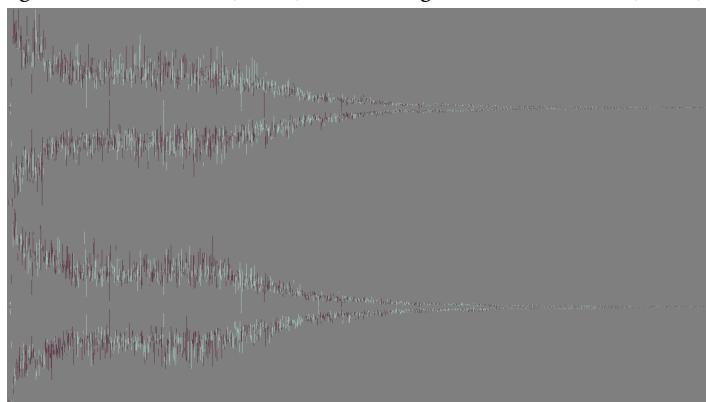
(c) The audio waves of the first and last shot placed on top of eachother, right and left channel (stereo). As you can see, there is virtually no difference between the two.

Figure 7.2: The diegetic UI of Half-Life: Alyx.

7.1.4   In-game emulations

There are some elements that can be emulated in-game:

- The magazines used can have visual indicators on them
- The slider can be left in the back position once the final bullet is fired
- Use a "click" sound when trying to fire an empty gun

Other elements are hard, if not impossible, to emulate:

- The arm fatigue of the player would not happen as quickly in VR as in real life, as the VR controllers are much lighter than a gun. The aim getting less accurate could be emulated programmatic to compensate for the weight difference.
- Weight difference is impossible to emulate with today's standards in VR equipment. You would have to add/remove weight without having somewhere to move the weight to and from. A pneumatic or haptic system could be used for such an effect. An haptic system has been attempted developed as seen in the product Grabity (Choi et al. 2017).
- Weight distribution is also not possible with today's standard equipment, but one could imagine that it could be possible to have a weight inside the hand-held controller that could mode up or down depending on how many bullets are left (as the guns get more top-heavy once the magazine is emptying), and with a greater change in weight position once the final bullet is fired and the slider is in the back position.

Chapter 8

Prototypes

8.1 Prototype goals

The aim of the prototypes is to test how we can create an immersive experience in VR while still providing the player the required in-game information. To achieve this, a certain level of fidelity is required in the prototypes. A low fidelity prototype could be made by using a simple block as a "gun", and pay no attention to the scenery in the prototype scene. As we want to measure immersion, having a low fidelity prototype would harm the perceived immersion as the scenery and elements themselves affects the immersive feeling (Krompiec and Park 2019).

With this in mind, we decided to create a high fidelity prototype. This enabled us to keep a certain level of immersion by using a gun range environment and a realistic model of a hand gun, while only changing the UI element. That way we only gathered data from how the UI affected the perceived immersion.

8.2 Choosing prototypes

Since we are trying to answer the questions "*How does diegetic, non-diegetic and spatial user interfaces affect perceived immersion in virtual reality?*" and "*How does traditional interface display for displaying remaining ammunition work in VR games compared to on a 2D screen?*", we require at least three different prototypes - one for each user interface type we are testing. One of these interface types should be the equivalent of the traditional interface display on a 2D screen in a VR environment.

8.2.1 Non-diegetic User Interface

The first prototype is an attempt at using the same principles as one would on a conventional flat monitor—display the number of bullets in a field in a corner of the screen (often bottom right). To emulate this in VR, it will be a fixed number in the bottom right corner of the camera viewport. This means that whenever the

user moves their head around, the UI will remain in the same position relative to their eyes. This is a non-diegetic UI, as it is not part of the game world, nor the game story (Figure 8.1 and 8.2).
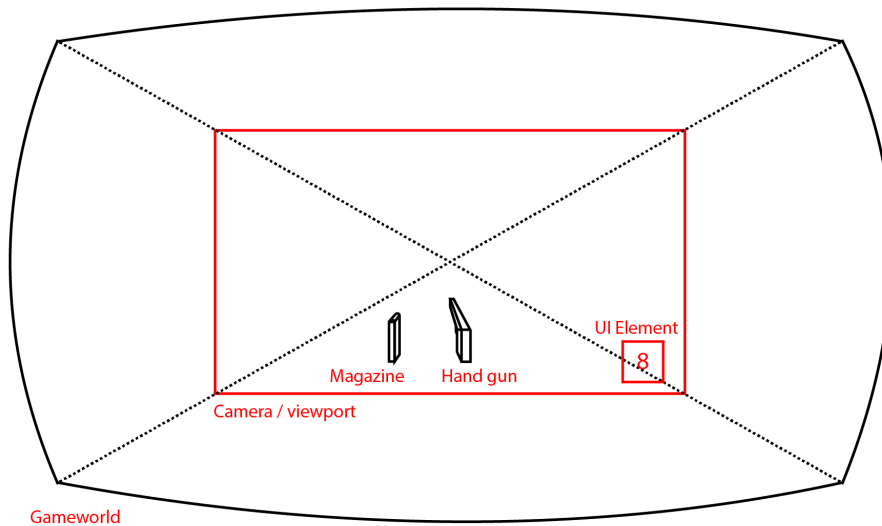
Figure 8.1: Visual representation of the Non-diegetic prototype

8.2.2   Diegetic User Interface

The second prototype will display the ammunition status on the magazine, using a magazine model with a window on the back so that each individual bullet is visible for the user. This is a diegetic UI—the element is all part of the game world and would be visible to anyone within it (Figures 8.3 and 8.4).

8.2.3   Spatial User Interface

The final prototype will display the number of bullets within the game world, as a non-game element. This is spatial UI, as the UI element is present in the game world but not visible to anyone else but the player. To try to make the UI as little disruptive as possible, the UI will not be visible unless two conditions are met: A magazine is loaded in the gun, and the user has their finger on the trigger (touch sensor) (Figure 8.5 and 8.6).

8.3   Creating the prototypes

The prototypes were created using Unity Game Engine and were made for use on an Oculus Quest VR headset. Pre-made assets and scripts were used to speed the development of the prototypes along, including pre-made 3D models for the gun, magazines, bullets and a firing range environment.
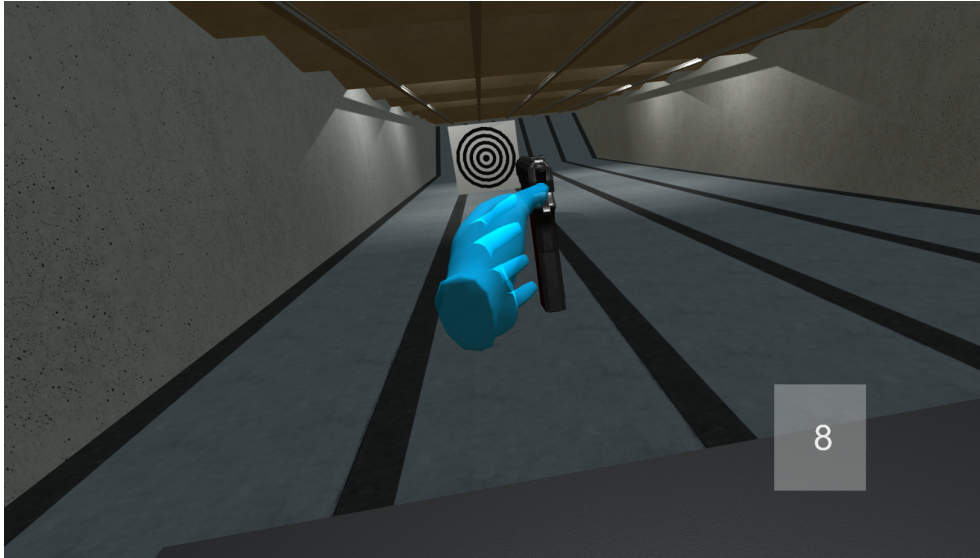
Figure 8.2: The Non-diegetic prototype while testing, as displayed in Unity.
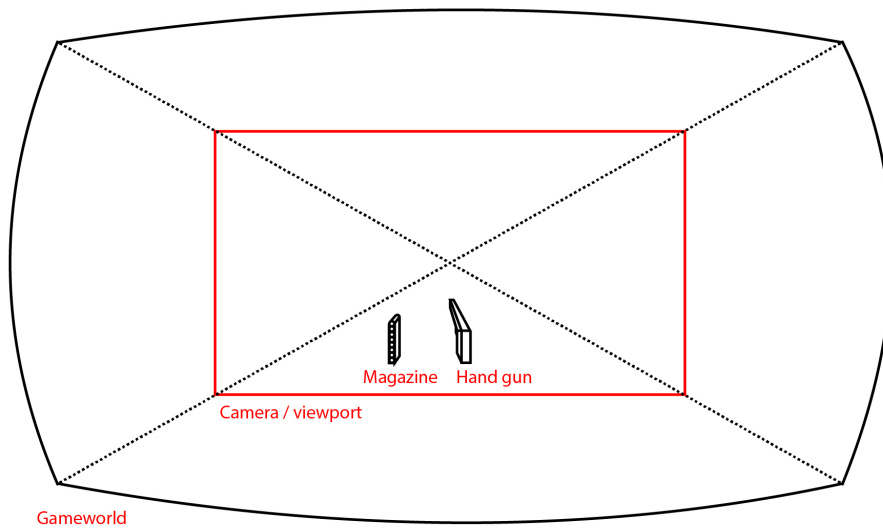
Figure 8.3: Visual representation of the Diegetic prototype
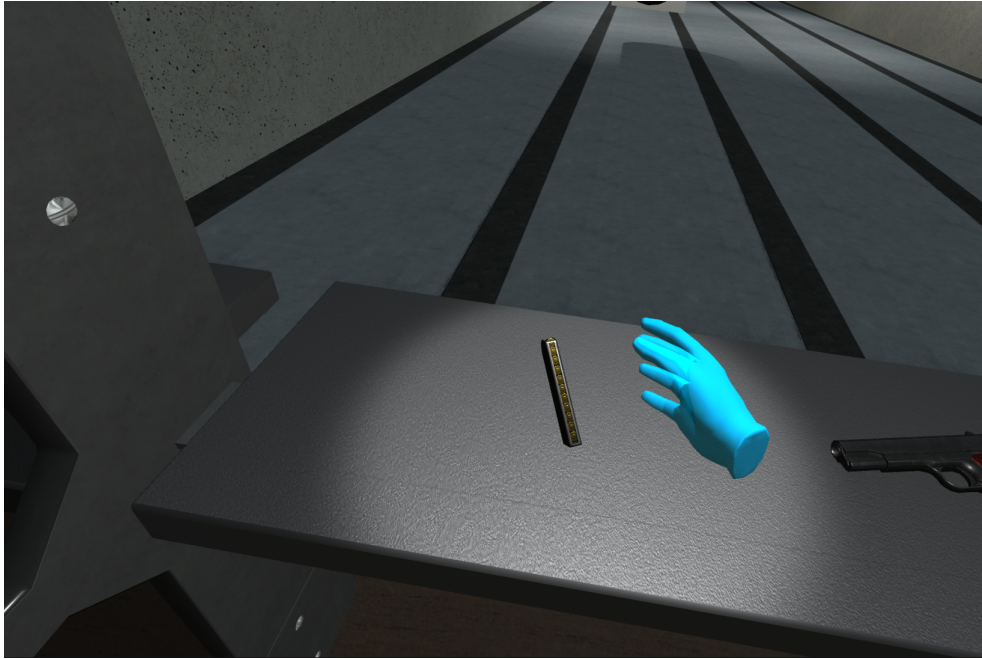
Figure 8.4: The Diegetic prototype while testing, as displayed in Unity.
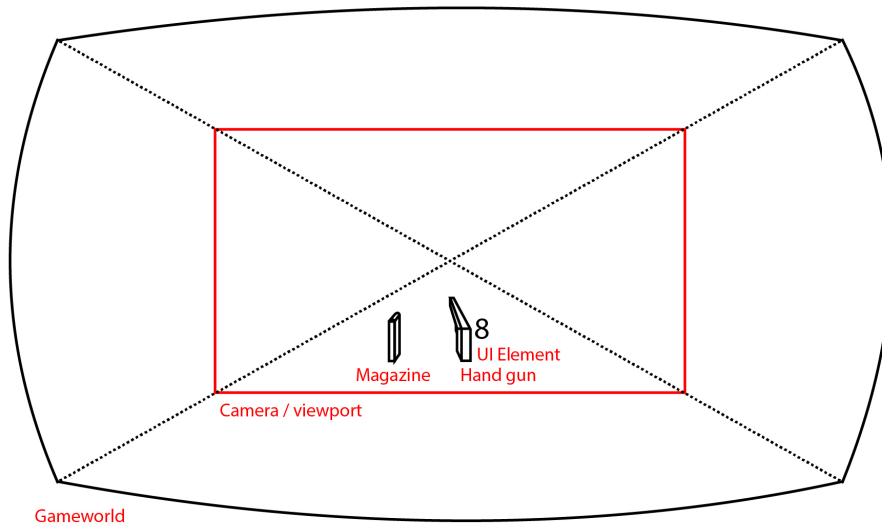
Figure 8.5: Visual representation of the Spatial prototype
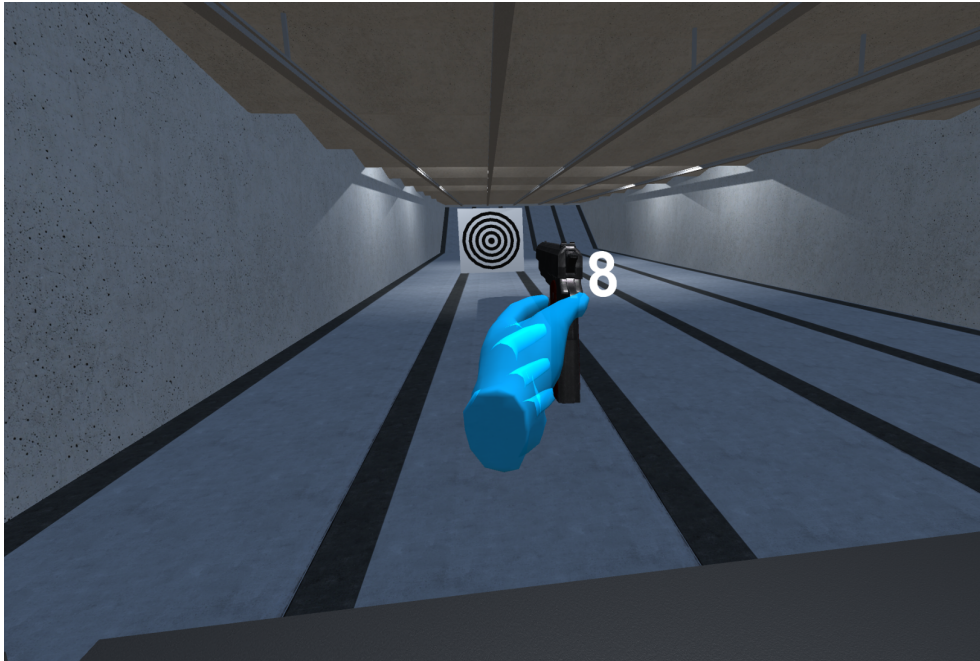
Figure 8.6: The Spatial prototype while testing, as displayed in Unity.

List of assets and scripts used as a basis can be found in appendix B.

The development of these prototypes has been very time-consuming and led to several challenges along the way. Trying to follow along with YouTube tutorials on how to create "simple" VR shooters always led to confusion, as changes in e.g., Unity, the Oculus Unity Integration or other vital elements for the prototypes made the tutorials out-of-date, even if they were less than half a year old.

As the prototypes were all the same in core functionality, but with different UI and logic behind the UI, we focused on making one prototype functional and complete before duplicating it and iterating on it to create the two others.

For the non-diegetic UI, a canvas and text element were created and set as child elements to the camera element in the scene. They were then positioned in the bottom right, and the shooting script was altered to update the text element with the number of bullets remaining.

The spatial UI was created in a comparable manner, but this time around the text element was a child element of the handgun itself and positioned to be just to the right of the gun.

The magazine used in the diegetic UI prototype was made by taking the pre-made 3D model and altering it in Blender to create the "window" in which the bullets would be visible. Each bullet was then individually added to the scene and

placed as child elements to the magazine, positioned so that they were aligned in the magazine to make it appear full. It took 11 bullets to fill the magazine. The shooting script was then altered to check the value of the variable "numberOf-Bullets" each time the trigger was fired. If the value equaled 11, then when the trigger was pulled the bullet asset with id Bullet11 would be hidden in the scene. This logic was then repeated for each individual bullet.

Ideally, we would like the slider of the gun remain in the back position after the final bullet was fired but were unable to get this functionality to work properly. Due to time restraints, this functionality was not implemented before testing. The testers still get an audio cue with the firing sound changing to a "click" when trying to fire an empty gun.

8.4   Testing the prototypes

8.4.1   Choosing test subjects

If we were to send the prototype package to someone else and allow them to test it on their devices and communicating through video link or similar, we would not be able to ensure same test conditions and experience, and it would be a lot more difficult to provide assistance if required. Therefore, all tests were held in-person. To ensure the test experience was the same for all testers, all tests were performed using the same hardware (the same desktop computer and the same Oculus Quest headset).

As covid-19 is still rampant in our society, the majority of test subjects have been chosen within the same office cohort to limit any possible cross-infection. This has of course limited the number available test subjects drastically but was required to ensure that one could test this within the guidelines applicable at the time.

Most testers work within software development and has high experience of general gaming experience and everything from low to considerable experience with VR games. To also get some data from users with no/low gaming experience, the prototypes have been tested with three testers outside of the office cohort.

We are aiming for 10–12 testers, with a minimum of eight, as Ritch Macefield states in his article in the Journal of Usability studies: "For comparative studies where statically significant findings are being sought, a group size of 8–25 participants are typically valid, with 10–12 participants being a sensible baseline range" (Macefield 2009):

> Based on extensive primary research conducted by Landauer (1988), Nielsen and Landauer (1993) found that statistically significant findings are unlikely to be produced by a study group of less than eight

participants, and it is this research that underpins the advice in the common industry format for usability test reports (CIF v2.02, 2002) to use a minimum group size (segment) of eight participants. This research also showed that a study utilizing 25 participants per group was quite likely to produce statistically significant findings.

Within this range, Spyridakis and Fisher (1992) found that a study group size of 10-12 participants will often produce statistically significant findings. This figure of 10-12 participants is in broad accordance with the advice of Rubin (1994) and Faulkner (2003).

8.4.2   Testing the prototypes

The subjects are first briefed on what we are testing and why. They are explained the three distinct categories of immersion that we are wanting to test, and that they are going to score the prototypes against each other from 1–10 in each of the three immersion categories.

They are then provided with an Oculus Quest headset with controllers, which is connected to a desktop computer running the prototypes in Unity.

Covid-19 precautions

The Oculus Quest headset and controllers were disinfected with antibacterial gel before and after each use. In addition, all test subjects disinfected their hands before using the headset. They were encouraged to wear a face mask and gloves.

Tutorial

The test subject is then asked to put on the Oculus Quest, and a tutorial scene is started for them. In this scene, they are in a sterile environment with only a white cube in front of them working as a table. On top of the cube is a gun and three magazines.

In this tutorial scene, the test subject is instructed on how to use the controls within the prototypes: how they can move around if required, how they pick up the gun, how they pick up a magazine, how to load the magazine, how to fire the gun and how to extract the magazine and change to a new one.

Doing this tutorial in a sterile environment enabled us to teach the test subjects how the prototypes would work in a neutral environment without any UI elements, allowing them to focus on the task at hand once the testing of the actual prototypes began.

Prototype test format

Once the test subject was comfortable with the controls and functionality, the scene was changed to the first prototype and these instructions were followed:

1. Ask test subject to pick up the gun
2. Ask test subject to pick up a magazine, inspect it, and place it in the gun
3. Fire five shots
4. Ask test subject "How many bullets do you have left?"
5. The test subject answers to me out loud. I take a note of the answer, and ask them to keep firing until they have one bullet left
6. The test subject keeps firing and stops once they believe they only have one bullet left
7. We wrote down the number of bullets they have fired, and asked them to fire until empty
8. The test subject fires until empty. The firing sound is replaced with a "click" sound if they try to fire some more
9. We started the next prototype, and repeated the above steps

Once all prototypes were tested, a Nettskjema form was used as a guide for a semi-structured interview, as well as being able to register their score from 1–10 in the different immersion categories. Any comments the test subjects had during the testing was also noted down in this form, as well as their comments for each immersion category for each prototype.

Having them rate the perceived immersions of the three prototypes in three distinct categories helped the test subjects reflect on why they were scoring them as they did—thus providing more relevant and in-depth feedback.

Chapter 9

Results

Eleven tests were performed. The data from the first test has not been included in the results presented below, as the test was not conducted properly (the subject did not get the guidance required to understand what they were actually testing). This means that data from a total of ten test subjects is analysed.

First, the results for each prototype will be presented individually before a comparison between the three will be presented at the end.

9.1 Prototype 1 – Non-diegetic User Interface

Immersion category	Average score	Median	Highest score	Lowest score
Environmental	5,10	5,50	8	2
Interactive	8,50	8,50	10	7
Realistic	4,00	4,00	8	1

Table 9.1: Perceived immersion with non-diegetic UI

9.1.1 Environmental immersion

For a game, it felt natural. I would expect to see my ammunition status somewhere.

The scores for environmental immersion ranges from 2 to 8, with an average of 5,10 and a median of 5,5. Some testers were used to the placement of it in the bottom right corner from traditional shooter games, and accepted its presence there in the VR environment as well.

Others, however, felt that the constant visible element took their focus away from the game world. And when moving your head around, it felt more out of place since it followed the camera statically.

9.1.2 Interactive immersion

It felt intuitive for me to have it in the bottom corner, as that is what I'm used to.

This is the highest scorer of the three prototypes when it comes to interactive immersion. Even though it might be an intrusive element for some, it does provide the player with the information they desire when they require it. It is easy to understand and follow, and the players are used to the positioning. One of the low scorers of 7 stated that it was a bit far down to the right for their peripheral, so they had to actively seek the information.

9.1.3 Realistic immersion

It is kinda "game realistic", but it was at the same time a weird element that was just "hanging there" and moved with me rather than feeling as static as on a traditional display.

With four test subjects scoring this prototype a 1 on realistic immersion, the other higher scorers could perceive this as realistic under certain conditions: it could be a visor or it could function as a screen displaying how many bullets you had remaining like in competitive shooting.

9.2 Prototype 2 – Diegetic User Interface

Immersion category	Average score	Median	Highest score	Lowest score
Environmental	8,10	9,00	10	2
Interactive	6,50	6,00	10	3
Realistic	9,20	9,00	10	8

Table 9.2: Perceived immersion with diegetic UI

9.2.1 Environmental immersion

At first it felt like something was missing - since I did not look at the magazine properly before placing it in the gun. But once I understood that, it felt believable and that it belonged in the world.

Most subjects scored this very high in environmental immersion, with only one (with a score of 2) scoring it less than seven. The comment they had was that "It would require a lot of training to know, and hard to remember/know the amount of bullets for each different gun, so for a game I would not want this".

The rest felt that it was very natural within the environment, and felt believable that they could see each individual bullet and extract the magazine to check the number of bullets they had remaining. Some commented that it "felt like a hardcore game".

9.2.2 Interactive immersion

Frustrating not to know exactly amount in a stressful situation. Would probably never bother to check in a game situation, but rather fired until empty, change to a new magazine and repeated.

The realism appear to hurt the interactive immersion. With an average of 6,5 and a median of 6,00 in interactive immersion, this is the lowest scoring of the three. The comments included "It felt cumbersome to count the bullets, and could be a challenge in a shooting game.", "When distracted, you would get the least amount of information of info here.", "It did feel intuitive in a realistic way, but not very practical".

I would say that the realism in this prototype made some of the testers go out of the flow state. The challenge of counting and remembering was so high that the game felt more like a chore than something fun. If presented with an actual challenge in the form of enemies to shoot, they would most likely quickly fall into the anxiety phase.

Another observation is that not all test subjects counted correctly. Some counted only ten bullets, while some counted twelve (there were eleven visible bullets in this prototype). Most did trust their original count, though, so when asked to fire until one bullet left or until empty, they missed the mark by one bullet. Only one of the subjects who miscounted double-checked their count by extracting the magazine and did another count before continuing firing.

The test subject who rated this a 10 on interactive immersion "brute-forced" it by firing the gun empty and counting each bullet before answering me how many bullets he had. We then restarted the prototype and prompted him to check the magazine. He then counted to eleven, and did not double check when asked how many bullets remained after firing five shots (as he had already confirmed to himself that he started with eleven bullets after the first round of brute forcing).

9.2.3 Realistic immersion

Felt like the real world – you have to count and keep count, as one would in reality.

Four subjects scored this a 10 for realistic immersion, and only two scored it an 8. Some of the test subjects stated that "If I were to fire a real gun, this is how I would imagine it would be". Another stated "I have no experience with hand gun

shooting, but I have not heard of magazines having displays showing how many bullets are left.", while one said "Absolutely felt realistic, from what I know there are magazines that can be open in the back like this". In other words, it does feel realistic even if the test subjects are not completely sure that it actually is, due to lack of personal experience with the real thing.

9.3　Prototype 3 – Spatial User Interface

Immersion category	Average score	Median	Highest score	Lowest score
Environmental	5,90	5,50	9	3
Interactive	7,90	8,00	10	6
Realistic	5,90	6,00	9	1

Table 9.3: Perceived immersion with spatial UI

9.3.1　Environmental immersion

Gave some meaning in a game world, as you would require the information. That the number disappeared helped the immersion as it was not as intrusive as the first one.

There is a difference from the non-diegetic UI when you look at the average score, but the median is the same. Some subjects liked the fact that it was not always-present, so the element itself was less disturbing or intrusive to them. Others felt that it was unrealistic in the game world due to it being a "floating number", but suggested that placing the number on the gun itself would've felt more environmentally immersive.

9.3.2　Interactive immersion

The placement could be intrusive when aiming since it was so bright and large. Could get in front of enemy players

That the UI appeared/disappeared when the finger was on the trigger, was not intuitive for most. But after some of them understood what made the UI appear, they seemed to like that it was only visible when you really needed it and thus felt much less intrusive than the non-diegetic UI.

Most did get the information they required, but some had issues with the placement and the size of the element itself. It was a bit large and bright, and when you would aim it could potentially be in the way of your line of sight.

Another interesting observation was that the subjects who kept their finger on the trigger while firing all had gun experience (either through hunting or army service).

9.3.3 Realistic immersion

> *Since the number disappared, it felt more realistic than the first one. As it's not ever-present.*

When comparing it to the non-diegetic UI again, most subjects did feel that it was more realistic. The second-lowest score was 4, so the one subject scoring a 1 was the "odd one out" of the bunch. Some commented that it did not really feel realistic in that setting, but in a more futuristic game it would definitely be viable. Since it does not feel too farfetched, it did not break their realistic immersion. The fact that it was not always visible also helped with the realistic immersion. The subjects were only reminded that they were in fact in VR once their finger was on the trigger, and then they would expect to see the information anyway.

9.4 Comparing the prototypes
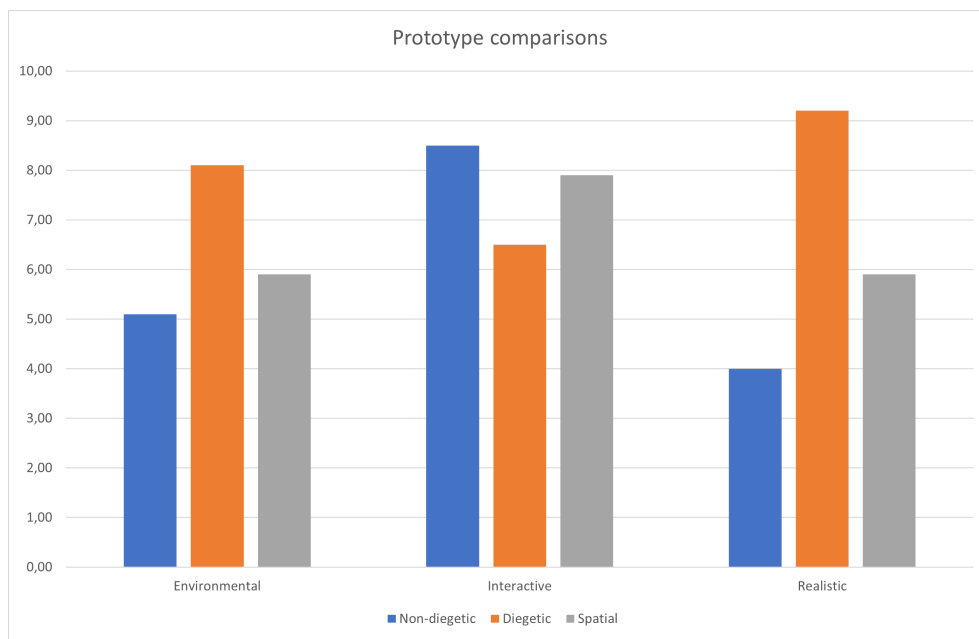
Figure 9.1: Comparison of prototype immersion scores.

> I think I would prefer to use #2 or #3, dependent on the type of game and genre. #2 would not be good for casual gameplay, but for a more realistic experience I think #2 would be best. So #3 would be the best for a quick and casual game.

As one can read from figure 9.1 and the tables in this chapter, the non-diegetic and spatial prototypes had similar scores on interactive immersion, but the spatial

prototype scores higher on both environmental and realistic immersion. The diegetic prototype scores very high on environmental and realistic immersion, being close to the real world in both look and feel, but the interactive immersion takes a hit as a result. Finding the right balance for the type of game you are developing is important.

> I would not like a VR game that is too close to reality, but also not like the traditional games as I would like to be more "inside the world". So a mix of sorts between the two last prototypes would fit me best.
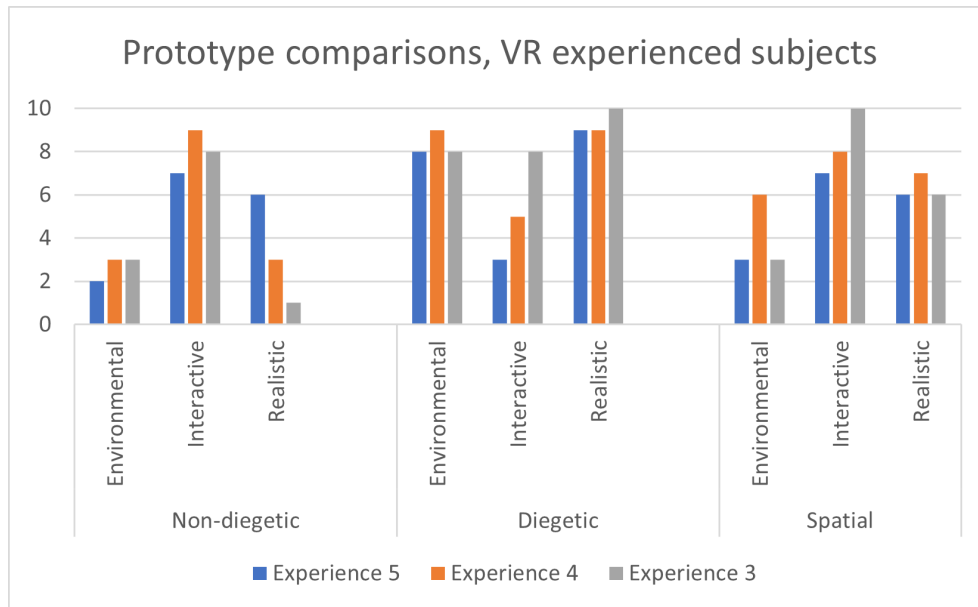
Figure 9.2: Comparison of prototype immersion scores for test subjects who rated themselves as averaged experienced or higher with VR gaming.

Figure 9.2 shows the three prototypes compared using only the data from the three test subjects who rated themselves as averaged experienced or higher with VR gaming (3 or higher out of 5). Here, the difference in the perceived environmental immersion is particularly noticeable when comparing the three. The diegetic interface displays a much higher score than the two others.

Another interesting observation is that the spatial interface is scored above average (6 or 7) on realistic immersion for all three participants, while the non-diegetic only had a high score set by the most experienced participant. It must be noted that he said that the interface "could be a visor", thus scoring it as he did.

Chapter 10

Discussion

As described in the introduction, problem statement that we have set for this thesis is:

> **How can an immersive experience be created while still providing the player the required in-game information?**

In this chapter, we will discuss the results from our project and try to achieve a set of guidelines to aid your game design and development in terms of immersion in Virtual Reality.

We will first discuss the two research questions before presenting the guidelines in the next chapter.

10.1   Research question 1

> **How does diegetic, non-diegetic and spatial user interfaces affect perceived immersion in virtual reality?**

As touched upon in the results chapter, the three different user interfaces affect the perceived immersion in different ways. The non-diegetic and spatial user interfaces are similar to each other in terms of perceived immersion, but it can be said that the spatial user interface appear to be a better fit for Virtual Reality than non-diegetic is. Several of the test subjects stated that they were okay with the non-diegetic User Interface because they were *used to it being that way*.

Jakob Nielsen's 10 usability heuristics for User Interface design is well known and does encourage the use of conventions as per heuristic #4 (Nielsen 1994). One can claim that the industry convention for First Person Shooter games is to use a non-diegetic UI in the bottom right corner, but since Virtual Reality is still a relatively new *platform*, one can also claim that the platform convention is not yet settled.

The diegetic User Interface scored differently than the other two. It had very high levels of realistic and environmental immersion, but at the cost of interactive immersion. It made it harder to get a quick overview of the ammunition status, and in a stressful scenario it can make the user anxious because of the increased difficulty level. If a realistic and "hard core" experience is what your game is aiming to achieve, then a diegetic User Interface could be the best choice for you.

10.2   Research question 2

> **How does traditional interface display for displaying remaining ammunition work in VR games compared to on a 2D screen?**

The non-diegetic prototype was the equivalent of the traditional interface display on First Person Shooter games on a two dimensional screen. Based on the feedback received from our test subjects, this is still a viable solution for players with less experience with VR games, but the players with more experience scored this significantly lower in environmental immersion for the players who rated their VR experience as above average (Figure 9.2).

This indicates that if your potential player base has experience with other VR games, then the use of a non-diegetic interface might not provide your players with the immersive experience you are looking for as when using a diegetic or spatial interface.

10.3   Research contribution

The model for Research Through Design presented by Zimmerman et al. provides a set of four criteria which can be used to evaluate research contributions through interaction design: *process*, *invention*, *relevance* and *extensiblity* (Zimmerman et al. 2007).

10.3.1   Process

Zimmerman et al. state that a research process must be documented in such a way that it can be reproduced. One must also provide a rationale for their selection of the specific methods employed.

In the methods chapter of this thesis, all methods used are stated with rationales of why those specific methods have been used. The research process has also been documented in chapters 2, 3, 4, 6, 7 and 8. We have gathered both historical knowledge and evaluated state-of-the art games. A field study has been conducted to gather data from the physical world to see if there were any elements that could be emulated in Virtual Reality. Based on the evaluations and field study, the prototypes were designed and developed. This process was key to

understanding how the prototypes should be designed and which User Interface types they should have.

10.3.2   Invention

The model by Zimmerman et al. also states that the research contribution must have produced a new integration from different fields to solve a specific situation.

A literature review has been performed to try to find other research within this field. As mentioned in the introduction chapter, we have found some research, but of an older date and before the Virtual Reality (VR) gaming became popularized.

The prototypes created in this project have combined the use of User Interface categories (Fagerholt and Lorentzon 2009) and immersion categories (Kvalnes 2020) to aid game developers to analyse their own Virtual Reality games in terms of perceived immersion and usability.

10.3.3   Relevance

According to Zimmerman et al., the researchers must formulate the motivation for their work, the detail of the current situation and the preferred state. These have been answered in chapter 1.

10.3.4   Extensibility

Finally, Zimmerman et al. defines extensibility as the ability to build on the resulting outcomes of the interaction design research. One can either employ the process in a future design problem, or understanding and leveraging the knowledge created by the resulting artifacts.

The results of this thesis is a set of guidelines for interaction designers and developers to use in their development of Virtual Reality applications, so it can absolutely be built upon and help others get valuable insight in the applications they are developing.

10.4   Guidelines elaborated

1. Define your primary player.
   a. Your primary player should dictate which type of immersive UI you decide to focus on. Are you seeking the hard-core player who wants the most realistic experience as possible and are ready for a challenge, or are you targeting the casual gamer who are looking for a relaxing experience and escape from reality?

2. Diegetic UI increases realistic and environmental immersion, but can severly affect interactive immersion.

    a. By using Diegetic UI, our research suggest that you demand more of your player. Getting the information they require using this type of interface can be more of a chore for the player than using Spatial or Non-Diegetic UI.

3. If choosing Diegetic UI, extensive user testing is suggested to ensure that the difficulty does not become too high as a result of the lowered interactive immersion.

    a. Following the previous point, the balance of challenge provided by the game and the players' abilities is very important when using Diegetic UI. To keep the player in the flow state while playing your game, extensive user testing is encouraged to find the perfect balance.

4. Spatial UI seem to be a good center-point between the traditional Non-Diegetic and Diegetic UI when providing information to the player.

    a. To help alleviate the lowered interactive immersion by the increased difficulty using Diegetic UI, our findings indicate that Spatial UI can be used to increase interactive immersion and lowering the difficulty while not lowering the realistic or environmental immersion as much as Non-Diegetic UI would.

5. If the Spatial UI can be hidden when not relevant, the perceived environmental and realistic immersion appear to be greater.

    a. To build upon the previous point, if the Spatial UI is hidden when the player does not require the information, the perceived environmental and realistic immersion is increased as the UI element is not a constant alien element in the game world.

6. If using Spatial UI, beware of disrupting the gameplay.

    a. When placing an interface element within the game world, you must beware of disrupting the gameplay, e.g. disrupting the player's field of view with its size, opacity and/or positioning.

7. If using Spatial UI, beware that the UI might be positioned behind other game objects at certain scenarios.

    a. An example of this could be if your player moves their gun behind a corner wall then the UI will also be positioned behind the wall—thus it is no longer visible to the player. This specific example can be a feature that is desired, but it is worth keeping it in mind in case the same occurs when it is undesired.

Chapter 11

Conclusion

11.1 Guidelines for immersive interface design in Virtual Reality applications

Our research indicates that to ensure an immersive Virtual Reality experience, the interface elements should in general be designed in a different way than for a traditional 2D display.

If you are creating a game with a realistic feeling and targeting the more dedicated and experienced gamers, then a mainly Diegetic User Interface would be applicable.

If your target group is the more casual gamer, a Spatial User Interface could be the most suitable.

These are some key elements you should consider when deciding on your choice of interface:

1. Define your primary player.
2. Diegetic UI increases realistic and environmental immersion, but can severly affect interactive immersion.
3. If choosing Diegetic UI, extensive user testing is suggested to ensure that the difficulty does not become too high as a result of the lowered interactive immersion.
4. Spatial UI seem to be a good center-point between the traditional Non-Diegetic and Diegetic UI when providing information to the player.
5. If the Spatial UI can be hidden when not relevant, the perceived environmental and realistic immersion appear to be greater.
6. If using Spatial UI, beware of disrupting the gameplay.
7. If using Spatial UI, beware that the UI might be positioned behind other game objects at certain scenarios.

The elements are elaborated in chapter 10.4.

11.2   Future research

It would be interesting to research if the use of haptic feedback (as e.g. the Grabity (Choi et al. 2017)) could both provide the information required and also enhance the immersive experience without the need of an additional Spatial or Non-diegetic User Interface element. This could potentially increase the interactive immersion when using Diegetic User Interface.

A subject that this thesis does not touch, is the accessibility of the different user interfaces. For instance: Does a user with severely reduced eye-sight perceive the different interfaces in another way than users with non-reduced or only slightly reduced sight?

The same principles for creating the prototypes and measuring immersion could also be used for Augmented Reality (AR), Mixed Reality (MR) and Cross Reality (XR) applications like using a Microsoft Hololens or similar.

Bibliography

ANDERSON, Craig A. and Karen E. DILL (2000). 'Video Games and Aggressive Thoughts, Feelings, and Behaviour in the Laboratory and in Life'. In: *Journal of Personality and Social Psychology* 78.4, pp. 772–790.

BAXTER, K., C. COURAGE and K. CAINE (2015). *Understanding your users: A practical guide to user research methods*. Burlington, Massachusetts, USA: Morgan Kaufmann.

BREWSTER, D. (1856). *The Stereoscope: Its History, Theroy, and Construction, with Its Application to the Fine and Useful Arts and to Education*. London, England: Joh Murray, p. 18.

BUTTUSSI, Fabio and Luca CHITTARO (2018). 'Effects of Different Types of Virtual Reality Display on Presence and Learning in a Safety Training Scenario'. In: *IEEE Transactions on Visualization and Computer Graphics* 24.2, pp. 1063–1076. DOI: 10.1109/TVCG.2017.2653117.

CHOI, Inrak, Heather CULBERTSON, Mark R. MILLER, Alex OLWAL and Sean FOLLMER (2017). 'Grabity: A Wearable Haptic Interface for Simulating Weight and Grasping in Virtual Reality'. In: UIST '17. Québec City, QC, Canada: Association for Computing Machinery, pp. 119–130. ISBN: 9781450349819. DOI: 10.1145/3126594.3126599. URL: https://doi.org/10.1145/3126594.3126599.

COATSINK/STEAM (2020). *Onward*. Accessed: December 17, 2020. URL: https://store.steampowered.com/app/496240/Onward/.

CSIKSZENTMIHALYI, M. (2002). *Flow: The psychology of happiness: The classic work on how to achieve happiness*. London, UK: Rider.

FAGERHOLT, Erik and Magnus LORENTZON (2009). 'Beyond the HUD - User Interfaces for Increased Player Immersion in FPS Games'. Accessed: October 1, 2020. MA thesis. URL: https://hdl.handle.net/20.500.12380/111921.

FRAYLING, Christopher (1993). 'Research in Art and Design'. In: *Royal College of Art Research Papers* 1.1, pp. 1–5.

JENNETT, Charlene, Anna L. COX, Paul CAIRNS, Samira DHOPAREE, Andrew EPPS, Tim TIJS and Alison WALTON (2008). *Measuring and Defining the Experience of Immersion in Games*. Tech. rep. Accessed: October 1, 2020. URL: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.157.4129&rep=rep1&type=pdf.

KENWRIGHT, Ben (2018). 'Virtual Reality: Ethical Challenges and Dangers: Physiological and Social Impacts'. In: *IEEE Technology and Society Magazine*. DOI: `10.1109/MTS.2018.2876104`.

KOMITEENE, De nasjonale forkningsetiske (2020). *Generelle forskningsetiske retningslinjer*. Accessed: December 17, 2020. URL: `https://www.forskningsetikk.no/retningslinjer/generelle/`.

KROMPIEC, Przemysław and Kyoungju PARK (2019). 'Enhanced Player Interaction Using Motion Controllers for First-Person Shooting Games in Virtual Reality'. In: *IEEE Access* 7, pp. 124548–124557. DOI: `10.1109/ACCESS.2019.2937937`.

KVALNES, H. H. (2020). *Categorizing Immersive Interaction Design in Video Games*. Gjøvik, Norway.

LAVIOLA, Joseph J. (2000). 'A discussion of cybersickness in virtual environments'. In: *ACM SIGCHI Bulletin*. DOI: `10.1145/333329.333344`.

LEEDY, Paul D. and Jeanne Ellis ORMROD (2015). *Practical Research: Planning and Design*. Essex, England: Pearson Education Ltd.

LUGRIN, Jean-Luc, Marc CAVAZZA, Fred CHARLES, Marc LE RENARD, Jonathan FREEMAN and Jane LESSITER (2013). 'Immersive FPS Games: User Experience and Performance'. In: *Proceedings of the 2013 ACM International Workshop on Immersive Media Experiences*. ImmersiveMe '13. Barcelona, Spain: Association for Computing Machinery, pp. 7–12. ISBN: 9781450324021. DOI: `10.1145/2512142.2512146`. URL: `https://doi.org/10.1145/2512142.2512146`.

MACEFIELD, R. (2009). 'How To Specify the Participant Group Size for Usability Studies: A Practicioner's Guide'. In: *Journal of Usability Studies* 5.1, pp. 33–45.

MITCHELL, Cory (2020). *Virtual Reality*. Accessed: May 19, 2021. URL: `https://www.investopedia.com/terms/v/virtual-reality.asp`.

NIELSEN, Jakob (1994). *10 Usability Heuristics for User Interface Design*. Accessed: May 19, 2021. URL: `https://www.nngroup.com/articles/ten-usability-heuristics/`.

POETKER, Bridget (2019). *The Very Real History of Virtual Reality (+A Look Ahead)*. Accessed: April 13, 2021. URL: `https://www.g2.com/articles/history-of-virtual-reality`.

SHELSTAD, William and Barbara S. CHAPARRO (2017). 'Gaming on the Rift: How Virtual Reality Affects Game User Satisfaction'. In: URL: `https://www.researchgate.net/publication/320544794_Gaming_on_the_Rift_How_Virtual_Reality_Affects_Game_User_Satisfaction`.

SICART, Miguel (2009). *The Ethics of Computer Games*. Cambridge, Massachusetts / London, England: The MIT Press.

TAKAHASHI, Dean (2020). 'SuperData: Games hit $120.1 billion in 2019, with Fortnite topping $1.8 billion'. In: Accessed: October 1, 2020. URL: `https://venturebeat.com/2020/01/02/superdata-games-hit-120-1-billion-in-2019-with-fortnite-topping-1-8-billion/`.

VALVE/STEAM (2020a). *Half-Life: Alyx*. Accessed: December 17, 2020. URL: `https://store.steampowered.com/app/546560/HalfLife_Alyx/`.

VALVE/STEAM (2020b). *Steam Hardware & Software Survey: September 2020*. Accessed: October 1, 2020. URL: `https://store.steampowered.com/hwsurvey/Steam-Hardware-Software-Survey-Welcome-to-Steam`.

YOON, Jong-Won, Su-Hyung JANG and Sung-Bae CHO (2010). 'Enhanced user immersive experience with a virtual reality based FPS game interface'. In: *Proceedings of the 2010 IEEE Conference on Computational Intelligence and Games*, pp. 69–74. DOI: `10.1109/ITW.2010.5593369`.

ZIMMERMAN, John, Jodi FORLIZZI and Shelley EVENSON (2007). 'Research through Design as a Method for Interaction Design Research in HCI'. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '07. San Jose, California, USA: Association for Computing Machinery, pp. 493–502. ISBN: 9781595935939. DOI: `10.1145/1240624.1240704`. URL: `https://doi.org/10.1145/1240624.1240704`.

Appendix A

Categorizing Immersive Interaction Design in Video Games

Project report by Håvard Hvoslef Kvalnes, autumn 2020, NTNU Gjøvik.

Categorizing
Immersive Interaction Design
in Video Games

Håvard Hvoslef Kvalnes

haavarhk@stud.ntnu.no

IMT4215 Specialization Project

NTNU Gjøvik, Autumn 2020

Abstract

This project will take a deeper look into what makes a video game immersive, and if we can categorize video game immersion into different types of immersion. As the term *immersion* can be quite illusive, I aim to define more precisely the different kinds of immersiveness that there are in a video game.

I will be looking at the problem from an interaction designer's perspective and interview a group of gamers to get their mental model of immersion, and what they perceive to be the key factors for an immersive game. I will also be analyzing some existing video game interfaces, control system and environment design to find out at which degree the use of interaction design affects a video game's perceived immersion.

The resulting categorization of different types of immersion can be of use for video game creators to analyze which category they need to focus on next to ensure that their video game reaches the level of immersion that they desire.

Contents

Introduction

Immersion is a term often used when describing video games, but as a descriptive term on its own it is rather illusive. A user can feel immersed when they spend hours upon hours playing their video game, leading to their personal definition of an *immersive* experience: "Time just flew by, and I completely forgot about the real world!".

Another user can state "Everything looked so real—it felt like I was really there!" and consider realism to be the reason to why it felt immersive. While a third user might say "The controls were so great, I didn't even have to think about which buttons to press—I was one with my character!".

All three users will claim they have had an *immersive* experience.

User A was playing a 2D third-person top-down view game called Stardew Valley, where they were responsible for fixing an old farm outside a small village; planting, watering and harvesting crops, meeting other villagers and fishing every now and then.

User B played Euro Truck Simulator 2. As the name suggests it is a game created to simulate the feeling of driving a truck in Europe, complete with real-life town names, realistic looking roads, road markings and signs individual for each country and real-life branded trucks to choose from. It is of course in 3D and it sets the player in first-person view of a truck driver.

User C was experiencing the fluent control scheme of Dark Souls, a 3D third-person game where the player was controlling a character who needed to defend himself from different beasts and monsters using swords, spells and dodging mechanics.

If you asked either one of them if they found the video game that they were playing to be immersive, their answer would be "Yes". But if you were to claim the video game that you were creating, which they still knew nothing about, to be immersive—they could have very different mental models about what your video game is like.

The immersive fallacy

With increased computing power, game developers can churn out better graphics such as more polygons in their 3D models, more realistic lighting and higher detailed textures. For some, it seems to be the ideal to create the most immersive game. If a user feels immersed, the game is good. And if the game is more realistic, the user is more immersed… right?

This is an idea known as *The immersive fallacy*, referenced by Katie Salen and Eric Zimmerman in the book *Rules of Play* (pg. 450–541):

> "The immersive fallacy is the idea that the pleasure of a media experience lies in its ability to sensually transport the participant into an illusory, simulated reality. According to the immersive fallacy, this reality is so complete that ideally the frame falls away so that the player truly believes that he or she is part of an imaginary world."

But as User A and User C can testify, a simulation of reality on its own is not enough, maybe not even required, to create an immersive experience.

The immersive fallacy tries to close the gap between reality and the representation of reality. But this gap is what gives each individual a way to perceive the representation in their own way.

Frank Lantz gave a speech about the immersive fallacy at Game Developers Conference in 2005, stating (Lantz, 2005):

> "And even if you could, by some magic, create this impossible, perfect simulated world—where would you be? You would need to stick a game in there. You would need to look down and make chess out of the little simulated rocks and shells in your world. And… it's like going back to square one."

So realistic graphics and a simulated experience might not be enough on its own to make a game immersive, and it certainly is not the correct path to go for *every* game. For games like Euro Truck Simulator 2 it is, but to an extent. Create a too realistic experience, and the user might get bored, find it too hard or not really see the point in playing it.

Psychologist Mihaly Csikszentmihalyi describes the *flow* state to be a state in which the challenge presented to you matches the skill you have (Csikszentmihalyi, 2002). If the difficulty is too low, it leads to boredom. If the user does not have enough skill, the experience leads to anxiety (figure 1).
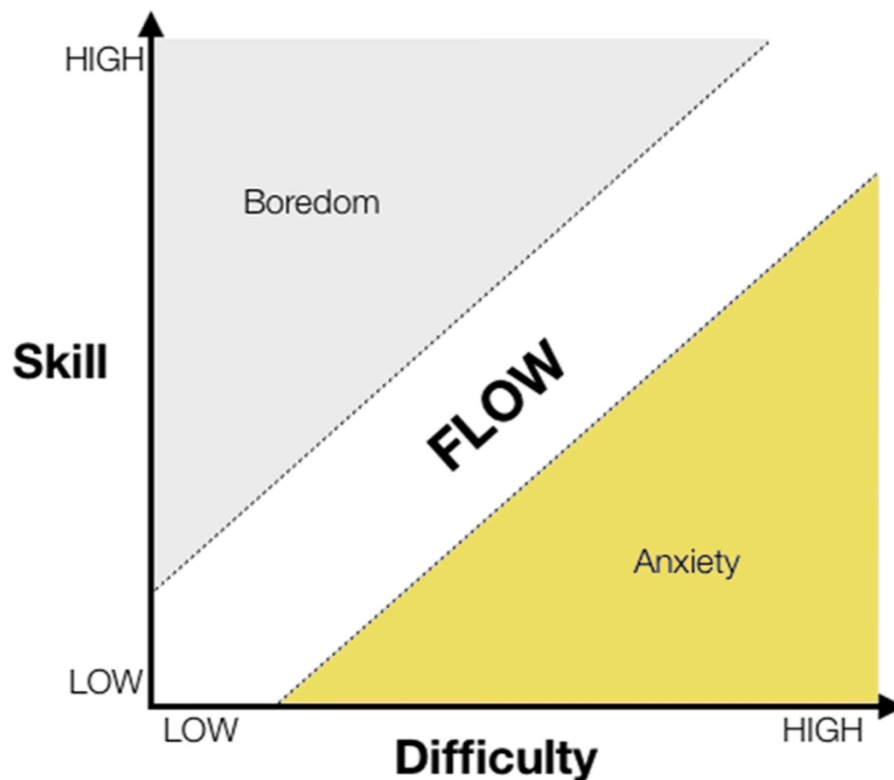
Figure 1, flow state.

The real world is usually difficult. It is not easy for everyone to climb a mountain. To drive a racecar. To play top-level football. A game is usually made to be an escape from the real world. To live out your dreams. To experience a different life. But if game developers were to believe that a game *must* be immersive to be good and that it *must* be realistic to be immersive, we will end up with games that look and feel just like the real world but end up being near impossible to *play*.

Interaction design and immersiveness

I have touched upon it briefly, but parts of what makes a game feel immersive is closely related to the interaction design that is put into the game.

A fluent control scheme allows the user to get the expected response from the character they are controlling whenever they desire. It can be that the controls feel natural—that moving the joystick this exact way makes the character do whatever the user expects it to do. It can be the lack of input lag, meaning that the response from the character happens close to immediately instead of having that brief milliseconds delay that allows the opponent to get in a hit before the character was able to dodge the attack.

The game world must feel *believeable*. By that I don't mean realistic in comparison with our own world, but that within the game world there must be consistent rules that are followed (like our laws of physics) and that a certain art style is kept throughout. This includes the user interface like the menu, head up displays, which fonts to use, which colors to use and so on.

In most games, the user does not want to spend time navigating the menus, while in others the menus might play an integral part in the gameplay. In both cases, the menus need to be designed in such a way that the user finds what they expect to find in the expected places so that their gaming experience is not hindered by a poorly created menu system.

Games must not be *unfair* to the user. The game must convey crucial information to the user at the right time or place. This can be done by placing some text on the screen, alerting the user, e.g. "You're about to be hit by lightning...". But that breaks the immersive experience. Legend of Zelda: Breath of the Wild solved this by making any metal objects your character was visibly carrying begin to spark with an increasing frequency and intensity until your character was struck by lightning. This gave the user both a hint that lightning was about to strike, but also that wielding metal objects in a thunderstorm is a bad idea...

Problem description

This project will take a deeper look into what makes a video game immersive, and if we can categorize video game immersion into different types of immersion. What makes a video game acclaimed for being immersive? What separates it from its competitors? What is the mental model of immersion for gamers?

I will be looking at the problem from an interaction designer's perspective, and analyzing existing video game interfaces, control systems and environment designs to find out at which degree the use of interaction design affects a video game's perceived immersion. I will also be interviewing a group of gamers to get their mental model of immersion, and what they perceive to be the key factors for an immersive game.

Research questions

Which elements of interaction design affect video game immersiveness the most, and in which ways?
I want to understand which elements of interaction design affect immersiveness in video games. If some elements are more important than others, e.g., control scheme is more important than menu design, or if all parts are more or less equally important to create the ultimate immersive gaming experience. I will also try to understand in which ways the elements affect the perceived immersiveness.

Which categories can we divide video game immersiveness into, if any?
I aim to create categories for different types of immersion to be of use for video game creators to analyze which category or categories they need to focus on next to ensure that their video game reaches the level of immersion they desire.

Methodology

Case study

A case study usually studies a particular individual, program or event in depth for a defined period of time. However, it can also be focused on a single case to learn more about a little known or poorly understood situation (Leedy and Ormrod, 2015, p. 271–272). As the term immersion can be such a vague description and have different meaning for different users, I felt that doing interviews in a case study manner would be beneficial in this project.

Interviews

I needed a method that gave me a deeper understanding on how users define immersion. I therefore chose to do unstructured interviews based on the way Baxter, Courage and Caine describes the method:

An unstructured interview is the most similar to normal conversation. The interviewer will begin with general goals but will allow the participant to go into each point with as much or as little detail and in the order he or she desires (Baxter, Courage & Caine, 2015, p. 222)

This method would give me a better understanding of the users compared to a survey, as I could ask follow-up questions if needed, and allowed the users to go more into detail in their answers.

Due to Covid-19 restrictions, the interviews were held over Microsoft Teams. Preferably they should've been held in person, to be able to pick up on things that aren't said—like body language and subtle clues—and make it easier to interpret the meaning behind their answers.

I made a guide for the interviews (appendix X). The guide is based on the five phases of an interview where you have an introduction, a warm-up session where you ask non-threatening questions, body of the session and a cooling-off and wrap-up phase. All the steps are needed even if the interview lasts for five minutes or one hour (Baxter, Courage & Caine, 2015, p. 238).

During the interviews I had to make sure to pull the users back on track if they were wandering off topic, keep my own opinions to myself and ask open-ended questions that allow the user to tell me their version rather than making assumptions or indications in the way I ask my questions. I also asked for clarifications whenever it felt necessary.

Since I was not taking a sound recording (but was continuously taking notes) and was not recording any personal data, I did not make a consent form for the users. They were however briefed about the project and the usage of the interviews before the interviews began. All interviews were written down to make it easier to analyze the data afterwards, except the warming-up and cooling-off questions as they could contain personal data.

The data from the interviews were analyzed using an affinity diagram. This method was chosen to be able to identify trends and themes in the data by grouping them together (Baxter, Courage & Caine, 2015, p. 253). I first made all the cards and grouped them in a way that made sense to me, before labelling the groups.

Advantages and disadvantages

As mentioned, interviews give me the opportunity to go more in-depth and get qualitative data from the users. As the term *immersion* can be perceived differently by

each user, I wanted to be able to have an open-ended interview where I could ask questions as I saw fit, while still getting the answers I required from every participant.

Compared to a questionnaire, doing interviews will give me fewer responses and a smaller data set. It can be trickier to analyze, as I can't necessarily put the answers directly up against one another and compare them. I also can't be entirely sure that the findings are generalizable to all other games.

Performing the interviews digitally also made it a bit harder to read the users' body language, and I could be missing some vital clues this way.

Content analysis

I will also be performing a content analysis to identify patterns, themes or biases when it comes to immersion in video games. This will be done after the interviews, so that I have a certain insight on what users feel make a video game immersive before I try to analyze it.

The body of material to be analyzed is video games, and I will be analyzing a selection of some games that are critically acclaimed to be immersive (referenced in game reviews) and some games where the creators themselves claim the game to be immersive.

I will look at graphical realism, the menu design, the use of head up displays and the control scheme of the game to see if I can find any similarities. Then I will be performing an objective judgement based on my findings.

Advantages and disadvantages

A content analysis allows me to go in-depth and combined with the interviews from the case study, I will get a systematic sampling of data (Leedy and Ormrod, 2015, p. 275).

If my research questions are not good enough, then the flexible nature of a qualitative study like this might make it much more challenging to come to a satisfying conclusion.

Results and Analysis

Interview affinity diagram

What drives the player	The visuals	Technical
A good, engaging and believable story and/or goals and achievements that the player can reach.	The realism of graphics is not the most important, but the consistency within the game world both in graphics and game physics is important.	Technical bugs and glitches in the game draws the player out, and limitations of the hardware (which makes the game run slower/choppier).
Fluency	**Engaging**	**Interface**
The control scheme is important, as poor controls will make the movements seem illogical and annoy the user. Loading screens are a limitation.	Games that are made to be social and/or competitive seem to have a high level of engagement among the users.	The interface in the game either works well enough for the user to not pay them any mind, or they can be too complex or have a bad user flow, which makes the user annoyed and taken out of their experience.

Table 1, Interview affinity diagram

The findings from the affinity diagram (table 1) shows us different elements that affect the user's gameplay and immersion. Some are obviously more important than others, and some are purely technical limitations while others can be linked to interaction design.

Analysis of existing games

Firewatch

Firewatch is a game launched in February 2016 where the player is left on his own as a fire lookout in the Wyoming wilderness. It is recommended by Steam Curator Aquamarine's Fleet to be "...a pure exploration game that will naturally pull you into its immersive narration." (Aquamarine's Fleet, 2016). The game review site Polygon refers to a tweet by Game Maker's Toolkit in 2016 stating "Turn off 'Show Location on Map' in the settings. Much more immersive." (Polygon, 2016).

But what makes it so immersive?

Looking purely at the graphics, it is a more stylized, cartoon-ish version of our own world. Through a good story telling and believable voice acting, the creators have done a great job into making a game world that pulls the user in. In addition to this, several UI elements are done in such a way to make the user feel they are "one" with their character:

Main items that the user must use often, like the compass, the map and the radio, are all visible to both you and your characters within the game world at once. This is called *diegetic UI*, where to look at the object you would need to actually move the camera (or your line of sight) to see and/or use them. The opposite would be *non-diegetic UI*, where the information is only visible to you, the player on the other side of the screen, and not your character in-game. A typical example of non-diegetic UI is a Head Up Display or info text popping up on screen (Fagerholt, 2009).

The use of a diegetic map in Firewatch makes the user feel more that they are actually using a real paper map (figure 2). In addition to this, the map gets scribbled on with notes and circled areas as the game processes, as a real fire lookout would normally do.

The game is supposed to make you feel alone in the wilderness. You're supposed to feel a bit helpless. An always-visible map and compass in the corner of your screen would make that feeling less intense, as you can look at it at a glance. While with a diegetic map and compass, the user spend time with all their focus on the map and compass trying to figure out where they really are—as one would in real life!

Figure 2, diegetic map and compass in Firewatch. Screenshot from the game.

Figure 3, non-diegetic radio menu interface in Firewatch, with the diegetic radio in the player character's hand. Screenshot from the game.

The in-game radio element uses a mix of the two (figure 3). The radio itself is diegetic, and the user must pick it up and look at it while using it. But the radio responses the user can choose from are set as text elements in a menu-like interface in the middle of the screen. Also, a radio icon appears at the left of the screen whenever the radio is called. Still, if the game had not used non-diegetic UI for the radio responses, the user would not really have any way of giving a response—as they would have to choose from pre-defined responses and would need a way to know what they were. The radio alert icon also serves as a visual reminder for people hard of hearing to allow them to understand that the radio is being called even if they can't hear the call.

So, non-diegetic UI might have immersion-breaking characteristics, but they are still important to ensure that the user flow of the game is not broken. The balance between the two is very important for the perceived immersion of the game. Firewatch uses diegetic UI as the foundation and used non-diegetic UI to fill in the gaps when they had no other choice but to do so—otherwise the user would potentially quit the game due to not getting the information they required.

Stardew Valley

We've taken a look at a 3D game acclaimed as an immersive experience, but what about a 2D game; can that be immersive as well? Usually, the concept of immersion brings to mind large, open-world 3D games like the Grand Theft Auto or the Elder Scrolls series. They can be claimed to be immersive because your character is small, and the world is large.

Creator of Stardew Valley, Eric Barone, explained his inspiration game Harvest Moon in an interview with Vulture that "They [the Harvest Moon developers] had created these rich and special worlds that you could get lost in. The gameplay was very simple, but there was something kind of addictive about it: You wake up every morning, you check your farm, and you're excited by the simple beauty of your crops going from seed to harvestable product. There was something about that relaxed gameplay in this

immersive, beautiful world that felt really special. It was touching in a certain way." (Singal, 2016).

To get that immersive feeling in Stardew Valley, Barone has done a lot of small, graphical touches that allows the user to feel a more vibrant world around them. Every now and then, small critters will run around, squirrels climb up a tree, a bird takes flight, frogs jump across the path and so on and so on (figure 4). Those little details bring the world to life, and when you add in small animation details when the user is doing an action like sweat dripping when chopping down wood or hoeing grass (figure 5), the total experience does feel more real—despite the game's very distinct pixelated graphic style.

Figure 4, a vibrant game world. Here the player (on the right) encounters another villager while a cow roams the fields above. Screenshot from the game.

Figure 5, working is hard! Screenshot from the game.

The game has, in its core, a simple gameplay. You inherit a beat-down farm, and it's up to you to restore it to its former glory. Along the way, you meet the town folks and get involved with fishing, mining and some treasure hunting. But really, it's all down to the user how they want to experience the game. Some might just focus on the farming; not introducing themselves to the town folks, not entering the mines or not attempting to fish. And that's perfectly fine. The game gives the user some quests to complete (if they want to complete them), but nothing is mandatory.

This allows the user to either follow the game's directive and goals, and in turn more quests and more less-obvious goals will occur for them. For instance, the Town Hall is also beat-down and in danger of being purchased by the capitalist organization called Joja Mart. To refurbish the Town Hall, the user must either complete certain tasks (mostly gather certain items, crops, etc.) or decide to go the other route and purchase a membership in Joja Mart, giving them enough money to purchase the Town Hall and turn it into a warehouse.

The user has so many options to choose from, but the options are introduced gradually and none of them are forced upon the user to follow. This gives them a sense of choice, and a feeling that their choices have consequences in this world.

Working on a farm is hard work. You must dig, plant, water and harvest. You must clear the old trees to make more farm land available. You must clear rubble and rocks. Everything takes a toll on your character's energy, which works as a limit as to how much you can do each day. If you're not in bed by 1 AM, your character will wake up with half the energy available the next morning due to not getting enough sleep.

The user can relate to these things, and along with the goals the game provides they can set their own goals—like "Build the largest cauliflower farm you've ever seen!".

And the user is rewarded. Constantly. You can visually see your crops grow, day by day. If you enter the mine, the deeper you go the better ores you can find. But then the enemies also become stronger, increasing the difficulty but also increases the satisfaction of succeeding.

Everything is based on the in-game clock, even the towns people have their set schedule for where they are and what they do on a Wednesday at 3 pm. The time limit makes it so that the user almost never completely gets done with whatever their task for the day was, but since each day does not last all that long, it's very easy to tell yourself "Just one more day…". And that one day often leads to two, three or four extra in-game days without you really thinking about it.

Stardew Valley achieves their level of immersion by nurturing the user's internal drive to achieve something, in addition to a believable and relatable game world. This drive to reach your goals, to keep playing for just one more day, one more turn, one more match… It allows for time to fly by for the user, leaving them with the wonder of where the time went. They forget about the surrounding world for a while, they are immersed in the game.

Microsoft Flight Simulator 2020

TechRadar reviewed the 2020 release of Microsoft Flight Simulator, and used the word *immersion* four times (Hanson, 2020):

1. Using cutting edge technology and graphics for the ultimate immersive experience, this isn't a game that's going to be for everyone, but if you're its core demographic, you're going to love it.
2. And while you don't necessarily need them [specialized flight simulator controls], we really recommend them (or something similar). It helps with the immersion immensely.
3. Also, as your plane climbs higher you'll see frost begin to form on the windows. As you descend, the frost melts and the water streams off the glass. This is seriously impressive stuff, and the smallest details help immensely with the overall immersion of the game.
4. Combine that with peripherals and a good monitor (we used an ultra-wide monitor, which adds to the immersion)

As the name suggests, Microsoft Flight Simulator 2020 is meant to be a simulating experience. It uses realistic 3D models of real-life aircrafts, has modelled thousands of real-life airports and uses real-life satellite and weather data from Bing to map the entire world—including real-time weather effects if desired.

The user can change the difficulty according to their skill level, allowing the game to take some control over the airplane or to let the user control the plane as if they were a real pilot—having to know what every single button and switch in the cockpit does.

The learning curve is steep, but that allows for a sense of progression for the user. They desire to become better, maybe to become more and more independent from the computer aided flying and will eventually reach the level of involvement that is just perfect *for them*.

TechRadar mentioned the use of technology twice to increase immersion in their review, most noticeably the use of a real-life joystick, throttle and switchboard to make a "mini-cockpit" of your own by your computer instead of playing it traditionally with a keyboard and mouse.

The other things they mentioned were more related to the visuals. An ultra-wide monitor added to their immersion as the view out from a cockpit is usually through a wide window, and it also allows the peripheral vision to be more into play than with a

traditional 16:9 ratio display. The weather effects on the windshield of the plane's windows were small, but highly effective, graphical touches that just made their experience more realistic—more believable (figure 6).
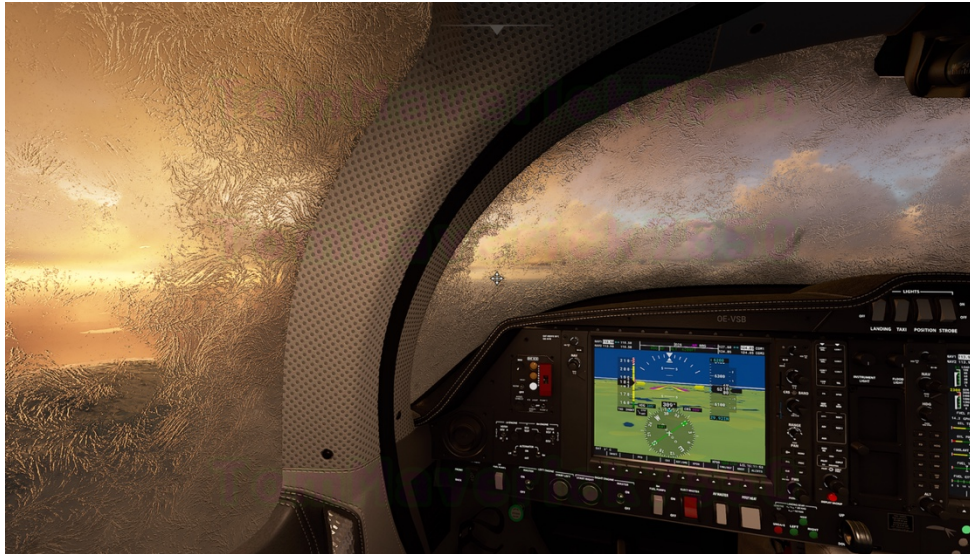
Figure 6, weather effects on the windscreen. Screenshot from the game.

Figure 7, a realistic cockpit with every dial and knob for an amateur pilot to interact with. Screenshot from the game.

For a game like Microsoft Flight Simulator 2020, where the whole premise is to give the user a simulating experience, the graphics obviously plays a part. And some of the graphics in this game require a lot of both computer power but also internet connection as the map is streamed in continuously during gameplay. If the user does not have the required technical equipment or a fast enough internet connection, they will not get the same immersive experience as they could have got.

Discussion

Categories of immersion

Looking at the findings from the interviews and game analysis, I would like to categorize immersion into five types of immersion. Not every category will be important for the general immersive feeling of every game, but they can work as a guideline for developers.

Environmental immersion

This relates to the game world, where it's important to have a consistent look and feel throughout. Everything from Non-playing characters (NPCs) the user can interact with to the game physics. The game developers need to create a believable world/universe, where set rules apply. It is then important to keep the same rules applied in all circumstances. Small details like birds flying by in the sky or rats scattering when you enter a dark room add to the environmental immersion. Typical games that score high in this category are Subnautica, Skyrim, Stardew Valley and Legend of Zelda: Breath of the Wild.

Engaging immersion

A game with high engaging immersion has a certain weight of competitive and/or social aspect. In these games, it's especially important to find the right balance between the challenge provided and the skill level of the user—the flow state described by psychologist Mihaly Csikszentmihalyi. Typical games with a high engaging immersion are Among Us and the Fifa series.

Realistic immersion

Games that relate closely to the real world and in some way or another try to emulate it use realistic immersion. It can either be games that try to perfectly replicate real-world situations or controls like Microsoft Flight Simulator 2020 or Euro Truck Simulator 2, or games that use real-life data to allow the user to take their spin on a well-known real-life concept. Typical games for the latter are the Football Manager series, which use a massive database with real player, team, stadium and staff names to make the experience of taking over a real football club as their manager as realistic as possible.

Interactive immersion

The users' direct interaction with the game is important for most games. This is the feeling of an intuitive and fluent control scheme, where your character can feel as an extension of yourself. Especially games in Virtual Reality (VR) makes use of this, where the user has to physically move their hands and head around to make the character move accordingly. But it is also important in more traditional non-VR games where e.g., a dynamic and fluid combat system in addition to intuitive controls add to the immersion. Typical games in this category are Beat Saber and Dark Souls 2.

Driven immersion

The games that use in-game story, goals and/or achievements to make the user progress through the game has a high level of driven immersion. Either an engaging story that the user feels like they are a part of, or a set of goals and achievements which the user can accomplish, are used to keep the player wanting to play more. The goals and achievements do not have to be explicitly written out for the user; some games allow the user to set unwritten goals for themselves to reach—making for an even greater feeling of having shaped the game into *their* game. Typical goals with driven immersion are Stardew Valley and Crusader Kings.

Analyzing your game's immersion

When play-testing your game, you can use the five categories of immersion as a tool to analyze which parts of the game you need to work on to reach the level of immersion that you desire for your userbase. You can for instance make your testers try to score your game in each category from 1–10 and set the resulting average score in a radar diagram to easily see which categories might need attention (Figure 8). Remember, though, not all categories need to be a 10. That's not the purpose and is likely not possible to reach.
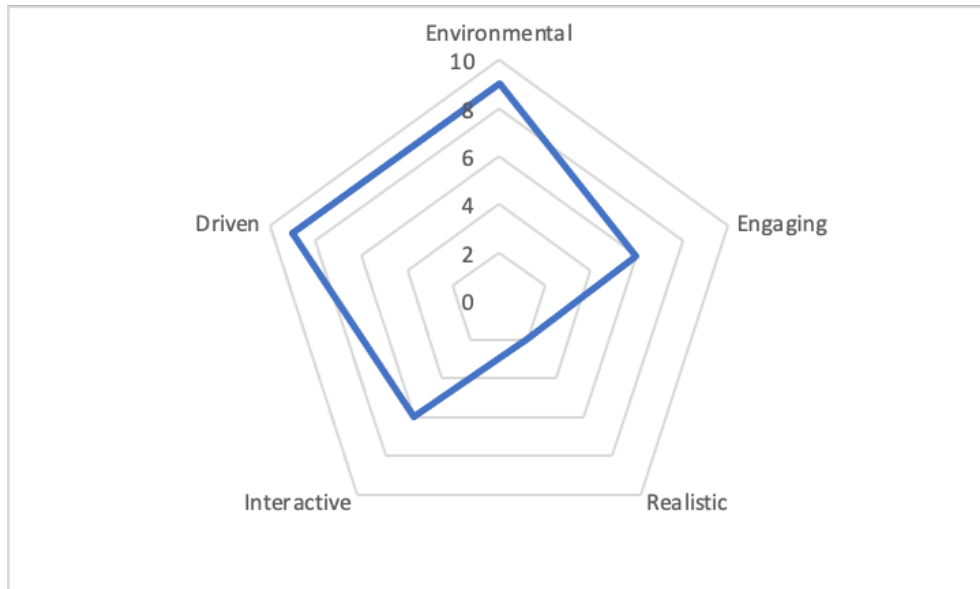

Figure 8, an example of a diagram for a game which scores high in environmental and driven immersion, but low in realistic immersion. The popular and critically acclaimed immersive game Legend of Zelda: Breath of the Wild would have a diagram similar to this.

It also helps the developers to know more what they need to ask their users to get the answers they need to improve the game. As the interviews have shown, *immersion* means something different for everyone. On its own it is not a concrete enough term to use, but when broken down into these categories and explained a bit more thorough, the user and game developers are more on the same page when discussing the different levels of immersion.

Interaction design affecting immersiveness

Based on the feedback from the interviews, I would claim that interaction design definitely plays a part when it comes to the perceived immersiveness for the user. Some "traditional" interaction design elements like the menu or interface appear to not play as big a part as I initially thought when starting this project—when it works, it works. It is only a problem when it *doesn't* work, but the threshold for it to not work appear to be higher than other elements. The parts that play a significantly larger role is the story and the interaction with the in-game world objects—be it NPCs that have believable dialogue and does more than just "stand around and wait for the player all day", or "physical" game objects you as the character can interact with whenever you expect to.

It's also a battle between the game and the real world with its chores and duties calling the player out from the game world. A game like Among Us or Fifa can work wonders with their 10–15 minutes long matches/sessions, allowing the user to engage in an immersive experience in a short timespan instead of dreading to even

begin a larger, story-driven game because 10–15 minutes is barely enough to get started on a quest.

Reflection

Performing the interviews both digitally and on my own, it was at times difficult to be both interviewing and taking notes. I had to come up with new questions, take notes and listen to the answers given all at once. A possible solution could be to record each interview and transcribe them later.

Interviewing a more diverse sample of the population would also be beneficial for the validity of the results. Especially interviewing some female gamers would be of use, to investigate whether there are any gender differences when it comes to immersion.

Conclusion

This project has led to a set of categories which can be used as a method in game development, giving the developers valuable insight in their user testing. It also gave myself valuable insight in what parts of interaction design affect immersiveness, and how the users perceive and interpret the term immersion.

Doing interviews instead of a questionnaire was great, as the illusiveness of the term *immersive* would not make me able to get the answers I needed from a questionnaire. It required me to speak to the persons directly and allow them to think out loud before taking their answer. I think it would be very challenging for me to create the questions for a questionnaire in such a way that I would get any real value out of the answers given.

For future work, the categories and method for analyzing a game in its test phase should be tried out in a real-life scenario. This way one would be able to see whether the categories are precise enough and if the method is actually useful or not. It might be that the categories need to be tweaked, defined more precisely or that some new category must be added or even scrap an exisiting one.

Bibliography

Aquamarine's Fleet (2016) URL: http://steamcommunity.com/id/aquamarine/recommended/383870 (accessed 9.12.2020)

Baxter, K., Courage, C. & Caine, K. (2015). *Understanding your users: A practical guide to user research methods*. Morgan Kaufmann.

Csikszentmihalyi, M. (2002). *Flow: The psychology of happiness: The classic work on how to achieve happiness*. London, UK: Rider.

Fagerholt, Lorentzon (2009) "*Beyond the HUD - User Interfaces for Increased Player Immersion in FPS Games*". Master of Science Thesis, Chalmers University of Technology

Hanson, Matt (2020). URL: https://www.techradar.com/reviews/microsoft-flight-simulator (accessed 9.12.2020)

Lantz, Frank (2005). URL: https://www.youtube.com/watch?v=6JzNt1bSk_U (accessed 7.12.2020)

Leedy, Paul D., Ormrod, Jeanne Ellis (2015). *Practical Research: Planning and Design*. Pearson Education Ltd., England

Polygon (2016). "Playing Firewatch? This is the first thing you should do" URL: https://www.polygon.com/2016/2/10/10960122/firewatch-map-first-thing (accessed 9.12.2020)

Singal, Jesse (2016). "How a First-time developer Created Stardew Valley, 2016's Best Game to Date", Vulture, URL: https://www.vulture.com/2016/03/first-time-developer-made-stardew-valley.html (accessed 9.12.2020)

Appendixes

Appendix A: Interview guide

- Inform the participant that you will be taking notes, and that no identifying data will be recorded. Get their consent that this is okay.
- Inform the participant briefly about your project, about what you wish to research.
- After the interview is conducted, do a recap where you tell the participant what they have answered on each question. Ask more questions if needed and allow them to fill in if they have more to say during the recap.

These questions should always be included. Ask more questions if it feels natural and is needed:

- How often do you play?
- On which units do you normally play?
- How long do you play each session?
- Which genres do you normally play?
- Why these genres in particular?
- How is the physical environment around you while you're playing?
- What does the term immersion mean for you?
- What are the reasons to why you've become so immersed?
- What draws you out of the immersion?
- Which games have you felt the most immersed in?
- Why those?
- How important would you say that graphics is for your immersion?
- How would you say that menu system, inventory system and other interface elements affect the experience?
- How important is the control scheme?

Appendix B: Interview 1: Male (26)

How often do you play?

Daily.

On which units do you normally play?

Desktop PC.

Why do you choose the PC when you have a console (Playstation 4) as well?

I feel that I play better on a PC, it's what I'm used to and it's easier for me to do the actions that I want.

How long do you play each session?

About 4–5 hours.

Which genres do you normally play?

RPG and MMORPG.

Why these genres in particular?

I like the variation in gameplay they provide. Other games, mostly FPS games, feels more linear. I like the more diverse gameplay where I can play with my friends and change our style of playing as we og.

How is the physical environment around you while you're playing?

I sit in a seperate room, on a dedicated desk. I use a headset with a microphone.

Why headset and not loud speakers?

Mostly out of habit – the headset has a microphone and the sound is more "bang on". The sound quality is good, and it doesn't bother other people in the apartment.

What does the term immersion mean for you?

I've never really thought much about it until now. I guess it's when I forget all about space and time, and suddenly I've spent three hours. I've been so immersed, sucked into the game.

What are the reasons to why you've become so immersed?

I guess the game keeps me engaged in a new way. It has an exiting story, a goal.

What draws you out of the immersion?

Either that I reach the goal, or that everyday tasks get in the way—I have to go to work, walk the dog, sleep, etc.

Not every game has a clear goal, e.g. Minecraft. Has Minecraft been an immersive experience for you?

Well, yes, I did forget time when I played that [about four years ago]. There were no obvious goals, but still—you kind of created your own. Get the first diamond, kill the ender dragon, build your first castle and so on.

Which games have you felt the most immersed in?

Grand Theft Auto V and Skyrim.

Why those?

I didn't really expect to be, to be honest. I've only played previous GTA iterations to fool around, but this time I decided to play the main story and it was great fun.

Skyrim was an offline RPG, and I had until then mostly just played online RPGs. But I had just purchased a new PC and the game was recently released... I purchased the game, could play it on Ultra graphics and was just blown away.

How important would you say that graphics is for your immersion?

It's not hyper important, but it is somewhat important. I do play a lot of fantasy games, like World of Warcraft, and the graphics there is not really great. If it gets too realistic it kind of misses its distinctiveness.

How would you say that menu system, inventory system and other interface elements affect the experience?

Loading screens especially takes away from the immersion. It gives you time to think. The menu in Skyrim was really poor, I find it better to have a simplified menu with few options, and rather have submenus with grouped options. I don't like looking through a long list of options, and if so I usually end up not tweaking the options to my liking.

How important is the control scheme?

The controls must feel intuitive. Make sense. I played Dark Souls on PC, and it became very obvious to me that this was a game developed for console. It felt so clunky. In Skyrim, the left mouse button attacks with your left hand/weapon, while the right mouse button attacks with the right. That makes perfect sense and just feels good.

Also, not every game needs to "reinvent the wheel". Shift is often used to sprint, while ctrl crouches. It is annoying if these two are swapped in a game, as one is used to it being the other way around.

Appendix C: Interview 2: Male (29)

How often do you play?

Not as much as before, but a couple of times a week on average.

On which units do you normally play?

95 % desktop PC, some Nintendo Switch in social settings.

How long do you play each session?

2–2,5 hours. Can be up to 4–5 hours at most.

Which genres do you normally play?

First Person Shooters (FPS), but mostly with a multiplayer and co-operative focus. Some party games like Among Us and similar games. Russian Life Simulator, for instance.

Why these genres in particular?

Because it allows for social gaming, online multiplayer.

How is the physical environment around you while you're playing?

I have a combined office and gaming room in the attic. A small room with just a chair and a desk.

Do you use a headset or loud speakers?

I use a headset. Always. And a separate microphone.

Why always headset?

Combination of not wanting any echo in the microphone, and I enjoy to have the sound more "close up". Especially in FPS games where one can hear footsteps.

What does the term immersion mean for you?

That I feel that the game gives me something more than I'm just playing it. A sense of innlevelse, I get dragged in. It varies a lot from game to game. If I play a story-focused game, then the graphics might not be as important and vice-versa.

What are the reasons to why you've become so immersed?

For me, history, lore and world building is the most important. That Non-Playing Characters (NPC) are not super-obviously programmed. This has become a lot better the past years. A world that feels natural.

What makes the world feel natural?

That you feel that you have a choice, that it's not a linear experience and that your actions have consequences. That you do not have to speak to this guy just because the game tells you to, but that you choose to do it yourself.

How important would you say that graphics is for your immersion?

It's not the most important, but of course it does matter in some games. If the game is advertised as a AAA game with focus on great graphics, then it surely matters. But in party games where the graphics are not the main selling point it's less important.

What draws you out of the immersion?

Bugs are completely hopeless. For instance, in early Assassins Creed games the NPC could sometimes just spazz out. Railroading must feel natural and not forced.

Which games have you felt the most immersed in?

The Assassins Creed series is important, but also Borderlands series despite its gimmicky feel.

Why those? Why does Borderlands get away with being gimmicky?

They sell it as a gimmicky game—it does not try to be anything else. Mechanically it works great, but you are prepared in advance that the game can be a bit weird.

How would you say that menu system, inventory system and other interface elements affect the experience?

It does matter quite a lot. I've played some games where the interface has nearly ruined the gaming experience. Warhammer Wermintide. It was completely hopeless. You wouldn't want to keep on playing until they've updated the interface. Even if the game itself is wicked good. But also Borderlands can have an awful interface, but the game is so good that it gets away with it.

What is with the Borderlands interface that is so bad?

Illogical placements, which buttons we use when—suddenly you've sold a weapon because a button has a different function than it use to. Bad user flow, really.

How important is the control scheme for your immersion?

I think its quite important. I tend to set up custom controls where I can so that it feels familiar. So the standard system is not that important to me, since I usually change it, but that in turns obviously means that the control scheme is important.

Appendix D: Interview 3: Male (29)

How often do you play?

1–2 times a week, a bit more than once a week.

On which units do you normally play?

Nintendo Switch and Xbox Series X, and some Among Us on iPad.

How long do you play each session?

About 1,5 hours, up to three hours.

Which genres do you normally play?

Party games, local-ish multiplayer games. AC Valhalla, RPG. Some Fifa (sport games)

Why these genres in particular?

Sport and party games is mostly for the social part. The RPG is more of an escape from reality – it feels nice to hit someone from time to time, an alternative to the real world and just fool around doing stuff you normally wouldn't.

How is the physical environment around you while you're playing?

Sitting in the living room, it varies if I play alone or with my girlfriend. Mostly loud speakers, headset if I'm in my office playing Among Us.

What does the term immersion mean for you?

For now, absolutely nothing. Do you have a good Norwegian word for it?

I think "Innlevelse" is the best I've got.

Okay, yeah, uhm. I think it must be connected to the escape from reality – to control and act like a different character than I normally am. I'm focused at the task ahead, and block the external world out. Especially in competitive games, one gets really focused to win.

What are the reasons to why you've become so immersed?

One part would be winner instinct in a competitive game, while in a single player game it is more... well. The feeling of immersion. I'm often too impatient in games with too much repetitive gameplay. A too open world will also feel not enough defined, I do need some direction. Some freedom is good, but too much is demotivating.

How important would you say that graphics is for your immersion?

To pull me in to begin with, it's semi-important. But it means less to me once I'm already pulled in. It makes it easier for me to get immersed in the first place, but its more the initial fascination over the nice graphics the first time I'm playing and at the second time playing I don't really pay any mind to it.

What draws you out of the immersion?

Typically other chores. Or that you have played for long enough that you feel "done", especially in competitive games. In single player games its more the feeling of "guilt"—I should be doing something else, or a "rage quit" where you get so annoyed at something that you just want to quit—that can be bad design, too difficult.

Which games have you felt the most immersed in?

I often return to Super Mario 64, a lot of the Mario games has a high re-playability for me. New releases of competitive games like Fifa makes me immersed because of new features, graphics and updated team sheets and so on. Feeling of something fresh.

Why those?

Mostly nostalgia, really. It [SM64] was the first game that really pulled me in. It has a graphic style that does not feel as dated as it maybe should. In my opinion, SM64 has held its ground a lot better than for instance Legend of Zelda from the same era.

How would you say that menu system, inventory system and other interface elements affect your experience?

I don't really feel the need to use inventory systems and stuff like that, and try to avoid it really. Its often too much a focus on details, which I don't feel give me anything. But one can get annoyed when the menu system does not work as intended or as one would expect. I have not really experienced any interface I would say was great—but that might be because one really only remembers the bad interfaces where one has been annoyed.

How important is the control scheme for your immersion?

One does notice that some control schemes feel more fluent than others, and if the control schemes start to annoy you then you stop playing and have a higher threshold for picking the game up again because you know you'll be annoyed. So it is more like the menu system again, that if it works you're not really paying any attention to it, but when it doesn't it really sticks out.

Appendix E: Interview 4: Male (29)

How often do you play?

Periodically, everything from not playing for months to playing 3–4 days a week.

On which units do you normally play?

Playstation 4, Nintendo Switch, some on laptop.

How long do you play each session?

Typically 1–2 hours. Up to 4–5 hours.

Which genres do you normally play?

RPG (Witcher 3), Platformer (Spelunky, Mario), Adventure RPG (Zelda), Strategy – not as often as it is time consuming.

Why these genres in particular?

Platformer: Easy to play in a normally hectic day. RPG: Good history, exiting and good gameplay and a nice world. Strategy: A good challenge.

How is the physical environment around you while you're playing?

Comfortable. In the living room, mostly in couch. By the living room table while playing on laptop.

Do you usually play with headset or loud speakers?

Loud speakers.

What does the term immersion mean for you?

A bit hard to answer in just one word, innlevelse/dypdykk. Innlevelse is probably the best word I've got for it. To "live in the world", get indulged in.

Which games have you felt the most immersed in?

Hmm... Good candidates would be GTA:SA, Witcher 3 and Horizon: Zero Dawn. I think probably Witcher 3 will be my pick.

Why those?

Good and catching, well-written, story. An interactive world, interesting side characters. But the story is likely the most important. Still, a good story on its own might not be enough.

If so, what makes a good story not enough on its own?

It does not need to be fancy graphics, in example Undertale. It must be consistent, feel like good craftmanswork, not bugs and a certain flow in the gameplay. Things make sense within the world.

What do you mean by "flow" in the gameplay?

That you feel some progression, that... I don't know if I have a better answer than that, no.

What are the reasons to why you become immersed?

The main reason is history. And that it's a character that you can get to know and relate to—in addition to the side characters that feel believable. Not necessarily life-like, but believable.

What draws you out of the immersion?

Firstly, the surrounding world. Chores, tasks, planned events and so on. Obvious things in game that doesn't make sense or are wrong—bugs and glitches.

How would you say that menu system, inventory system and other interface elements affect the experience?

It does affect it. Trying to think back to the games I've played recently, and they're all mostly good. I think I've only got good experiences with them, so I don't have any bad experiences that I can think of.

How important is the control scheme for your immersion?

Not the most important, but it must be playable. But it's usually a case of getting used to them. I've heard that the controls in Death Stranding is a bit wonky, but I don't know how that would affect me as I haven't played it. In the games I've played, the controls have mostly been good. I'm not really critical when it comes to controls, but I did notice the difference from Spelunky 1, where you had to hold down a button to sprint (which you normally would want to do), to Spelunky 2 where the character sprinted by default and you had to hold down to walk instead. Going back to Spelunky 1, I did think that it felt unnecessary to be holding down a button to sprint, but I did not feel that way until Spelunky 2 had shown me the better alternative.

Appendix F: Interview 5: Male (29)

How often do you play?

I play less now than I used to, but about 2–3 sessions a week.

On which units do you normally play?

Gaming laptop PC and Playstation 4.

How long do you play each session?

1–3 hours, usually. Not less, I would rather do something else. But not more than four hours, I usually get bored then—no matter how good a game it is.

Which genres do you normally play?

Action Adventure games, RPGs and Strategy. Some management sims (tycoon games).

Why these genres in particular?

Action adventure and RPGs: I like a good story, I play more for the story than for gameplay, even though I appreciate both. This is especially present in RPGs.

For strategy and management sims, I just like the feeling of "doing something", and can be the ones where I have the longest sessions since I'll be building something or creating something.

How is the physical environment around you while you're playing?

PlayStation is played on the couch, while I have a gaming chair and the dining table for my laptop. Everything takes part in my living room.

Do you use a headset or loud speakers?

I use headset on my laptop, but loud speakers on console. When I play on laptop I sometimes play music instead of in-game sound (strategy games). If menu sounds or other sound effects in-game annoy me I tend to mute the game and play music in the background instead.

Another thing I sometimes do is to listen to podcast while I play a rather repetitive or mindless game. This is perfect for me, as I get restless if just listening to the podcast alone, but having some mindless task, it could also be a puzzle or Lego for instance, to do while listening makes me focus on both the podcast and the task at once.

What does the term immersion mean for you?

Translated to Norwegian, I would call it "innlevelse". It's the only thing that matters for you then and there. I don't consider immersion to be either on or off, but that there are different degrees of immersion. I can play games where I don't really have to think—a low degree of immersion. But some games... You just get in the flow, so you're only focused on that one thing.

Which games have you felt the most immersed in?

That depends how you consider immersion, but there are some games where I've thought "I could sit here all night." That would be Crusader Kings 2—to color the map with all my color is an appealing thought. History-wise, the stories are usually quite "banale", but in Witcher 3 I did feel it some. But boss fights can draw you out of it, because you're fighting the boss and not following the story.

What draws you out of the immersion?

I wouldn't say that a boss fight draws me out of the immersion, but the immersion is kind of changed character. I'm no longer driven by the story, but by the challenge of defeating the boss. But if the boss battle is too difficult and I have to keep trying then it draws me out and becomes more of a chore. Then again, if it's too easy, the challenge immersion is lost.

How important would you say that graphics is for your immersion?

I would say that its less important than a lot of other stuff. Photorealism is not really a point to me, but a nice graphic is always nice to look at. But I can still play PlayStation 2 games and have a great time with those. A good art style is better than photorealism for me. Older games with a timeless art style have longer longevity. An appealing art style does pay a role for the immersiveness, but story and gameplay are more important for me.

How would you say that menu system, inventory system and other interface elements affect the experience?

I like a good menu. I like the games with detailed menus, I like to dig down in the details. Entering a menu does not affect me, because I think it's a game anyway, so I don't feel dragged out of it. I think some games, like Dead Space 2, has all its menu interface on the person, but that's not a point for me.

How important is the control scheme for your immersion?

If the controls annoy me, I am drawn out. Assassins Creed has been a struggle for me, especially in foot chases. I remember that I hated Assassins Creed: Brotherhood, that my character suddenly went up a different building than I wanted. Also, in games like Fifa, if the pass goes in a different direction or to another player than I desired, the immersion is lost. This is not that important for RPGs and strategy games, as they don't have the same requirement for a precise control scheme.

Appendix G: Interview 6: Male (29)

How often do you play?

3–4 times a week.

How long do you play each session?

About two hours, maybe. I have played around 12 hours one day the past six months, but that's rare.

On which units do you normally play?

Playstation 4.

Which genres do you normally play?

RPG, sports games, some other versions of RPGs, turn-based and so on. Some arcade games.

Why these genres in particular?

Arcade: Good to play on the couch, local multiplayer. Platforms and RPGs: More single-player games, more story-driven games. Sports games (Fifa) because of general interest in football and it's fun to play.

How is the physical environment around you while you're playing?

I sit or lay on my couch in the living room. Usually use the loud speakers, but sometimes play multiplayer games online and use headset to be able to talk with the ones I play with.

What does the term immersion mean for you?

It means that I care about what happens with the characters in the game that I play. That my actions have consequences. Or that the environment your character is in will be affected.

How important would you say that graphics is for your immersion?

Graphics is... On a scale from 1–10, I would say that it is around 6–7. But as long as the graphic is acceptable, then a good story is the most important.

What do you mean by "acceptable"? Is it life-like? Is it not "choppy"?

That you can move around without it feeling choppy, that the game flows and that the graphics have a certain dynamic. It's not just you who's moving around in the universe. Games like World of Warcraft, where the non-playing characters who give you a quest with a large exclamation point above their head all day long is ruining my immersive feeling.

What other things draws you out of the immersion?

Illogical elements that appear in-game. E.g. "plot armour" [the character survives something they shouldn't, because they are needed for a later plot in the story]. In Mass Effect: Andromeda, it felt like being in a class, one could stay for 10 minutes just listening to the NPCs. The company boasted that they had the highest amount of voice acting in-game, but it was just too much. It also sounded like a bot was speaking the lines.

Which games have you felt the most immersed in?

That's a difficult question. I quite liked Mass Effect 1. And the Witcher series.

Why those?

They give you a character with a sound background story, and the universe is rich in detail. Your goal is not to "save the world", and there is no entirely correct or wrong actions, but everything is in a gråsone. That can be a flaw in some game, where everything is just black and white.

I forgot one thing about immersion, by the way: The sound image can be quite important. That the right music starts playing at the right times, that can really set the mood—e.g. in a dark room and ominous music starts playing in the background, or you meet a new character or move into a new room and a sound starts playing to spook you as the player while at the same time giving you the impression that your in-game character is spooked.

How would you say that menu system, inventory system and other interface elements affect the experience?

A good interface is important for a game. There should not be too many "ledd"—preferably all of my inventory should be in one screen for example. If there are too many subcategories and I have to click around, I lose track of where things are.

How important is the control scheme for your immersion?

Bad camera control can be a real deal-breaker. Some games require you to adjust the camera manually, but others are automatic. In general, I would say that automatic can be beneficial, but there are always some blind spots in-game where automatic does not work.

And if you take into consideration combat controls, your control inputs?

Well... In the Witcher, the controls can be less fluent at times. There are some "opposite lag", I feel that the character just acts immediately with rash movements, in real life it would be a bit smoother movement and more nuanced. In Fifa, you don't really give any input other than direction or whether you should tackle or pass. It's somewhat of an "auto-combat" in other games.

Appendix B

List of Unity Assets

Here is a list of the assets from Unity store used in the prototypes:

Nokobot: Modern Guns: Handgun (https://assetstore.unity.com/packages/3d/props/guns/modern-guns-handgun-129821)

Tirgames assets: Shooting Range Interiors (https://assetstore.unity.com/packages/3d/environments/urban/shooting-range-interiors-62603)

Olivier Girardot: Free Sound Effects Pack (https://assetstore.unity.com/packages/audio/sound-fx/free-sound-effects-pack-155776)

Appendix C

Prototype demo

A simple demo of the prototypes can be seen here:

  https://youtu.be/jojZsg11xZE