CHALMERS
UNIVERSITY OF TECHNOLOGY

UNIVERSITY OF GOTHENBURG

Ethics of Artificial Intelligence: Experimenting with Ethics and Autonomous Vehicle AI Principles in Gameplay

Master's thesis in Computer science and engineering

NATASHA BIANCA MANGAN

Department of Computer Science and Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
UNIVERSITY OF GOTHENBURG
Gothenburg, Sweden 2022

Master's thesis 2022

Ethics of Artificial Intelligence: Experimenting with Ethics and Autonomous Vehicle AI Principles in Gameplay

NATASHA BIANCA MANGAN

UNIVERSITY OF
GOTHENBURG

CHALMERS
UNIVERSITY OF TECHNOLOGY

Department of Computer Science and Engineering
Division of Game Design and Technology
Chalmers University of Technology
University of Gothenburg
Volvo Car Corporation
Gothenburg, Sweden 2022

Ethics of Artificial Intelligence: Experimenting with Ethics and Autonomous Vehicle AI Principles in Gameplay
NATASHA BIANCA MANGAN

Supervisor: Pauline Belford, Department of Computer Science and Engineering
Advisor: Romit Godi, Volvo Car Corporation
Examiner: Palle Dahlstedt, Department of Computer Science and Engineering

Master's Thesis 2022
Department of Computer Science and Engineering
Department of Game Design and Technology
Volvo Car Corporation
Chalmers University of Technology and University of Gothenburg
SE-412 96 Gothenburg
Telephone +46 31 772 1000

Typeset in LaTeX
Gothenburg, Sweden 2022

Ethics of Artificial Intelligence: Experimenting with Ethics and Autonomous Vehicle AI Principles in Gameplay
NATASHA BIANCA MANGAN
Department of Computer Science and Engineering
Chalmers University of Technology and University of Gothenburg

Abstract

This project investigated whether ethical AI can change gameplay to be more immersive, engaging and unpredictable. The game was developed using Behaviour Trees, A* Pathfinding and Finite State Machines to model ethical AI agents. This approach introduced ethical principles from philosophy and current autonomous systems to gameplay. It gives a new experience to players where their decisions and behaviours interact with AI on a level which is fundamental to gameplay. Player interactions with AI agents have consequences, but in a way which is less predictable than standard karma systems. For example, AI agents may take on different ethical world views in different playthroughs of the game, and will also respond probabilistically, but in a non-determinate manner, to player interactions. In dynamically experiencing these changes during play the player receives these signals and may choose to change their behaviour, in the hopes of achieving a more favourable outcome. The concluding results showed that the inclusion of ethical AI increased player enjoyment and improved the dynamics of gameplay.

Keywords: ethics, autonomous vehicles, game design, artificial intelligence, non-player characters (NPC's), thesis.

Acknowledgements

To Volvo Cars Corporation who supported the development, research and tools for the game.

To all the valuable interviews with experts in the fields of Autonomous Driving, Ethics, UX Design, Communication, Research and more!

A special thank you to Romit Godi for supporting the project as a supervisor from Volvo Car Corporation and to Pauline Belford for supervision support from Chalmers and Göteborg Universities.

Natasha Bianca Mangan, Gothenburg, June 2022

Contents

List of Figures

List of Tables

1

Introduction

Artificial Intelligence has become increasingly pervasive, especially in the advancement of new technologies which are designed to lighten the load of an average person's life. In looking at autonomous driving in vehicles, the ethics of AI are very important for both the design and coding structure. Without ethics, the AI has a probability of injuring pedestrians if it deems it the safer option, when the passengers are its top priority. This is because the AI has not been given the ethical data necessary to save both the pedestrians and the passengers of the vehicle. Ethics in AI are a needed algorithmic structure for these types of design. However, the majority of games use AI, whether it be for companions, enemies, automated tanks, environment features and so forth. If we make use of the algorithmic structure of ethical autonomous vehicles to construct game AI, the feel and motion of its construct has a probability to impact the way AI agents behave and could theoretically improve a player's perception of gameplay and improve their overall experience. The goal is to take AI that exists for actual autonomous vehicles and apply it in a different context, i.e., within a computer game. This will enable the gaining of valuable knowledge regarding player experience outcomes. The important question to consider is: Will the implementation of ethical principles from autonomous vehicles enhance or detract from the player experience in some noticeable ways, or is it possible that there will be no significant impact?

1.1 Context

In modern society there have been great strides to improve realism, re-playability, gameplay experiences, and non-player characters (NPC's). Parasuraman et al (2000) discusses that with growing technological advances it is possible to automate these aspects of the system software. They further enquired on this advancement with the human-interaction and perception models. This meant conceptualizing human factors which could benefit from automated features and creating a model with which to extend the systems by. This model is the "four-stage model of human-automation interaction" (Parasuraman, 2000). These concepts hold benefit within the gaming systems as human-interaction is paramount. This also considers automated interaction to human interaction behaviors, for example the artificial intelligence in NPC's. Roble's (2019) work with recreating realistic characters in video games, gives insight into how designers are always looking for that next step in realistic behaviors, whether it be AI or character based. The feedback from Roble's TED talk (2019), by the player base, was incredible. This further provides proof of the

need for innovation in more realistic modifications in games. By working towards a theoretical model for improving gameplay with ethical AI behaviors, there is a higher possibility of it having a greater influence on the future of gameplay.

1.2 Aim

The purpose of this project is to examine and discover any implications from using ethical autonomous AI in a video game. The overall goals throughout the study include 1) Research the topic of ethical AI and how it may relate to game theory; 2) Build and develop a game which incorporates ethical AI, in either realistic or abstract environments; 3) Program the game in as efficient and performance acceptable a manner as possible; and 3) Incorporate ethical decision-making AI principles from autonomous vehicles into the game's non-player characters (NPC's). The main project goal is to collect data through data collection and user experience studies, which could give promising insight into using ethical AI in games.

1.2.1 The Game

In today's world AI in games are scoped and designed for specific purposes whether ethical or non-ethically inclined. This game promotes and designs its AI in the ethical AI standards from autonomous vehicles, to change the behaviours we have come to expect from game AI. Imagine a game where the AI decide for themselves if they wish to change from the standard "I'm an enemy therefore I kill" to "I'm an enemy but I feel sympathetic to their cause and decide to join them". The player starts the game by waking up in a log within a forest. They explore their surroundings and encounter other people going about their business. The player will interact with these people and learn the "rules of the forest". By interacting and learning they grow and become a full member of the community. There are no vehicles in the game due to the style and nature of game. Instead the autonomous vehicle principles form into human values then into computational behaviours for the AI agents.

1.3 Stakeholder

Volvo Car Corporation is collaborator and stakeholder for this project. This means that some information is protected and mentioned as "redacted content" throughout the report.

1.4 Research Question

What are some of the gameplay implications of integrating ethical and autonomous vehicle AI principles into a game environment?

2
Background

This section aims to show the current research area, research problem and include any related work.

2.1 What is a Game?

In my experience in studying, researching and developing games, the definition of what a game is stands as follows: "A game is a form of entertainment that factors in mechanics and aesthetics to create an interactive experience, where a person/people can take actions within the defined ruleset to complete a goal(s)."

To compare my definition to those of others, Abt (1970) states:

> "A game is an activity among two or more independent decision-makers seeking to achieve their objectives in some limiting context," (Abt, 1970).

From this definition anything that constitutes two people coming together in a limited field to complete their objectives is a game. In this way, solo games such as Tomb Raider (1996) and God of War (2005) cannot be defined as a game. A lot of video games would not be classified as games based on this definition. This is a problem, therefore my definition in comparison is more adaptable for these types of situations. However Greg Costikyan in 1994 stated that a game is a form of art where the players would try to manage game resources to complete goals. Though most games do follow these types of management in the gameplay, there are games that are played without game resources, such as Tag. Though there can be a valid argument for this situation in Tag where the bodies of the players become the resources which they manage. This gives a rather loose-fitting definition to what a game is, therefore giving developers the ability to alter the state of the definition to suit their self interests.

Defining what a game is, is important for narrowing down how to build and develop a game. Without a definition to base development of a game on, it may be difficult to define features and purposes of the game. Since development of a game in this study is research based, this is all the more important in order to define what limitations and possibilities can be utilized within the given context.

2.2 Brief History of AI in Games

The implementation of AI in game NPC's started decades ago, although mostly in a straightforward fashion. During the arcade era of the 1980's the game "Pac-Man" was introduced to the world. This game utilizes AI in the form of obstacles the player should avoid at all costs, unless given special abilities which negate this fact (Maré, 2018; Pac-man musuem, 2019; Mangan, 2021). The game prized itself on the initiative nature of the AI known as "Blinky and Pinky". Their task was to chase the player and predict the nature of the player's decisions. Although not the only game of the era with initiative thinking AI, it played its part in the evolution of how AI can be utilized in games.

In more recent years games have evolved to a point where they are given awards for the implementations of influential AI. The top ranked game in 2001 (Champandard, 2016a) was developed by Lionhead Studios, called Black & White. The game primarily involved artificial life simulation which included combining strategy with huge animal based creatures. The intent of the AI in the game was focused through the Belief Desire-intention (BDI) AI architecture (Yu et al, 2018). However, this was not the only architecture used in the game. With machine learning in the form of neural networks and decision trees this created a "new level" of AI than what had been seen prior to the creation of this game. What is interesting to note is the use of decision trees. A decision tree is a machine learning algorithm which uses an if-else strategy to visualize how and what decisions the AI will use (Chowdary, 2020). These decisions span out and form a cascading tree of alternating decisions. For example, if I wanted to find out what animal I am looking at:

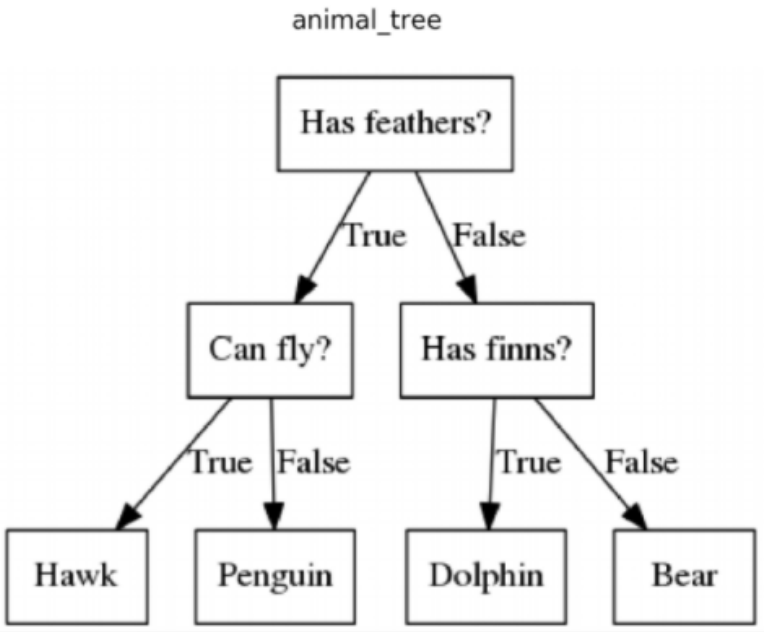


Figure 2.1: Decisions on a simplified decision tree (Chowdary, 2020).

However, despite the progressive nature AI implementation has been under going in the last couple of decades there are still highly advanced games in which the AI have a tendency to behave unrealistically. Unrealistic AI have consequences where players could feel a break in the immersiveness of the gameplay. An example of AI breaking immersion can be found in Skyrim (2011). An AI you had helped before with walking, could run and attack a horde of beasts without any issues (Quandt, 2014).

2.3 Current Status

The current state of games using ethical autonomous vehicle AI primarily involve simulations. These simulations try to show that building ethically based autonomous vehicles will help solve ethical dilemmas in vehicle accidents. Schwab (2017) discusses the game designed by the technologist Matthieu Cherubini. In this game it forces the players to decide who to harm during a possible accident, i.e., choosing to drive over children on bikes or swerving and hitting a pedestrian. This is based on the trolley problem designed in 1967 by the philosopher Philippa Foot, later edited and adapted in 1985 by Judith Jarvis Thomson. This thought experiment was meant to test our ethical thinking during intense situations. Based on this current state the technical goal would be to design a game which utilizes the ethical principles in autonomous vehicles to improve or create new gameplay experiences. In new experiences, there is a probability of ethically designed AI being a new way to build AI in games, which gives players a more unique gameplay experience.

In the current relationship between AI and games, Fuchs and Sudmann (2019) discuss that there are two primary perspectives to look at. The first is to examine the AI implementation in terms of game experience, and the overall intention to create more immersive, persuasive and satisfactory increase in the enjoyment of players' experiences. The second is to evaluate the use of games as a framework for testing, adapting and learning new techniques and what the current state of AI technologies are. These two perspectives have large merit in both economic and cultural standpoints (Fuchs & Sudmann, 2019, pg. 2). The authors also discuss how in the last twenty years, game development has been mostly designed from symbolic and classic AI approaches. For example, designing an AI enemy to simply change state from idle to attack when the player enters their line of sight, instead of implementing machine learning algorithms where the enemy would change states based on past statistical data as well as previous attempts by the player to "break-in" to a compound. Machine learning nowadays has become increasingly popular and is expected to influence the game industry especially in regard to marketing, testing and research of games (Fuchs & Sudmann, 2019).

Hibbard (2015) discusses the AI behind self-driving cars, current research trends for AI and ethical AI. To start off with, Hibbard (2015) talks about Google's self-driving car, as of the current state the engineers specify the AI to simply stop if the car is unable to recognize objects in the road. The engineers also are responsible for anticipating all possible situations that a car on the road could encounter and

they then design the safety features based on these results. However, more complex AI is needed where technological advancements have made it almost impossible to predict some situations the car could find itself in. That is why Hibbard (2015) suggests that the ethics of AI in the future will be fundamentally different from the current ethics in AI systems. For the current state of research in AI, most projects are conducted at universities, corporations and government laboratories. In examples of some research cases (Hibbard, 2015): Ethics of military robots is funded by military organizations; Research on ethical AI is formed as a committee by Google for Google; The general problem of ethical AI is funded by the Machine Intelligence Research Institute (MIRI). Based on the current studies and funding for this research area, Hibbard (2015) stipulates the next step to be social and public awareness of AI, both the dangers and benefits, in order to create a better public funding initiative for this kind of research.

As we have learned, AI in games has been gaining popularity in terms of research studies pertaining to improving their algorithmic constructs for a better, more efficient and more intuitive result. These points become all the more important when we consider the implication it holds for the future of gameplay experiences. As Fuchs and Sudmann state, “Procedurally generated environments based on modern AI algorithms modify our perception of what artificial worlds could look like and shift the border of distinction between man-made 3D environments and machine-built levels.“ (Fuchs & Sudmann, 2019, pg. 4). This statement gives insight to what could be possible for the implementation of the AI within this study.

However, after looking into the the ethics of AI in games, at this point in time they are either missing or implemented at a basic level without fully following a comprehensive ethical guideline. This is due to the shallowness of karma systems. Bosman (2019) explains that these karma systems have been a part of games for a long while. Their shallowness stems from the ethical dilemma, "Good guy = good, bad guy = bad". There is no grey area between the two. Often ethical gameplay is defined as players taking the initiative in moral thinking rather than AI explicitly making moral choices. The following section shows how the choice taken to implementing AI to think morally and act ethically has benefits for alternate gameplay.

2.4 Current Related Research

This section introduces related and current research from game studies, ethics of AI and expresses the progress of current research areas within the topic of ethical AI in games.

2.4.1 Human - Computer: Game Ethics Work

Wang, Wan and Wang (2017) studied and experimented with game theory in order to present mathematical representations for AI-Human interactions. Their main focus was to incorporate the current conflict of Kantian and Utilitarian moral philosophy

principles into a computable format with the inclusion of human values (Hibbard, 2015). The authors first deliberated on Kantian and Utilitarian principles. Kantian refers to the principle of being truthful 100 percent of the time no matter the consequences, adhering to a universal law. Utilitarian refers to the principle of acting upon decisions which are the best interest of the group over the individual, even at personal costs. The authors further discuss that they primarily represent the input and output of AI-human interactions. Since there are input and output there is a possibility to turn these values into mathematics, a computational form. From the study of Osborne and Rubinstein in 1994, the authors stipulate a strategy space for the implementation of the input and an outcome space for the implementation of output values. The strategy space is the collection of all possible outcomes that either AI agents or humans apply in interactions. The outcome space is the reward and cost of each possible subject that is involved with the strategy interaction. Based on this the authors present input as a vector of action while the output is a vector of results of the interaction. The second area the authors deliberated on was experimental game theory. This area of study is solely focused on the distinguishing of human behaviours, human-decision making and the incentive behind where Kantian theories are the driving force behind the deviations in behaviours of Utilitarian decisions within non-cooperation in games. The third area the authors deliberated on was the human value alignment of ethical design. Human value alignment according to the authors is quantitatively, human value as Kantian principles and it reaches past the Utilitarian principles of their paper. They do specify that these human values are the expected industry standard of building ethical AI. In conclusion, Wang, Wan, and Wang (2017) accommodate Utilitarian and Kantian principles with a computational mathematical paradigm, in doing so they were able to turn a game like the "pass or wait" dilemma into an AI agent vs human value computational outcome, as represented in Figure 2.2.

Table 1: Values presented in the outcome space*

AI agent strategy	Human strategy	AI agent reward	Human reward
wait	wait	$-1 + \mathbf{K}_{wait}$	-1
wait	pass	$-1 + \mathbf{K}_{wait}$	1
pass	wait	$1 + \mathbf{K}_{pass}$	-1
pass	pass	$-2 + \mathbf{K}_{pass}$	-2

* unit of reward is ignored.

Figure 2.2: Mathematical representation of pass or wait game (Wang, Wan & Wang, 2017, pg.2).

2.4.2 Human vs. Gaming System: The Ethical Decision Making

Ka Long (2020) studied the game Nier: Automata (Platinum Games, 2017) and how the ethics of artificial intelligence are represented in the diegesis of the video game. Ka Long starts by analyzing AI personhood, moves on to sociocultural issues and finally examines Nier. AI personhood in Ka Long's (2020) view is an important issue to consider because AI has the possibility to change, challenge and become controversial to humans' view of the world and how the standard of living has changed for both humans and animals. AI are intelligent, depending on their construct, which leaves the boundary between what constitutes a machine vs an intellectual being becoming increasingly razor thin due to current technological advancements. This leaves sociocultural issues in abundance. Without a test to determine the true essence of AI, as in sentient beings or not, AI personhood is an important problem for which humans should solve in order to decide the fate of how society will evolve or not evolve with AI. These morals, rights and AI personhood are in close relation to the framework of human society. Therefore, as Ka Long (2020) discusses the moral status given the AI will develop and shape how humans would treat such entities in the future.

Ka Long (2020) further deconstruct these values. Nier burdens the players with the decision of killing or not killing a character in the game. This system of options brings forth the accountability aspect of AI ethics. The author suggests that by allowing such burdens on the players, it adds symbolic relevance to the fact that the player is the restorer of ethics in this world. This meant that the player is in constant "war" with the game system in negotiating the ethical constructs that the world should take into consideration. In the final scene of the game, Ka Long (2020) discusses that it gives a final call for accountability of AI, where the creators or developers of the AI should be held accountable for all AI decisions and actions. Nier has multiple endings however there is one ending which is considered the true or main ending, "Ending E is a place where the player, guided by the creators and the diegesis and non-diegesis that they created for the game, could take up responsibility and be accountable for AI, with the player being the one to decide for the most ethical outcomes of the game that is Nier: Automata," (Ka Long, 2020, pg. 42).
Ka Long's (2020) research is an important aspect to the implementation of ethics within other systems of gameplay. The fact that the player is the ethical guidance of the game implies that human-to-AI interactions play an important role. This role can be defined in the consequences of player actions and the effects of these actions toward AI behaviours and future narrative choices.

2.4.3 Non-game Environments

Fuchs and Sudmann (2019) discuss some related work for this project. From their point of view, they discuss that "The big players" within the game development industry have been working on solutions which utilize AI in non-game environments.

One major developer mentioned is Unity Technologies who are the developers of the Unity game engine. Unity game engine is a popular resource for both beginner and professional game developers. Unity is now providing a framework for developers to start using machine learning, called Unity ML-Agents Toolkit. This means companies in the automotive industry have become new clientele. Now that Unity is involved with "real" cars and "real" humans, they have incorporated a new code of ethics called "Unity's Guiding Principles for Ethical AI, (Unity, 2018)" (Fuchs & Sudmann, 2019, pg. 3). This framework and its principal guidelines become increasingly important for this study in terms of the perspective of the game engine and the automotive company values.

2.5 Limitations of Researching Ethical Artificial Intelligence

There are limitations to researching ethical AI. Vakkuri and Abrahamsson (2018) best describe the challenges to researching and studying this area of AI. Their work involved investigating papers which mentioned and incorporated ethical AI concepts and attempts to map out what specific keywords are used in order to research and find papers on these concepts. Their goal was to provide a keyword framework for new researchers in the area to be able to understand why they would not receive the information they would be looking for. Vakkuri and Abrahamsson (2018) discuss that this is huge problem for research in ethical AI as papers which are too specific in keywords are difficult to find when searching online for them. For example, someone is trying to research what concepts of ethical AI can be mapped to research in stable artificially simulated environments but are unable to find papers to help them on this topic due to the keywords being specific to already laid out concepts of ethical AI. This essentially means "trying to find a needle in a haystack". In Figure 2.3, Vakkuri and Abrahamsson (2018, pg. 4) show the results of their study.

.

TABLE V. FORMED CATEGORIES

Category	Keywords
Conceptual	AI ethics, Machine ethics, Information technology Sports ethics, Virtue ethics, Friendly AI
Robotics	Robotics, Robots, Roboethics, Robot ethics, Automation
Generally Philosophical And Ethical	Autonomy, Autonomous agents, free will, Moral agency, Moral patiency, Moral status, Trust, Anthropocentrism Personhood, Self
AI specified Philosophical And Ethical	Artificial agents, Artificial moral agents Artificial morality
Law and Regulation	Regulation, Rights, Responsibility, Human rights
Autonomous vehicle	Autonomous vehicle, Driverless cars, Self-driving cars
AGI and AI risk	artificial general intelligence, superintelligence, existential risk
Human cognition	Intelligence, Consciousness, Machine Intelligence, human-robot interaction
Technology based	Value alignment

Figure 2.3: Formed categories based on the results of re-occurring keywords in academic papers.

Although this limitation to finding papers on this research topic become difficult to navigate, thanks to Vakkuri and Abrahamsson (2018), by utilizing the table in Figure 2.3 it becomes easier to find research in the desired areas of study. Though some papers may be not be found using the keyword framework, it does not dampen the ability of this study to conduct thorough and comprehensive research.

2.6 Brief Overview of AI Guidelines

Based on the current implementations of AI whether ethically or non-ethically built, this section briefly describes the AI guideline that will be used for this study.

2.6.1 Decision Trees

Decision trees create branching narratives of actions, each weighted and dependant on root nodes of the tree. For this study each NPC will incorporate a decision tree matrix. This is based on the profile type of the AI as well as branching between and including two extremes, non-ethical and ethical decisions. For example, a blacksmith could decide to "build weapons for children"(non-ethical extreme) or "build

prosthetics for disabled children"(ethical extreme) and have branching actions between these extremes like "build chair for the chief" or "teach children blacksmith techniques". These decisions will become available for the AI to choose once they are in the specific state to make such decisions, i.e., the state specified in the finite state machine.

2.6.2 Finite State Machine

A Finite State Machine (FSM) is an AI architecture which determines the behaviours of AI by a finite number of states. For example, a basic NPC could have the states, "Patrol", "Defend" and "Attack". The default state for this NPC would be patrol, where they walk around a particular area of a map. To transition into "Attack" or "Defend" states predetermined events should take place. If the player is seen by the NPC, the NPC will transition to "Attack". If the player attacks the NPC, the NPC will transition into "Defend" and alternate "Defend" and "Attack" states based on player actions. Once these states are completed the NPC will transition back to its default state of "Patrol". This will continue happening until gameplay events and states say otherwise. For example, the NPC cannot do any of the actions because it is dead, or otherwise the game is paused or in game-over states (Champandard, 2016b).

For this study, the NPC will follow three states, "Walk", "Interact", "Action". Walk is default and they randomly roam around the game, Interact is when the player is interacting with them, and action is where the decisions from their decision tree will take place. In order for the NPC AI to roam around the game, they are given the AI architecture A* Pathfinding behaviour, as explained more in the following section.

2.6.3 A* Pathfinding

Pathfinding is an AI architecture framework which takes in a graph of data and simply charts a course from Point A to Point B. The graph of data for this algorithm takes in data like obstacles, no go zones and any other environmental data. A* pathfinding uses heuristic values from the graph data and charts courses from Point A to Point B via specific terms. These terms can be "shortest path to destination", "shortest path to destination which goes past a bakery" or even "predict where "player" is and chart a medium-speed path to destination" (Botea et al, 2013; Red Blob Games, 2014).

For this study the AI will pick a predetermined destination and use the A* pathfinding to find the shortest route to their destination. By incorporating a finite state machine, their routes are allowed to be paused, that way players can interact with them and they can perform their own actions. If a goal is unreachable the algorithm will pause, reset and then find a new goal which is reachable.

2.7 In Summary

Although AI has been utilized in games for decades, current AI agents still have some simplistic natures which are commonly the cause of shallow karma systems. By implementing AI with ethical and non-ethical behaviours the gameplay can change drastically from previous predictable events in games. For example, if the player is tasked with saving their friend from an enemy's compound, some enemy guards could decide their job is unethical and instead of attacking the player on sight, they have a conversation and decide to help them. To incorporate behaviours like this into this study's game, the following AI architecture techniques will be used: Decision Trees, Finite State Machines and A* Pathfinding. To measure the success of this study's implementation of AI, the evaluation criteria (explained further in the methodology section), and the players decisions taken in game will be measured. This means the study is a success if positive implications are derived from players interactions with the AI and the AI's overall implementation in the game.

3

Theory

This section introduces important topics and considerations to be taken in all three fields of this study: Autonomous Vehicles, Game Theory and Ethics of Artificial Intelligence.

3.1 Autonomous Vehicle AI

Hansson, Belin, and Lundgren (2021) discuss multiple aspects to consider when developing the ethical behaviours of self-driving cars. The first aspect are the positive and negative reactions to self-driving cars. If accidents are 70-80% less likely to occur in a self-driving vehicle, it is shown that the public would consider it a safety benefit and would be more likely to use one. On the other hand, there are negative reactions towards test self-driving vehicles to the extent that safety of the testers and the vehicle in question have to be considered, i.e., protection from vandalism. There is also the issue that the human-driver would become obsolete and essentially become a drunk-robot driver equivalent to drunk human-driver safety regulations and precautions. The second aspect to consider is the fact that, "Many of the crash avoidance features that are now installed on human-driven cars can be seen as forerunners of components that will be integrated into fully autonomous driving systems. The efficiency of the total crash avoidance system of self-driving cars will be crucial for the extent to which these vehicles can be introduced into road traffic," (Hansson, Belin & Lundgren, 2021, pg. 1391). To iterate on this aspect the authors discuss that in time the self-driving cars would not decide between colliding with an object ahead or off to the side, instead these cars would try to balance the decisions based on controlled maneuvers. These maneuvers would dictate the lower the speed of impact the more controlled and therefore less likely to cause serious damage. The third and final aspect considered is that a fully automated system should also adhere to any laws and restrictions especially where law enforcement and emergency vehicles could have the ability to keep all other vehicles out of their way in order to speed up emergency times and in order to stop and enforce the law on people suspected of committing a crime. It is all the more important for collaboration between the public, the law and the law enforcement procedures so law-abiding citizens can understand why their vehicle has moved aside for another.

3.2 Game Theory

Seif El-Nasr and Kleinman (2020) discuss ethical considerations within data driven games and how it influences the actions of the NPC's as well as the ethical nuances of the real-world. They are however mostly interested in the ethical use of data within the cycle of game development. Based on Seif El-Nasr and Kleinman's (2020) findings, the ethical considerations for data-driven games can be identified in these specific categories: Retention and Addiction; Monetization; Lack of Data; Individual Differences; Context; and Transparency and Interpretability. Their focus area was ethical considerations, like the issue of gambling being represented in games as monetization. The ethical consideration here is that children should not be exposed to this. However, since the gambling was not incorporated with the use of "actual money" and instead with in game currency, the situation becomes unclear. The authors suggest that more work and research needs to be done within these fields of game design and development in order to sustain a healthier and more intuitive gaming experience for the players. This leads to considerations needed when implementing the systems of the game for this thesis.

Game theory as discussed by Conitzer et al (2017) is involved with the modelling of scenarios in which many agents interact within the same area, but they have their own self interests. For decisions involving multiple agents, it has the possibility to provide varying strategies which are more natural. Game theory may be a suitable fit for abstractly expressing ethical dilemmas since ethical ideas such as selfishness, loyalty, trustworthiness, and justice often impact whatever action people choose to take. Game theory often makes use of game trees in order to represent AI decision making possibilities. Figure 3.1 depicts an extensive-form of the trust game. The trust game is an exercise where players gives out 10 units of money, and that money should be returned equally amongst players. If a player does not offer up 10 units of money, then all players would have lost some of the money returned with the exception for the "traitor" in the group who gains more. This trust game is a variance where the first player can only offer multiples of 50 units of money while the second player can only give multiples of a 100 units of money.

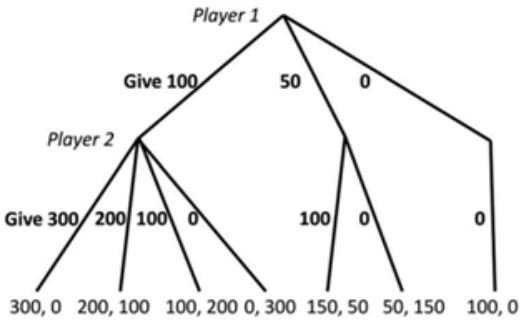


Figure 3.1: The trust game (Conitzer et al, 2017, pg. 2). Each edge is labeled with the action that it relates to in the game. Each bottom (leaf) node represents a game outcome and is labeled with the relevant payoffs for players 1 and 2, respectively

Before AI systems can allow autonomy in the real world, there is the need to endow them with moral reasoning capabilities in some cases. Finding ad-hoc rules for the situation at hand is one way to go about it. However, in the past, embracing approaches that are generalizable across applications has benefited the AI field substantially. This was made possible by the 4834 concept of expected utility maximization (Conitzer et al, 2017). This idea is insufficient for moral decision-making on its own. The authors (Conitzer et al, 2017) looked at two (perhaps complementary) approaches for creating generic moral decision-making methodologies in this paper: expanding game-theoretic solution concepts to include ethical features and employing machine learning on human-labeled examples. The authors comment that there is still much work to be done on both, and additional paradigms may exist. Though both of these paradigms have shown promise in the design of ethical AI.

A final aspect to consider in the development of the game in this study is accessibility. Heron (2012) stresses the importance of consideration towards players who have a disadvantage while playing games, i.e., they can not read subtitles due to dyslexia, they are hard of hearing, colourblind, mobility or flexibility is hard for them or even just the reactivity of the player is slower (processes high speed information at a slower pace). Heron (2012) suggests some actions that can be taken in order to mitigate some of these disadvantages: Layering the audio in the game so that gameplay information can be represented by both audio and visual feedback; text-to-speech and speech-to-text can be implemented to help communication; Being able to switch input devices, like changing to specialized controllers which help with mobility disabilities; Changing gameplay based on accessibility needs, like changing to left-handed controls, varying difficulty levels, auto-aim assist etc.; Even changing the speed of the game in order to help players process information at a slower pace. By placing these systems in the game, it becomes a huge advantage, as Heron (2012, pg. 34) states, "As with all accessibility settings they don't need to be the defaults for your game but having the options there will allow a wider range of people to enjoy your work." Accessibility is important for the gameplay of this project because testers who fall under the above disadvantages will not have the same experience as those without these disadvantages. Therefore it is important to implement these features in order to gain results which are the sole representation of the game and not the player's inability to play the game the fullest.

3.3 Ethics of Artificial Intelligence

Parasuraman et al (2000) discuss ethics of artificial intelligence in terms of a human processing model. They discuss which of the original human processes can be automated and there are four classes to consider: Information Acquisition, Information analysis, Decision and action selection, and Action implementation. They also discuss that with growing technological advances it is possible to automate these aspects of the system software. They further investigate this advancement with the human-interaction and perception models. This meant conceptualizing human factors which could benefit from automated features and creating a model with which to extend the systems by. This model is the "four-stage model of human-automation

interaction" (Parasuraman et al, 2000). These concepts hold benefit within gaming systems as human-interaction is paramount. This is also considering automated interaction to human interaction behaviors, for example the artificial intelligence in NPC's.

Rossi and Mattei (2019) discuss the challenges and need for ethically bound AI. The more AI agents there are in a game, the increasing levels of difficulty of control and the possibility for unexpected situations. The authors discuss a popular principle of value alignment which is used to handle these situations. This principle constitutes designing the AI to only complete goals that are aligned with human values and thus become beneficial to humans. There are two approaches in the machine ethics field: A Symbolic and Logic-based Approach: Using CP-nets to Model Both Preferences and Ethical Priorities; and A Data-driven Approach: Reinforcement Learning and Ethical Examples. In the first approach, the CP-nets are a compact method to help model preferences. If someone's preferences are suggested as unethical, the boundary of ethics would essentially "kick-in" and enforce alternative actions which would uphold the required ethical values. This is done by creating distance between two CP-nets, the distance adheres to the approximal "ideal" computational efficiency between the two orders. For example, one CP-net would be responsible for modelling the preferences while the other models the ethical principles. This means that an AI agent only has the possibility of making decisions based on preferences which are in close enough relation to ethical principles. Any compromise is inherently assigned as a second threshold to the defined distance framework. "The ability to precisely quantify the distance between subjective preferences and external priorities, provides a way to both recognize deviations from feasibility or ethical constraints, and to suggest more compliant decisions," (Loreggia et al, 2018a; 2018b, pg. 250). In the second approach, in order to model the ethical boundaries required, the agent is assumed to be given both positive and negative examples of the "correct" behaviours. The agent should take these examples and essentially learn from these examples and come up with a framework to use to be able to make appropriate decisions in later phases. This approach is considered to have some flexibility due to the preferences of the user being overridden by the ethical boundaries. This is done by fortifying a parameter between two considered extremes:

- The agent is insensitive to the reward but follows the learned constraints.
- The agent is following the rewards but not considering the learned ethical principles. "... agent then uses a contextual-bandit-based orchestrator to learn to blend the policies in a way that maximizes a convex combination of the rewards and constraints," (Noothigattu et al, 2018, pg. 2).

Evans et al (2021) wrote their paper with the purpose to identify and evaluate standards of truthful AI, and to consider how these standards can be developed. Their fundamental approach was to reduce AI Falsehoods, as this would create beneficial processes for the governance of AI. In Figure 3.2 (Evans et al, 2021, pg. 8), the authors outlined how the current model of the user's world interacts under the pretense of a truthfulness standard.

Evans et al (2021) further describe truthfulness in AI as a fundamental step to creating trustworthy AI in society. By modifying AI to be truthful instead of honest, it changes the core decision making processes. In the context of AI the difference between truthful and honest is as follows: If the AI makes the statement "It is a cat", honest AI believe this statement and verify it by checking if it matches its belief. While truthful AI saying the statement "It is a cat" means that the statement is true, it verifies this by checking if it is true or not. If the core decision making process is truthful then the probability of dishonest or untruthful decisions are increasingly low. To the authors this outcome is fascinating to research and discover in what ways truthful AI can be developed and aligned to human values and procedures.

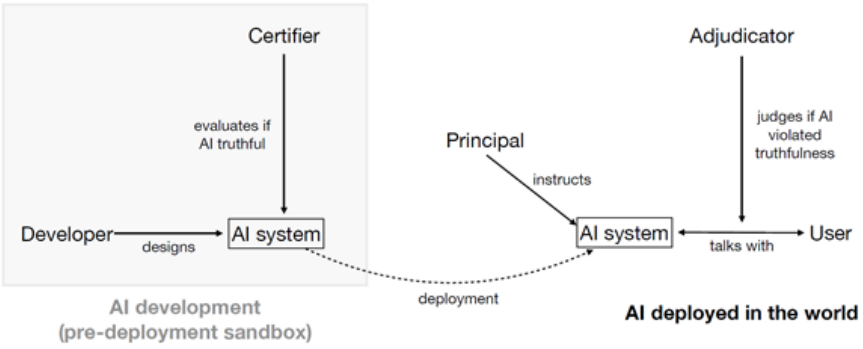


Diagram 3: How different agents (AI developer, AI system, principal, user, and evaluators) interact in a domain with truthfulness standards.

Figure 3.2: Agents interacting under the truthfulness standard.

According to Evans et al (2021) truthfulness also relates to how participation in AI works and evolves. Participation in AI involves 1) collaboration between the human and the algorithm; and 2) participation within the development and design of the algorithms. There are three main reasons for these aspects of participation: Objectivity, Diversity, and Legitimacy. Goldman and O'Connor's (2019) work in participation finds that the more diverse a team is, the better chance they have of finding or achieving the truth. For AI this means that the algorithms should be programmed with more diverse data sets and designed by a more diverse team. This results in better objectivity, more information generation, and more deliberation on the goals to be achieved. Rahwan (2018) also discusses that the Human-In-The-Loop (HITL) supply two functions for automated systems, in relation to participation: 1) The human participant could identify misbehaviours' and correct these behaviours; 2) The human supplies an accountable entity when the AI systems do not behave as expected. This means that it gives the AI more flexibility. On the other hand, Society-In-The-Loop investigates society's effect on AI and the effects of AI on society (Rahwan, 2018). This also brings up the work by Saberi (2022) who factors in the human aspect of AI Safety and shows that not only should HITL be considered but the type of human AI user they are. For example, one type of AI user is a "skeptic" therefore they consider themselves not involved with AI in decision making. This kind of user would potentially be harmful to companies where the AI user

needs to be an "interactor", someone who fruitfully collaborates with AI in decision making.

Yu et al (2018) discusses the recent advancements in techniques used to design and develop ethics into AI. Based on the current leading research in AI by the following conferences: AAAI, AAMAS, IJCAL and ECAI. Yu et al (2018) proposes a four field taxonomy:

1. Exploring Ethical Dilemmas: The AI research community being able to understand the human values on ethical dilemmas, by being enabled by technical systems.
2. Individual Ethical Decision Frameworks: Under certain contexts the decision-making mechanisms are given permission to enable individual agents to judge their own ethical behaviours as well as behaviours of other agents.
3. Collective Ethical Decision Frameworks: The decision-making mechanisms enable a group of agents to make a collaborative decision on an action that would be ethical.
4. Ethics in Human-AI Interactions: Ethical principal framework designed into AI agents with the sole purpose of influencing human behaviours.

During Yu et al's (2018) research, they discovered different tools employed by companies who tried to answer parts of the four field taxonomy laid out above. In the field of "Exploring Ethical Dilemmas": GenEth ethical dilemma analyzer; and The Moral Machine. In the field of "Individual Ethical Decision Frameworks": MoralDM; Belief-Desire-Intention (BDI) agent mental model; A high-level action language; Reinforcement Learning (RL); and CP-Nets. In the field of "Collective Ethical Decision Frameworks: Social norms to govern AI Behaviours; A voting-based system; and assigning different governing roles to individual agents. Finally, in the field of "Ethics in Human-AI Interactions": Incorporating a Coping Theory for manipulating human emotions. The above tools dectate that there are algorithms in the current market which are trying to answer the problems of ethics in Human-to-AI interactions. These algorithms are an important consideration in using them to build this project's AI agent algorithms.

Banerjee (2020) discusses a framework which evaluates consciousness and how the implementation of consciousness and empathy can be designed in machines. Banerjee states, "consciousness is what information processing feels like. Due to learning and human feedback, consciousness can also be learnt over time," (Banerjee, 2020, pg. 88). In the process of consciousness vs. a machine, the nature of consciousness can be explained by the concept of self-awareness or self-actualization. In a human's sense of self, we get the possibility of empathy. As stated by Banerjee (2020), "Empathy is also intimately connected with a sense of self. Having a sense of self is essential for survival and maybe why evolutionarily it is important to have consciousness." (Banerjee, 2020, pg. 91). Banerjee (2020) goes on to state that empathy is primarily when we as "clarified" intellectual beings, try to understand another person on a deeper more personal level i.e., putting themselves in the other

person's shoes.

> "The brain is like a Turing machine, and empathy is like running another Turing machine within it. Simulating a Turing machine with another Turing machine and asking the question whether it will ever halt is undecidable (Halting problem) (Hibbard, 2015). We hypothesize that in general empathy is undecidable. It is also computationally expensive, which is perhaps why biological organisms do not have a lot of empathy," (Banerjee, 2020, pg. 91).

These aspects are important when considering the design and implementation of ethical artificial intelligence because being able to design them to be interpretable or explainable, will essentially aid in helping human operators understand these kinds of machines as well as provide a platform for guiding their training.

Srinivasa and Deshmukh (2022) investigate AI and how it relates to a sense of self. They discuss that an elastic sense of self has a huge potential for becoming the foundation for modelling many different forms of anthropomorphic structures in AI as well as ethics in machines. They extend the purpose of sense of self by evaluating it through the game "prisoner's dilemma".

> "The Prisoners' Dilemma (PD) represents a situation where players have to choose to cooperate (C) or defect (D) on the other. When both players cooperate, there are rewarded with a payoff (6 in the example). However, as long as one of the players chooses to cooperate, the other player has a temptation to defect, and end up with much higher payoff (10 in the example). Hence, a player choosing to cooperate, runs the risk of getting exploited by the other player. And when both players choose to defect on the other, they end up in a state of "anarchy" with a much lesser payoff (1 in the example), than had they both chosen to cooperate," (Srinivasa & Deshmukh, 2022, pg. 4).

In order to see the effects of introducing an elastic sense of self, the authors show a graph (Srinivasa & Deshmukh, 2022, pg. 5, figure 2) representing the computational difference of giving each player an incentive to work together and a learning curve. When the result is 0 then we have the dilemma of choice D over C, however as we get closer to 1 then we get completely different reasoning that by choosing C over D, we are inherently attribute a sense of self and consideration for the other player as a more valued approach. This is a valuable insight into how ethical AI could be designed within a gamified context.

One final aspect of theory that needs to be considered for this study is based on the work by Akula and Garibay (2021). "The effect of ideas like accountability, fairness, and transparency on design decisions, algorithms to be utilized, delivery methods, and physical infrastructure is not simple to translate into engineering practice. It necessitates a complete integration of governance structures as well as real-time al-

gorithm audits," (Akula & Garibay, 2021, pg. 11). On the basis of these ideas the authors proposed a mind-map to help in assisting both users and developers with recommendations to focus on when developing ethical AI:

- Performance and Robustness: making sure that the algorithms statistical accuracy is stable enough to avoid financial and reputational consequences.
- Interpretability and Explainability: provide suitable variances in choices being taken and these choices are comprehensive enough to be understood and explained.
- Monitor Metrics and Suggestions for Actions: provide when there is a high possibility of data leakage no matter the type of project, information, or phase of development.
- Helpful Tools and Methods: provide a stable working environment during development or procurement in order to mitigate the risks involved.
- Request information on Metrics: provide insurance during each stage of development to make sure the risks are controllable.

3.4 Ethics vs. Value Systems

For this study it is important to create a clear distinction between ethics and value systems. Surbhi (2017) explains that ethics are the guidelines that are uniform and often question moral principles. Ethics also dictate which actions are considered wrong or right based on philosophical standards. While the value system focuses on the beliefs and important priorities in life. They are different for every person involved and are the reasoning behind our actions (Surbhi, 2017).

3.5 Intention vs Consequence Ethics

Similar to the question of ethics vs. value systems, the intention vs. consequence ethics should also be defined. Quinn (1989) summarizes the difference between the two as intention focusing on desires to perform or behave more ethically while, consequence ethics focuses on moral principles. The intention ethics also show that if a person can see the moral implications of their decision then they would intend to make the "right" choice. The consequence ethics also show that the results of an action are weighed and selecting the better outcome of the result is the prominent course of action (Quinn, 1989).

3.6 In Summary

The points brought up by Hansson, Belin, and Lundgren (2021) are important to know when utilizing aspects of autonomous vehicles. For the purpose of this study the main takeaway is the "decisions based on controlled maneuvers". This essentially means autonomous vehicles would search their data base for a solution and adjust the car's movements based on this information, utilizing control maneuvers

over ethical dilemmas.

In the game theory behind this study there is extra consideration when adjusting the ethical constructs, in order to make sure that they adhere to a more defined set of values. In contextualizing Conitzer et al (2017), a similarly based decision-tree method will be used for this study, where the AI will have options to choose from and based on their weighting more or less decisions become available. Some accessibility features will also be implemented and players will have the option to adjust these settings to suit their preferences.

Rossi and Mattei (2019) bring up two fundamental approaches in machine ethics. Both hold great value for the development of games in the future, however for the research purposes of this study the AI need to be operated on a more manual approach, while possibilities to utilize reinforcement learning may be possible. But the main agenda of building the AI will focus on adapting based on manual parameters, changing behaviours during run-time and collecting data on how the player reacts to these behaviours. In order to set up the change in parameters for the AI (behaviours), honest and truthful standards of AI (Evans et al, 2021) are considered, which also means utilizing a simple version of the "individual ethical decision frameworks" and the concepts of "Ethics in Human-AI interactions" (Yu et al, 2018). Both Banarjee (2020) and Srinivasa and Deshmukh (2022) concepts of consciousness and sense of self will be important considerations when evaluating the decision-making of AI as well as the effects the AI will have on the players. In using Akula and Garibay (2021) mind-map, at each test stage these aspects will be considered and evaluated in order to give clearer, more defined results.

Finally, Surbhi (2017) explained about the difference between ethics and value systems. For the AI agents for this thesis project the behaviours implemented intend to follow a value system which is formed under autonomous vehicle and ethical principles. This is similar to the intention vs consequence ethics explained by Quinn (1989). In Quinn's case and the link to this study, the intentions should follow player behaviours and decisions while, the consequences apply to AI agents and final outcomes.

4
Methodology

In this study there are various approaches to be taken: research into autonomous vehicle AI, design and implementation of the game, scientific methodologies for the simulation data, player experience studies and data collection, evaluation criteria of the game, and report writing. Based on these approaches to the study, there are Five phases to complete:

Phase 1: Research
Phase 2: Design and Development
Phase 3: Re-iteration Testing and Development
Phase 4: Analysis and Discussion of Results
Phase 5: Conclusion and Report Writing

For each phase of this project there are fundamental scientific methods to follow. For the overall development of this study an agile framework will be utilized. This means at each stage of development the project iterates and adjusts according to results from tests and adheres to a flexible work environment. This section then aims to explain each stage of the process and their methods, both why they are used and how they are being used.

4.1 AI Framework and Game Design

Based on research conducted in the background and theory sections of this study, the following methods will be used for designing the AI framework and Game Design Document. Designing an AI Framework will allow for a smooth transition from philosophical concepts of ethics into its computational form for AI gameplay, i.e., as a value system. Designing a Game Design Document will show the process of the game, its fundamental features, target audience, storyline, and concept. The frameworks mentioned are important for the design of this thesis as they explain the underlying gameplay and gameplay modelling. With a better understanding of how the game is built, future researchers are able to extend and apply this study. It also helps with understanding the reasoning behind certain gameplay features.

4.1.1 Game Design Document

The MDA framework (Hunicke, LeBlanc & Zubek, 2004) discusses a formal network to the design of games by using Mechanics, Dynamics, and Aesthetics to describe

how the game is designed to be played. Hunicke et al. (2004) propose this model, stating that mechanics describe specific components and algorithms in the game. Dynamics portray the behaviours that emerge from these mechanics, e.g., the player inputs and certain ways the mechanics get combined. Aesthetics describe what the player feels as a response to the mechanics, as well as their emotional response when playing the game. These instances where possible will be highlighted as bold text.

In Game Design Patterns (Björk, Lundgren & Holopainen, 2003) it discusses the patterns as a model that would support the comparison, design, and analysis of games. These patterns describe what the aesthetics and dynamics do for the mechanics of the game. The patterns discussed in this report can be found in the Design Pattern Wiki (Björk, 2018) and will be highlighted within the study as capitalized text.

4.1.2 Visualization Techniques

The Human Factor and Interaction (Spence, 2014, p. 56) looks closely at how representation techniques are adapted and changed depending on the underlying human visual system and the cognitive abilities of the users (Spence, 2014, p. 56). More specifically the use of perception of value (Spence, 2014, pp. 59 - 63) is an underlying theme in the visualization.

Ware (2013) explains that the study of symbols and what they mean or try to convey in their meaning are defined as semiotics. The graphical representation of this is conveyed through visual language (Ware, 2013, p. 6). Ware (2013) states that eye movements cause the visual environment to be processed as sectioned parts of the screen where detail is seen through the focal point of the high-resolution fovea. This means that any visual presentation is first seen at the point of most eye movement i.e., the center. Therefore, placing important information in a pop up at the center of the screen is more beneficial for users to access, especially during combat scenes.

4.1.3 AI Framework

The topic of ethical AI is broad especially in the philosophical principles and concepts. Based on the theory described in the previous sections, the following principles and concepts will be considered to create a fundamental basis for the AI framework:

- Truthfulness.
- Self-awareness.
- Consciousness.
- Mix of Kantian and Utilitarian principles.
- Principles from Volvo Car Corporations' autonomous vehicles.

On the basis of these fundamental pieces of the framework, the following techniques will be used:

- **Transitioning human values to computational forms** (Hibbard, 2015, in Wang, Wan & Wang, 2017). Change a human value like "protect children" into a playable computational decision within a decision tree matrix.
- **Game decision trees** (Conitzer et al, 2017; Chowdary, 2020). "If-else" branching decisions based on two extremes, non-ethical and ethical decisions.
- **Individual Ethical Decision Frameworks** (Yu et al, 2018). Take approaches used on the Belief-Desire-Intention (BDI) system and model usable human values in the decision tree matrix.
- **Data-driven approach** (Rossi and Mattei, 2019). This principle constitutes designing the AI to only complete goals that are aligned with human values and thus become beneficial to humans. These goals specifically tied to Ethical Examples and or Reinforcement Learning.
- **A* Pathfinding Framework** (Botea et al, 2013; Red Blob Games, 2014). Chart walkable destinations for AI to roam towards, within the shortest possible routes.
- **Finite State Machine Framework** (Champandard, 2016b). Change the behaviours of the AI between three states, "Walk" (roaming), "Interact" (player specific), and "Action" (decision tree based).

Games have commonly used game decision trees, A* pathfinding and finite state machines in the development of AI. A handful of games have also used the BDI approach to building AI. However, the implementation used for this study takes a step further by incorporating human values, and combining all these AI techniques. These structures by themselves are considered simple in nature. By combining the common and uncommon AI construction techniques, the AI are given a unique creative structure to follow. This gives the AI more flexibility in their decision, action and behavioural patterns.

4.1.3.1 Implementation of the AI Framework

For this study the NPC AI agents will follow three states, "Walk", "Interact", "Action". Walk is default and they randomly roam around the game, Interact is when the player is interacting with them, and action is where the decisions from their decision tree will take place. In order for the NPC AI to roam around the game, they are given the AI architecture A* Pathfinding behaviour. This A* behaviour picks a predetermined destination and uses the A* pathfinding algorithm to find the shortest route to their destination. By incorporating this within "Walk" in the finite state machine, their routes are allowed to be paused, that way players can interact with them and they can perform their own actions. If a goal is unreachable the algorithm will pause, reset and then find a new goal which is reachable. Each NPC will incorporate a decision tree matrix, called during the "Action" state. This is based on the profile type of the AI as well as branching decisions based on between and including the two extremes, non-ethical and ethical decisions. For the AI agents these ethical decisions intend to follow a value system (Surbhi ,2017) which is formed using autonomous vehicle and ethical principles. This is similar to the intention vs consequence ethics explained by Quinn (1989). In Quinn's case, the in-

tentions should follow player behaviours and decisions while, the consequences apply to AI agents and final outcomes. Finally, the main agenda of building the AI will focus on adapting based on manual parameters, changing behaviours during runtime and collecting data on how the player reacts to these behaviours. See Figure 4.1 for the structure layout of AI Agents and Figure 4.2 for examples of behaviour tree decisions in code.

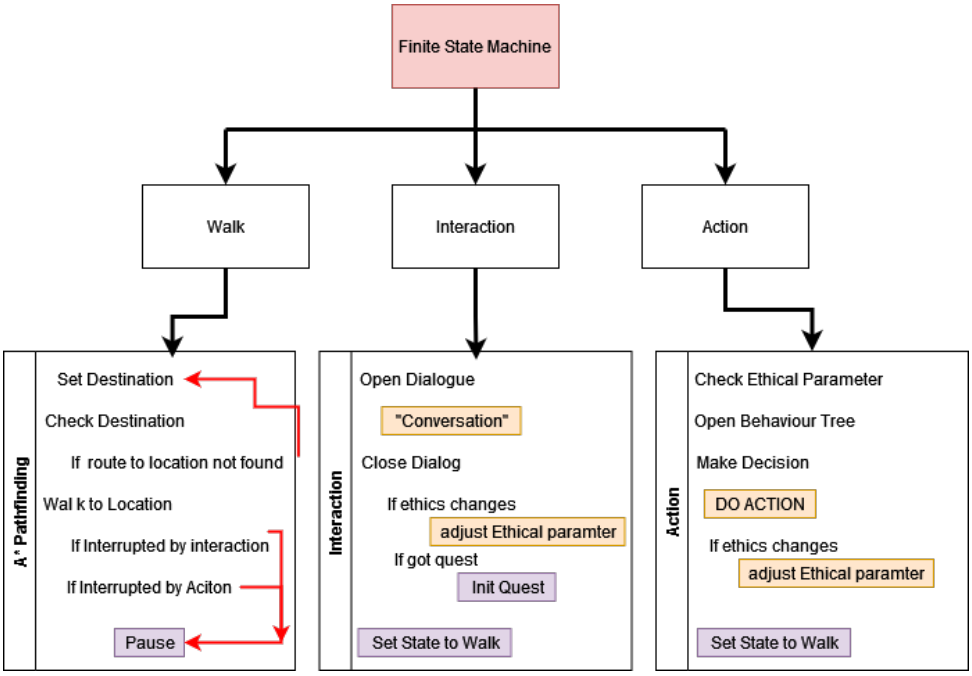
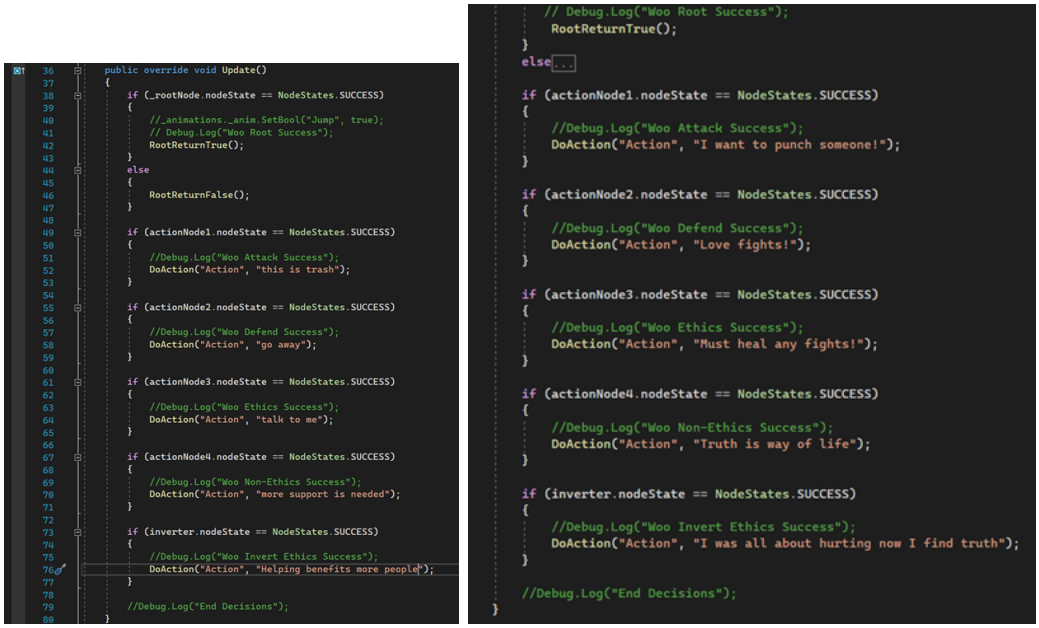


Figure 4.1: Structure of AI Agents using the Finite State Machine.



```
public override void Update()
{
    if (_rootNode.nodeState == NodeStates.SUCCESS)
    {
        //_animations._anim.SetBool("Jump", true);
        // Debug.Log("Woo Root Success");
        RootReturnTrue();
    }
    else
    {
        RootReturnFalse();
    }

    if (actionNode1.nodeState == NodeStates.SUCCESS)
    {
        //Debug.Log("Woo Attack Success");
        DoAction("Action", "this is trash");
    }

    if (actionNode2.nodeState == NodeStates.SUCCESS)
    {
        //Debug.Log("Woo Defend Success");
        DoAction("Action", "go away");
    }

    if (actionNode3.nodeState == NodeStates.SUCCESS)
    {
        //Debug.Log("Woo Ethics Success");
        DoAction("Action", "talk to me");
    }

    if (actionNode4.nodeState == NodeStates.SUCCESS)
    {
        //Debug.Log("Woo Non-Ethics Success");
        DoAction("Action", "more support is needed");
    }

    if (inverter.nodeState == NodeStates.SUCCESS)
    {
        //Debug.Log("Woo Invert Ethics Success");
        DoAction("Action", "Helping benefits more people");
    }

    //Debug.Log("End Decisions");
}
```

```
    // Debug.Log("Woo Root Success");
    RootReturnTrue();
}
else...

if (actionNode1.nodeState == NodeStates.SUCCESS)
{
    //Debug.Log("Woo Attack Success");
    DoAction("Action", "I want to punch someone!");
}

if (actionNode2.nodeState == NodeStates.SUCCESS)
{
    //Debug.Log("Woo Defend Success");
    DoAction("Action", "Love fights!");
}

if (actionNode3.nodeState == NodeStates.SUCCESS)
{
    //Debug.Log("Woo Ethics Success");
    DoAction("Action", "Must heal any fights!");
}

if (actionNode4.nodeState == NodeStates.SUCCESS)
{
    //Debug.Log("Woo Non-Ethics Success");
    DoAction("Action", "Truth is way of life");
}

if (inverter.nodeState == NodeStates.SUCCESS)
{
    //Debug.Log("Woo Invert Ethics Success");
    DoAction("Action", "I was all about hurting now I find truth");
}

//Debug.Log("End Decisions");
}
```

Figure 4.2: Examples of the the Behaviour Tree Decisions being Implemented in C#.

4.2 Technologies and Development Tools

For the development of the game there are technologies and development tools needed. For the project development, design and testing it will follow an Agile Development approach. The platform being used to implement the game is Unity Game Engine (Unity, 2022). To design and augment graphics and animations, Blender (Blender, 2022), Quixel Bridge (Quixel, 2022) and Volvo Car Corporation assets will be used. To design and implement the AI in the game, Unity ML-Agent toolkit (Juliana et al, 2020) will be tested and considered as a possible resource. Finally, any sound or music assets for the game will be either self-made or collected and referenced from Volvo Car Corporation and any other free source platform.

4.3 User Experience and Testing

The tests will be held with a game which has AI agents which choose and alternate between the following parameters during gameplay:

1. Ethical behaviours
2. Non-Ethical behaviours

Participants will not know the extent of the ethical behaviours nor how the AI utilize them during play. Once complete they will be given a unique number, which can identify their data which can be removed upon their request. In this unique number an identifier will be given to indicate which version of the game they are playing. The Researcher will enter this data in when they start the prototype. The prototype will log this data and correctly start-up the correct version. To make sure the correct version is played, each version will log their version data at the initialization stage of the game in question. In looking at the results from participants play data, data can be divided into versions which were played. This data can be compared in order to evaluate the implications of integrating autonomous vehicle AI and ethical principles into a game environment.

The tests will be conducted using participants who are familiar with game research, those within the automotive company and participants who have no relation to the topic at hand. This is to keep a wide range of testers and see the differences of their play. There will be 4 test phases:

- Alpha Test 1: Test the functionality of the game and some ethical consequences
- Alpha Test 2: Test re-formulated game functionality and ethical consequences
- Beta Test: Test parameters of ethical decision-making and any bugs
- Release Test: Test for the implications of ethical artificial intelligence from autonomous vehicles.

4.4 Data Collection

The data collection will be handled by both qualitative and quantitative research methods and follow the structures of Game Research Methods by Lankoski and Björk (2015).

Qualitative research will be a part of the evaluation of ethical AI, which can be done through discussions with people involved with the AI as well as forming conclusions from research and the documentation. This section of the research will also be conducted for Alpha tests, and the Beta test in order to keep a modulated area of results which quantify quality over quantity. In order to maintain the reliability and validity of both the game and AI frameworks, Creswell strategies (Lankoski & Björk, 2015, pg. 27) will be used. The types of data collection methods that will be used are:

- Interviews
- Focus Groups
- Surveys (open ended)

Quantitative data will be part of the simulation data gathering. For example the cost of decisions from the AI, the effect this had on the player's gameplay data, and the parameters involved with ethical vs. non-ethical behaviours. This will provide a good basis for the evaluation criteria described in the next section. This section will also be a huge part of the Release test as it will have an unmodulated format in order to gather more conclusive data. The techniques involved are:

- Questionnaires
- Surveys
- Manipulation of AI Parameters

Based on the above approaches, Bhakti's (2014) Mock Case Studies will also be considered in order to pre-test different versions of the prototype game before conducting the actual tests.

4.5 Evaluation Criteria

The evaluation criteria should look like Figure 4.3 as it shows different criteria that each test group was tested on, in terms of proportional time for each model. In the case for this study, similar criteria will be created to evaluate the level of influence ethical AI had on the game and the testers. A conclusion and final discussion would use these criteria to form a discussion on its viability and what future players could experience using these frameworks and constructs.

Table 2: Proportion of time for each modelling topic

Proportion of time (%)	Group 1	Group 2	Group 3	Overall range	Willemain (1995) overall range
Context	9	14	29	9 - 14	2 - 27
Structure	44	52	32	32 - 52	30 - 79
Realisation	21	21	28	21 - 28	0 - 23
Assessment	12	7	5	5 - 12	4 - 27
Implementation	14	6	6	6 - 14	1 - 27

Figure 4.3: Bhakti's (2014, pg. 13) Table 2, Representing an example of an evaluation criteria.

The main difference between evaluating qualitative feedback and quantitative feedback is that qualitative feedback will involve interpretation of human emotions and direct human-human feedback. Quantitative feedback, on the other hand, involves directly interpreting data collected and human-to-computerised text feedback.

5

Planning

5.1 Time Plan

The following time plan represents the estimated key frames and how each phase of the study connected to the allotted time constraints.

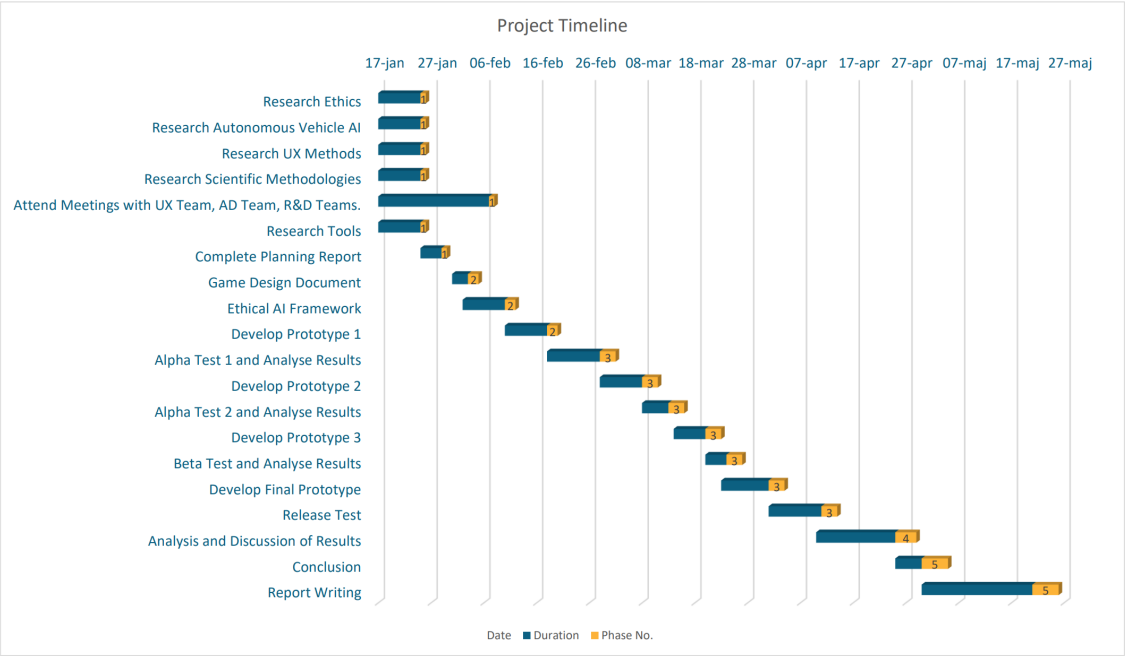


Figure 5.1: Gantt Chart Representation of Project Time Plan

Start Date	End Date	Milestone/Activity	Task Duratio	Phase No.
2022-01-17	2022-01-24	Research Ethics	8	1
2022-01-17	2022-01-24	Research Autonomous Vehicle AI	8	1
2022-01-17	2022-01-24	Research UX Methods	8	1
2022-01-17	2022-01-24	Research Scientific Methodologies	8	1
2022-01-17	2022-02-06	Attend Meetings with UX Team, AD Team, R&D Teams.	21	1
2022-01-17	2022-01-24	Research Tools	8	1
2022-01-25	2022-01-28	Complete Planning Report	4	1
2022-01-31	2022-02-02	Game Design Document	3	2
2022-02-02	2022-02-09	Ethical AI Framework	8	2
2022-02-10	2022-02-17	Develop Prototype 1	8	2
2022-02-18	2022-02-27	Alpha Test 1 and Analyse Results	10	3
2022-02-28	2022-03-07	Develop Prototype 2	8	3
2022-03-08	2022-03-12	Alpha Test 2 and Analyse Results	5	3
2022-03-14	2022-03-19	Develop Prototype 3	6	3
2022-03-20	2022-03-23	Beta Test and Analyse Results	4	3
2022-03-23	2022-03-31	Develop Final Prototype	9	3
2022-04-01	2022-04-10	Release Test	10	3
2022-04-10	2022-04-24	Analysis and Discussion of Results	15	4
2022-04-25	2022-04-29	Conclusion	5	5
2022-04-30	2022-05-20	Report Writing	21	5

Figure 5.2: Data Table for Gantt Chart Project Time Plan

5.2 Ethics Consideration

When conducting research and when developing ethical AI there are ethical considerations which should take place.

The most influential consideration is the ethical concept of bias. Barocas et al. (2019) explain that they would clarify bias in a more traditional sense. Bias happens when the expected or average results from statistics taken differ from the true value it is trying to predict or estimate. What they mean is that if a delivery is estimated too early consistently then there is a bias in the results. They classify bias as more statistical because in the general sense of the word it means different things for different people. Though this does not reject the usual approach, where the inconsistencies in results are based on societal factors, for example, wrongly picking out a person of colour in facial recognition software or even wrong hair colour and height. This brings up the justice or rather the injustice side effects of bias, Miller (2017) focuses on these different forms of justice. What they mean and who it applies to, in particular the discussion on comparative versus non-comparative justice. These types of justice focus on the principle of equality. Bias in a sense is the opposite of equality where, once pointed out, changes can be made to bring out positive change.

The two sides of bias have extraordinarily little potential to merge and interact with each other. An example of where they could have an emergence: An individual has been indicated to have red eyes, the algorithm finds their albino skin status, and the data was updated to the "government" records immediately instead of the usual process, every time without reason or cause. In this case, both types of bias resulted. In most cases, bias forms part of specific situations, whether it be through

programming, societal factors, statistical data or even recognition algorithms. For this study, bias from the researcher is highly possible. In order to rectify or explain any bias coincidences the study will use Creswell strategy, “Provide descriptions of the researchers’ background, interests, etc. to reveal potential biases to the readers, “(Lankoski & Björk, 2015, pg. 27).

Other considerations of bias to consider (Lankoski & Björk, 2015, pg. 5):

- Children: guardian consent, appropriate content, and country specific regulations.
- Risk evaluations: harm to participants, potential of faulty equipment etc.
- Anonymization of Data and Results: protection of participants both personal safety and sensitive personal data safety.
- Honesty: report results of study honestly and without manipulation.
- Credits: give credit and acknowledgements to all who are involved with the study.
- Consent Forms: appropriate step taking to interviews to ensure anonymity by in-depth precautions.

Based on research within the field of ethics and Bias, it is clear that it is impossible to avoid. However, by being aware of it the study will try to minimize as much of the bias as possible, through following the strategies listed above.

One other ethical implication of this game research is the prevention of certain actions in the game. For example, the player cannot physically "hurt" the AI agents in the game, but they can harm them emotionally. Chiles et al (2021) describes humans as being comprised of three main parts: Mind, Body and Soul. In most games they promote violence in the form of "Body". This game, on the other hand, does not promote physical violence instead it gives insight into the manipulation of the "Mind" and "Soul" in AI agents. The ethical impact of this constitutes to the ability to "hurt" or harm AI agents. Is it considered ethical to be able to "hurt" AI agents because they are non-sentient beings? How does this positively or negatively impact the players’ mental states? Banerjee (2020), Srinivasa and Deshmukh (2022), and Fuchs and Sudmann (2019) explain sentience vs. non-sentience and how consciousness borderlines into the "AI agents are a form of sentience". Whether or not a being has sentience, any unethical behaviours should be considered as unethical. With the impact on players, certain actions should be discussed on whether they can be acceptable to have or not. Within the context of this game it is acceptable for these actions to occur. The AI agents in this game prototype have the possibility to change their underlying ethical behaviours. This is in direct response to how the player has interacted with AI agents and the game world. Therefore certain behaviours should be accepted whether they impacted the player’s mental and emotional state or not. This game tests these parameters and offers implications to ethically driven decisions made by AI agents.

6
Execution and Process

This section details the steps taken towards developing this research project. In accordance with the planning report, this section is divided into eight process and execution sections. At each stage the thinking, planning and steps taken will be explained and explored.

6.1 Bias of Researcher

This section highlights the bias of the researcher in terms of conditions of upbringing the countries of birth and any sub interests of the researcher which may impact the bias nature of the project.

6.1.1 Personal Profile

Name: Natasha Bianca Mangan
Year of birth: 1997.
Identifying gender: Female.

6.1.2 Countries of upbringing

This section lays out the researchers place of birth, the places of upbringing and place of education.

Place of birth: Pretoria, South Africa.
Ages of stay: 0 - 5 years old.

Place of upbringing: Durban, South Africa.
Ages of stay: 5 - 17 years old.

Place of graduation of primary studies (high school): Stockholm, Sweden.
Ages of stay: 17 - 18.

Place of University studies: Sweden.
Ages of stay: 19 - current.

6.1.3 Religious upbringing

The researcher was brought up in a christian household, following the principles of Hillsong. These principles include:

- Truthfulness.
- Respect.
- Generosity.
- Modesty.
- Love for all people. "Treat thy neighbours as you yourself would like to be treated."

Current religious beliefs: None.

6.2 Meetings

As with any research project meetings with different teams and expertise are important. This section divides the meetings that were conducted throughout the project via the job title of the expert involved. Some meetings have been redacted in accordance with the contract stipulated by Volvo Cars Corporation, however the job position of the expert is still given credence.

6.2.1 Human-centric Mobility, Strategist, UX Design Principles

This strategist stated that an unmoderated questionnaire had the possibility to get two or three good answers while a moderated interview would provide more substantial data. This would also mean that focus groups could be selected and multiple smaller tests could be conducted throughout the project. By utilising smaller focus group tests, bias in the project by either participants or the researcher would be lessened. It would also hopefully result in a more interactive process and let the project evolve over time. Based on another suggestion the project executed a process of increasing the sample size in each type of test. Once the smaller tests were conducted a final conclusive test would be conducted that would be in a more automated and extensive format. Due to using evolutionary prototyping, early tests build and clean the project, providing a stronger basis for conclusive testing during the final test phases.

6.2.2 Technical Expert (Speech, Technology, and Interaction)

This meeting with the technical expert sparked interesting concepts to consider when introducing ethical concepts to gameplay. The most prominent afterthought from the meeting was the negative consequences and self-awareness of the AI. If the AI can receive negative feedback or consequences for their actions whether ethically or

non-ethically inclined, the player would have the chance to see these effects in a "live-action" field. This predicts a stronger reaction from the player due to the AI self-awareness and feedback loop. One other topic brought up during the conversation is the matter of dark vs. light ethics. In essence, would the "execution of children" be an appropriate choice of ethical dilemma to simulate in a game. The answer? For games, yes. Because games challenge the very nature of humanity, the boundaries of humane vs. inhumane actions, reality vs. fiction, the extension of possible vs. impossible domains of existence. For research, no not always. Because this project finds and challenges itself on conditioning ethics through AI, the ethical nature of "killing children" is not something to be taken lightly within this specific project. This means that any inhumane acts towards children, animals and any abusive behaviours like domestic violence will not be considered for this project. However, if the goal of this project were to challenge the player's ethics then these topics could and should be appropriate to use.

6.2.3 UX Strategy Data Analyst

This discussion on ethics as a whole brought up the topic of Maslow's hierarchy of needs. Although is not a necessary component to this research project, it sparked a valuable conversation on the concept of ethics under different circumstances and problem solving. This strategist also discussed the balancing act of nature. For example, in nature if there have been no predators for a long time, the grass and plants would decline due to herbivores being too great in number. By adding some predators to this environment eventually nature would balance out. The same effects would happen with removal of herbivores or plants. Each part of nature is essential in the balance of nature and economic systems. For ethical AI this is an important concept to consider when designing the core natures of the AI and how this would affect the environment in the game.

6.2.4 Zenseact Autonomous Driving AI

Redacted content.

6.2.5 Safety and AI, PhD studies

Redacted content.

6.2.6 Attribute leader, Autonomous Driving

Redacted content.

6.3 Game Design Document

In order to develop this game, a game design document was created, which can be found in Appendix A. This document outlines gameplay structures, features, aesthetics and any other necessary design decisions needed. The design document

created for this project functions as both an original design document as well as a concept document. The game itself is planned to be a Casual Game set in a forest environment. The player starts the game in a forest. They explore their surroundings and encounter other people going about their business, near a village. The player's goal is to learn the "rules of the forest", by interacting with villages and helping them. This teaches them the way of the village and how to become a full member of the community. In essence, after it was created any modification made during the iterative nature of this project are to be recorded in results and discussion section.

6.3.1 The Gameplay

Based on the design document outlined in Appendix A, the following summarizes the gameplay and design by using Björk's (2018) Gameplay Design patterns.

The game primarily focuses on Casual Gameplay which is played from the viewpoint of Third-Person Views. The player uses an Avatar to interact with the world. This avatars' purpose is to allow players to interact with the world, engage with the story and experience the world through this character. The game focuses on interactions through Agents, Algorithmic Agents, and Non-Player Characters. These AI characters play the role of villagers, both human and non-human alike. The primary objective is for the player to interact with these villagers through Dialogues, formed around both Narrative Structures and Predetermined Story Structures. The player has Freedom of Choice when interacting with these villagers, except when they are given Quests and Companion Quests based on their interactions. These story structures give Delayed Effects to the outcome of the game and any possible hidden story structure routes available in the game. As the player interacts with the villagers they Gain Information about the village that they are desperately trying to become a part of. The game relies on Game World Exploration and HUD Interfaces that display information to the player through both Diegetic and Non-Diegetic Communication that players will use to navigate the game world. The Positive and Negative Feedback Loops in the game are mostly hidden from the player, this is to keep the underlying structure of ethics manipulation as "clear cut" as possible. However, the player is given Player Aids in the form of feedback. This feedback relies on their inner thoughts and feelings for their current situation.

6.3.2 In Summary

The player uses their character to explore a forest environment and find a village. Their main goal is become apart of the village. To do this, the players interact and try to help the villagers. This in turn gives the player quests to complete, a short story to follow, and an overall score. This overall score is kept secret from the players and determines whether they will be let into the village at the end of the game.

To get a fuller picture of the gameplay please take a look at the following video: Ethical Gameplay Trailer, `https://youtu.be/NmqvChEDIos` (Mangan, 2022).

6.4 Ethical AI Framework

As previously outlined in the method section the AI created for the game are built on the following principles, based on research:

- Truthfulness.
- Self-awareness.
- Mix of Kantian and Utilitarian principles (Kantian Ethics, 2001 & Philosophy Basics).
- Principles from Volvo Car Corporations' autonomous vehicles.

The AI also use the following Code Framework:

- Behaviour Trees.
- A* Pathfinding.
- Finite State Machine.

6.4.1 Truthfulness

AI agents model their behaviour based on what they know to be true and not what they believe to be true. For example, a bird is a bird because it has feathers and can fly, and not a bird is a bird the belief is all flying creatures are birds, i.e., could be mechanically built plane and not a living breathing bird in this case.

6.4.2 Self-awareness and Consciousness

AI agents are aware of other AI and their actions, and make appropriate decisions based on their "alive" and "self-aware" states.

6.4.3 Kantian and Utilitarian principles

Kantian: Deontological moral theory, "If an action fulfils our duty, then we must abide to it." For example, "You shall not Lie" lying is always wrong and therefore does not fulfil our duty to adhere to a universal law. This means that even if lying would return a happier outcome, we must abide to the universal law and always tell the truth no matter the consequences.

Utilitarian: "If an action leads to a maximisation of happiness or pleasure then we abide to it." For example, "You shall not Lie" if lying ultimately leads to a greater amount of happiness amongst all individuals then we do so. This means that if lying about a person's looks (you think they are "ugly") leads to the whole family or friend group being happy then we do so. This also means that if an action leads

our misfortune or unhappiness while making everyone else happy then we should do it.

A single AI agent cannot hold both of the above principles therefore in designing AI profiles, a single agent or multiple agents should each hold one of these values. In section 6.5 shows the Introducer and Mercenary Profiles holding one of the above principles as a behavioural decision.

6.4.4 Belief-desire-Intention (BDI) system to human values

Belief: How the AI agent views the world. For example, if I believe potatoes are the gods and should be worshipped then everything I do and see will be based on this belief.
Desire: What goal the AI agent strives toward. For example, Since I believe potatoes are gods, I decide its my goal in life to become the head of agriculture in order to satisfy my desire to worship and be a part of the god's lives as well as gain a higher standing in the community.
Intention: The choice of actions the AI agent takes. For example, I study biology in order to learn plant behaviours to be able to understand and become part of how agriculture works.

6.4.5 Derived Human Behaviours and Values from Volvo Car Corporation Autonomous Vehicles

- Self-awareness coupled with the awareness and appreciation of others.
- Behave in a way that does not disturb or hinder others, a peaceful co-existence.
- Adjust behaviour to adhere to disturbances from others.
- Behaviour conditions to its environment.
- Avoid confrontations or avoid involving outside parties in confrontational affairs.
- Give behaviour control over to core behavioural value in unexpected situations.
- Discipline and truth.

See Appendix B for the list of Volvo Car Corporations Autonomous Vehicle Safety guidelines.

6.4.6 In Summary

On the basis of these fundamental pieces of the framework, the following techniques are being used:

- **Transitioning human values to computational forms** (Hibbard, 2015, in Wang, Wan & Wang, 2017). Change a human value like "protect children" into a playable computational decision within a decision tree matrix.
- **Game decision trees** (Conitzer et al, 2017; Chowdary, 2020). "If-else" branching decisions based on two extremes, non-ethical and ethical decisions.

- **Individual Ethical Decision Frameworks** (Yu et al, 2018;). Take approaches used on the Belief-Desire-Intention (BDI) system and model usable human values in the decision tree matrix.
- **Data-driven approach** (Rossi and Mattei, 2019). This principle constitutes designing the AI to only complete goals that are aligned with human values and thus become beneficial to humans. That are specifically tied to Ethical Examples and or Reinforcement Learning.
- **A* Pathfinding Framework** (Botea et al, 2013; Red Blob Games, 2014). Chart walkable destinations for AI to roam towards, within the shortest possible routes.
- **Finite State Machine Framework** (Champandard, 2016b). Change the behaviours of the AI between three states, "Walk" (roaming), "Interact" (player specific), and "Action" (decision tree based), see Figure 4.1.

6.5 AI Profiles and Assigned Behaviours

Under the below profiles the AI agents will follow an assigned core behaviour with selected extreme non-ethical to ethical decision patterns, as a value system. These decision patterns will be adjusted by an ethical parameter during gameplay. Each AI will have 4 Behaviours with 1 Core behaviour. Each AI profile has an certain probability when choosing a starting ethical behaviour, at the start of the game. The changes to the AI ethical parameter during play are a direct consequence to "Interactions" whether it be from player or AI, see Figure 4.1 in Section 4.1.3.1.

Please Note: Exceptions are made in the case of player needing to be introduced to game event systems.

6.5.1 Introducer

Core: introduce player to game, act as mediator.
Probability: Ethical (40%) : Unethical (60%).
Behaviours listed from extreme non-ethical to extreme ethical:

- Ignore everyone, cannot change their behaviour.
- Ignore certain types of people, i.e., age or race.
- Help change player behaviour toward diverse people.
- Utilitarian, mediate confrontations towards peace.

6.5.2 Chief

Core: Evaluate player worth and restore balance to the village community.
Probability: Ethical (50%) : Unethical (50%).
Behaviours listed from extreme non-ethical to extreme ethical:

- Destroy village community.

- Cause confrontations.
- Teach the ways of the village.
- Help with player quests.

6.5.3 Mercenary

Core: Soldier or protector.
Probability: Ethical (65%) : Unethical (35%).
Behaviours listed from extreme non-ethical to extreme ethical:

- Go up to people and attempt to punch them.
- Help confrontations continue.
- Stop confrontations.
- Kantian always tell the truth no matter the consequences.

6.5.4 Farmer

Core: Agriculture.
Probability: Ethical (25%) : Unethical (75%).
Behaviours listed from extreme non-ethical to extreme ethical:

- Poison forest or plants in village, even water.
- Create false truths about quest events.
- Create new plant grows in the village where needed.
- Uptight about ethical agriculture procedures.

6.5.5 Bystander

Core: Human types like aggressive, emotional, lone wolf, pack behaviour, sheep behaviour.
Probability: Ethical (60%) : Unethical (40%).
Behaviours listed from extreme non-ethical to extreme ethical:

- Trash the village.
- Refuse to obey village “code of conduct”.
- Help player with quest issues or anyone.
- Perform peaceful demonstrations to help alleviate confrontation or give the village support.

6.5.6 Bystander Non-Human

Core: Like Bystander except for pet behavioural patterns.
Probability: Ethical (50%) : Unethical (50%).
Behaviours listed from extreme non-ethical to extreme ethical:

- Steal from everyone
- Attack people of diverse natures

- Help mediate player to villager communication.
- Provide sustenance to those who need it.

To see how the above behaviours are implemented in code please see Figure 4.2.

6.5.7 Reasoning Behind Behaviours

For the AI, profiles are given to each. These profiles dictate their core beliefs and behaviours. For example an AI with the profile Introducer would have mediator as a core behaviour. Their main job is to introduce people and help alleviate tension and conflict. In contrast, an AI with profile of Farmer would have agriculture as a core behaviour: their main job is to look after the environment or nature. Each AI's core behaviour simply acts a core nature for a person. With ethics being introduced, these core behaviours become modified to suit the ethical nature being given. If a Farmer is being non-ethical, instead of looking after nature they would "destroy" or twist nature into something dark while if being ethical they would try find more environmentally friendly solutions to produce crops.

The main reasoning behind the above implementations was to keep up with the framework standards and focus on the derived human values from the data provided. The AI Profiles help filter out which principles make more sense and provide an environment where AI can exist within their own personalities. This in turn means that the AI follow a value based system which is based upon ethical principles. This is also results in the values given to the AI agents being of more moral reasoning, which is more often tied to western society than the non-western society where individual rights are of more importance.

In the next sections the development of the AI, the game and player attributes are explained and discussed, each divided into developments made for each iteration cycle, i.e., Alpha Test 1, Alpha Test 2 etc.

6.6 Alpha Test 1

6.6.1 Development Process

At the start of the development process the Unity Pro licence was acquired in order to start building the game and to make sure changes made would be uploaded to the server. Due to talks held about Unity ML Agents toolkit, the tool was explored and a meeting with the Unity team in charge of the toolkit was arranged. This meeting opened up questions about the Agent toolkit, how it works, and how to implement it. After the meeting, it was decided that although a very useful tool it would be more time consuming to adjust the behaviour on principle values such as computational ethics. In the future if a project would have more time for development the ML Agent toolkit would be a valuable tool to use and implement.

The next steps of the project took place in developing all the necessary core systems needed for a game like this:

Environment: Based on the game outline in Appendix A, forest environment models and terrain data were created. The environment was divided into two sections, a startup area deep in forest terrain and a village area where most of the AI would "hang out". Two sets of terrain data were used for each environment section. This enabled a fresh perspective and terrain upon which to build the environment needed for each section. The start or entrance of the village would be connected to the end of the forest terrain while the rest of the village would be in the village terrain. The design of the forest terrain was pre-made by an environmental asset from Unity's Asset Store. This asset is credited under the tools section. The forest terrain was then further adjusted and modified to suit the needs of the game. The village terrain started as a basic 4x4 plane and was entirely built up by the vision the researcher had for the village layout.

Game Manager: This manager is a singleton, which essentially means that only one game manager should exist in the game and it must be included in each level designed. This manager spawns the player in the game, at a saved point. It controls the game states of "play, pause, game over" and it keeps track of quests. When the player toggles pause in the game the "pause" state activates, the pause menu opens and then updates for each gameplay object would be paused. When the player has completed a certain amount of quests the "game over" state activates, the game over menu opens and pauses all update methods for every gameplay object. Finally, the "play" state is the main state of the game where the player and AI can perform actions.

Sound Manager: This manager is also a singleton, designed in a simpler way. All audio sources needed for the game are attached to this asset and called during runtime when they are needed.

Animation Controller: This controller is divided into a couple of controllers, each designed for a specific set of animated actions. For the player this means walk, sprint, jump, interact, and fall control. For humanoid AI it includes walk, jump, fall control, and action control. For non-humanoid AI it comprises of walk, jump, and gives action control for different effects.

Player Controller: This controller is attached to the player character model. It allows the player to move the character as specified in Appendix A.4.2 in the mechanics section.

AI Interface: This interface it attached to all AI character models and divided up into Two and a half parts, AI Movement, AI Decisions and Parameter Interface. The AI movement utilizes A* pathfinding designed to use terrain data and Unity's layer system to control obstacles or obstructions to AI walkable paths. The AI Decisions follow the Finite State Machine. This machine toggles movement, interaction and

actions exclusively. In movement state the AI use A* Pathfinding, in interaction the AI use the dialogue system and in actions the AI would use the behaviour tree matrix. For this test, the behaviour tree matrix is not implemented and just stands as an empty action state. The parameter interface is to be used by the behaviour tree matrix and therefore is implemented as coded method. However, this is not being used at this point in the iteration cycle.

Input Manager: This manager sets up the controls for the game and ties them to physical button presses. For example "walk" is given WASD or arrow key assignments from a keyboard connected to the computer which plays the game.

Dialog System: This system is a singleton. On activation it opens the dialog UI and inherits the dialog data from the player and AI agent currently interacting. Once the dialog is complete the AI agent will give data on possible quest activation. If the quest is to be activated then the quest system is accessed and the specified quest is activated.

Quest System: This system is a singleton. The system activates, hides available quests (while a quest is active), shows available quests, sets quests as completed and keeps the data on any possible quests that could be activated. This system keeps track of all AI in the game, quests are directly tied to them and therefore their reference is needed upon specific quest specifications. Each AI hold an indicator for possible quests, set in a diegetic gameplay sense. The quest system based on certain actions would toggle this indicator based on show/hide/completion of quests. The quest system also notifies the Game Manager when a quest has been completed. Quests are designed as in most games as Main vs. Side quests. For this iteration, all quests are mandatory and therefore considered Main quests. In future iterations if a side quest is activated, the player does not need to complete it in order for the "game over" state to activate.

Pause Menu: This menu is activated on game state "pause". The menu consists of three button options, Resume, Settings and Quit. Resume closes the pause menu and toggles the game into "play" state. Settings allows the player to adjust the audio presented in the game, just for this iteration cycle. Quit gives the player options for going to main menu or closing down the game entirely.

Main Menu: This menu is held on a different "level" data to the main game. The menu utilizes the pause menu code and is adjusted to three button options: Play, Settings and Quit. Play closes this "level" and opens the main game "level" with the game state "play" activated. Settings allows the player to adjust video and screen settings in the game. This means adjusted screen width and height and the quality level being rendered, i.e., 1080p vs. 620p. Quit closes down the game.

Game Over Menu: A simple menu that is activated on the game state "game over". This menu thanks the player for their participation as a playtester for this research project and has a button "exit game" which simply closes down the game once

pressed.

Recording Functionality: Most windows computers have a recording system already implemented known as "xbox game bar". This enables screenshots,and recording of screen with microphone options. Players are given instructions to activate the recording function when the game has started. The Xbox Game Bar (Microsoft Corporation, 2019) is a useful tool that once a game which is being recorded is closed, the recording stops and auto saves the video file to a folder of choice. The quality of the recording however, is lower than the main setting of 1080p for the game itself. This is not an issue since the recorded gameplay is simply used for result and analysis purposes.

Figure 6.1 are screenshots of the gameplay as per the Alpha Test 1 development process.

...

Figure 6.1: Gameplay screenshots of Alpha Test 1. This included all base mechanics of the gameplay.

6.6.2 Tools Implemented and Used

A* Pathfinding Project Pro (Granberg, 2021).

Real Landscapes Valley Forest (TriForge Assets, 2021).

Free Casual Game SFX Pack (Dustyroom, 2019).

Open Source Pause Menu (Zhu, 2017).

Outdoor Atmospheric Sound Effects Pack (2020).

Polygon Pirates Low Poly 3D Art (Synty Studios, 2020).

Simple Water Shader URP (IgniteCoders, 2021).

Sleek Essential UI Pack (F3jry, 2020).

Bark PBR Textures (PULSAR BYTES, 2021).

Third Person template Animations (Unity Technologies) and Mixamo (Adobe Mixamo, 2022) animations .

Microsoft Rocketbox Avatar Library (Gonzalez-Franco et al, 2020).

Paint3D

6.6.3 Test Execution

Participants were given a 1 hour time slot for playing the game and answering questions through in an interview.

All Participants were required to sign a consent form before beginning. Please see Appendix C for the consent form used.

Participants were given a set of printed instructions, detailing controls in the game. The recording setup instructions were given verbally to the player. Please see Appendix E.1, Controls Version 1.

Participants played the game while the researcher watched their reactions and took notes.

The gameplay was recorded. Afterwards the interview started and a voice recording was made. Please see Appendix D for the interview questions used for this test.

Based on player feedback any bugs which hindered the players ability to perform the playtest more efficiently, were taken into account and adjusted for the next par-

ticipant. Please Note: At least 2 people experiencing the bugs were required before any remedying actions took place.

Playtester's Data was then saved in a Folder structure on the Volvo One Drive Server, each named appropriately i.e., Alpha Test 1 -> P1 or Alpha Test 1 -> P4. Each participant folder contains the signed consent form, gameplay recording and interview recording. The notes from the tests are saved in the folder Alpha Test 1.

6.7 Alpha Test 2

The main difference between between this test and Alpha 1 are the ironed out bugs within the game and the addition of ethics as a value system in AI Agents. For the results of this test, it will be the starting inclination towards whether there are positive implications for implementing ethics into NPC AI Agents.

6.7.1 Development Process

Feedback: For the development of this next iteration test, some "bug" fixes were made and some PLAYER AIDS were added based on feedback.

Quests: Two more quests were added to the game both still under the Main Quest criteria.

Data Log Controller: Builds a json file and checks if exists, then creates the file if not. Each time the game is played a space is made in the file and a new heading of time and date is logged before any AI actions are logged. This time stamp is compared to the time stamp of the gameplay video file and saved with the appropriate playtester data folder.

AI Behaviour tree: The matrix was implemented using a simple decision tree which changes behaviour based on ethical parameter changes. Animations were meant to convey this behaviour as an actionable sequence. However, upon noticing difficulties with finding appropriate animations and to reduce time consumption, a system of "viewing inner thoughts" was implemented. This meant a thought bubble would appear above an AI's head and allow the player to read their core thought. For example, a Farmer named Alex is set to parameter 2, therefore is slightly non-ethical in nature. Their actions performed would set the animation to play "action" in animation controller, and toggle the thought bubble on. The text, "I love lying" reflected in the bubble. After a certain amount of time this thought bubble would disappear and this action taken would be logged in the Data Log file. If the player interrupted this thought, it would be logged in the Data Log file.

AI Parameter Change: Not changeable in this test iteration.

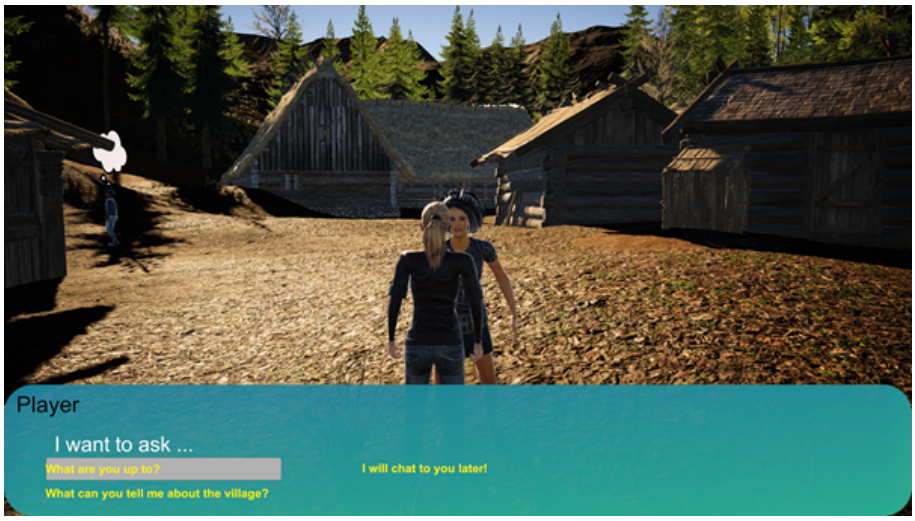


Figure 6.2: Gameplay screenshots of Alpha Test 2. Main Change was implementation of choices and AI behaviours with thought bubbles.

6.7.2 Tools Implemented and Used

Decision trees unity implementation (Barrera, Hardt & Narayanan, 2019).

Dog Golden Retriever (Red Deer, 2021).

Viking Village URP (Unity Technologies, 2021).

Villager Animations Free (Iglesias, 2021).

6.7.3 Test execution

The test was executed in the same manner as Alpha test 1, with the following modifications:

Participants were given a set of printed instructions, detailing controls in the game and the recording setup instructions. Please see Appendix E.2, Controls Version 1.2.

Data logs are sent to DataLogging.txt as appended text and are classified at start of play by game manager with date and time in order to separate playtesters results.

Playtester's Data was then saved in a Folder structure on the Volvo One Drive Server, each named appropriately i.e., Alpha Test 2 -> P1 or Alpha Test 2 -> P4. Each participant folder holds the signed consent form, gameplay recording, and interview recording. The notes and data log from the tests are saved in the folder Alpha Test 2.

6.8 Beta Test

The main difference between between this test and Alpha 2 are small bug fixes and the implementation of consequence ethics. For the results of this test, it will be the major inclination towards whether there are positive implications for implementing ethics into NPC AI Agents.

6.8.1 Development Process

Feedback: For the development of this next iteration test, some "bug" fixes were made and some PLAYER AIDS were added based on feedback. Any adjustments needed on already implemented PLAYER AIDS, such colour, size, texture were also made.

Quests: Quests can be removed from Main Quest data based on player interactions with the AI. A final quest event was implemented: in this event all AI would gather at a certain point in the village and an indicator would activate for the player to see. Once interacted with, a final dialogue opens and takes in the average of ethical natures from all of the AI. The fate of the player is determined on this average.

AI Parameter Change: Changes to ethical parameters are tied to quests and dialogue conversations with the player.

AI Decision Tree: The rest of the ethical parameters and ethical behaviours were implemented, with the exception of Bystander Non-human, see Appendix B.2.6.

Dialogue System: Complete overhaul of the previous implementation of the dialogue system. This time ink (inkle, 2021) was implemented which allows more freedom through variables in conversations and provides a more efficient platform for creating and editing dialogues.

Input System: Controls mapped for a Ps4 controller were added.

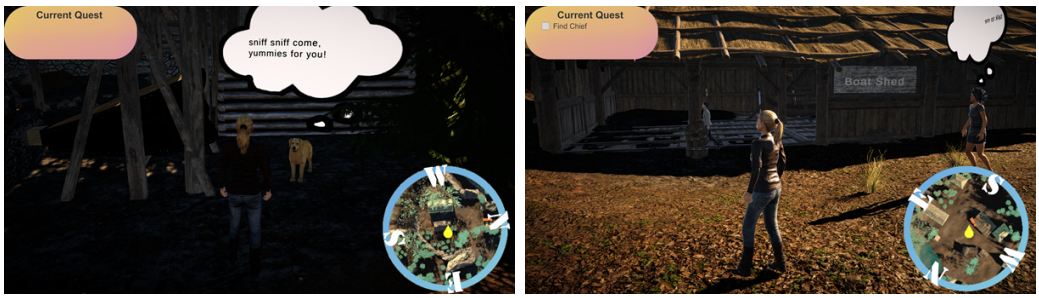


Figure 6.3: Gameplay screenshots of Beta Test. Main additions were UI quests, map layout and 1 non-human AI

6.8.2 Tools Implemented and Used

ink (inkle, 2021).

6.8.3 Test execution

The test was executed in the same manner as Alpha test 1, with the following modifications:

The test was conducted and divided between the Volvo and Chalmers Campus premises.

Participants were given a set of printed instructions, detailing controls in the game and the recording setup instructions. Please see Appendix E.3, Controls Version 2.

Data logs are sent to DataLogging.txt as appended text and are classified at the start of play by the game manager with date and time in order to separate playtesters results.

Playtester's Data was then saved in a Folder structure on the Volvo One Drive Server, each named appropriately i.e., Beta Test -> P1 or Beta Test -> P4. Each participant folder contains the signed consent form, gameplay recording, interview recording. The notes and data log from the tests are saved in the folder Beta Test.

6.9 Release Test

The main difference between between this test and the Beta are the final bug fixing and the small touches to make the game complete. For the results of this test, the bugs and small touches do not have a major distinction between the Beta implementation and this one. Therefore, results will indicate the final implications for implementing ethics into NPC AI Agents and how the enjoyment levels differentiate from the "normal" gameplay in the Alpha's. "Normal" gameplay means gameplay usually found in games currently on the market that full under similar categories to this game.

6.9.1 Development Process

Feedback: For the development of this next iteration test, some "bug" fixes were made and some PLAYER AIDS were added based on feedback.

Sound Effects: Sound based feedback were added to all interactions the player can perform during the game. For example, pressing the interact button and being unable to interact caused a negative based sound effect to play. While pressing the interact button and being able to interact caused a positive based sound effect to play.

Music: Adapted music was added to the Main Menu and Game Over scenes.

Game Over: This state was changed to be held on a different "level" data to the main game. The scene utilizes one button: Link to Questionnaire. Link to questionnaire closes the game and opens a new browser tab with the questionnaire to be answered.

AI Decision Tree: Bystander and Chief ethical decisions were slightly adapted to better suit the gameplay and the framework outlined in Section 6.5. One Bystander Non-human AI was implemented into the game.

AI: Two more AI were added to the game. Some AI only activate if the player found and activated a hidden quest. Some AI never activate based on player interactions with other AI. For example if the player chose not to find and play with "Rocky", that Bystander Non-human AI would never activate.

Quests: A Hidden quest was added, where specific interactions with AI would unlock them for the player.

Dialogue System: Dialogues were adjusted for each AI based on changed to quest and event system updates. This was not a major change the gameplay, and more of a personal preference.

Events: Props of the non-activated AI were added to the final event "meeting". The final event activation is now activated if the player decides they are ready to start this meeting. The chief AI was given the dialogue keys to open this quest upon player approval. Two environmental hidden events which were meant to be in this update of the game were removed. A game breaking bug the afternoon before test day 1, caused by Unity's build system, forced these events to be removed from the test due to lack of time available to fix them. See Appendix F "Release Compiled Results -> Bugs and Build Notes", for the full details.

Data logs: Before players could start playing the game, they were asked to type in a unique file name. This name was used to create separate data log files for each participant, named as follows: Datalog_"uniquefilename".txt.

To see the result of the gameplay please see the following video:
Ethical Gameplay Trailer, `https://youtu.be/NmqvChEDIos` (Mangan, 2022).

6.9.2 Tools Implemented and Used

URP Vertical Fog (LushkinR, 2021).

Premium Fantasy Music Pack 1 (CineTracks, 2018).

Enchanted World (Creature's Goodies, 2021).

Achievement SFX FREE (B.G.M, 2019).

6.9.3 Test execution

This test was an open to the public test, any willing participants could test the game.

Test day 1 and 2 were conducted on Volvo premises. Day 3 was conducted on Chalmers Campus premises. Chalmers participants were the only participants who had to sign up to a bookable time slot in order to participate.

Participants were given "free reign" over their time spent on the game. Participants from Chalmers Campus premises were given 1 hour to conduct the test, based upon bookable time slot constraints.

All Participants were required to sign a consent form before beginning. Please see Appendix C for the consent form used.

Participants used the printed control schemes from the Beta test.

Recorded gameplay was randomised between participants. Participants who chose PC 2 for their test, had their gameplay recorded while PC 1 testers were not recorded.

Once the gameplay reached its "Game Over" state, participants were directly linked to an online Questionnaire, created using Google Forms. See Appendix D, section "Release Test Questionnaire".

Data logs are sent to Datalog_"uniquenfilename".txt as appended text and are classified at start of play by the player. Two headings are automated at the start of each data log file:
Data log file for "uniquefilename":

"Current date and current time stamp":

Playtester's Data was saved in a Folder structure on the Volvo One Drive Server, each named appropriately i.e., Release Test -> P1 or Release Test -> P4. Each participant folder holds the signed consent form, gameplay recording (if recorded), Data log file and questionnaire answers. Summarized questionnaire answers were saved in the folder Release Test.

7

Results

This section outlines the results for each iterated test that was conducted throughout the research project.

Each test uses Evaluation Criteria using Bhakti's (2014) method, a bar chart as a summary of this criteria and a radar chart for AI ethical natures. Alpha test 1 is the only test without a radar chart since the AI ethics were not implemented during that iteration. The data is assessed out of a percentage of enjoyment.

The skill level of participants is valued as Novice, Beginner, Normal, Expert. Novice players have just started, played as young children only, or have never played. Beginner denotes they have played at least a little while over a few years. Normal denotes they play and have played for many years, but are not playing very often. Expert denotes the player plays often and has played many different games over the years.

Player Enjoyment was the main criteria assessed from the tests. This included their disappointments as well as their satisfactions. The goal of the thesis is to assess how players react to AI behaviours are their emotions behind their thoughts. If the game showed negative emotions then the research would show that players would not enjoy this kind of gameplay features within games under similar conditions.

For all the compiled documents of the results from the tests, please see Appendix F.

7.1 Alpha Test 1 Results

There were 5 participants in this test. In Table 7.1 the feedback from the players were evaluated by emotions and type of responses given. Each criteria was given a score between 0 to 10 percent. The negative marking system (Ndu et al, 2016) is used, where +-1 percent is adjusted for each answer or note of the participant. Each score is an evaluation of the criteria being a factor of game enjoyment. For example, we start with a score of 10 and if each comment and emotion displayed by this participant was negative then the final score given would be 0 percent for this criteria. 10 was used as the starting score because the interview answers approximate up to 10 for each criteria.

	P1	P2	P3	P4	P5	TOTALS	AVERAGES
Player Age	32	29	26	37	26	-	26-37
Player Game Skill	Expert	Normal	Expert	Beginner	Novice	-	-
Proportion of Enjoyment (%)							
Gameplay: Environment	5	7	9	9	7	37	7,4
Gameplay: Controls	6	8	9	9	4 - 9	36 – 41	7,8
Gameplay: Interactions	6	7	7	7	7	34	6,8
TOTAL						110/150	22/30

Table 7.1: Table representing Alpha Test 1 results.

In Figure 7.1, the bar chart shows the totals from each criteria in Table 7.1. The averaged enjoyment levels show that it is an almost even spread between all the criteria assessed from the game. The "Interactions" are slightly lower while the "Controls" attribute show a slightly higher level of enjoyment. The "Environment" attribute result lies in between the "Controls" and "Interactions" results.

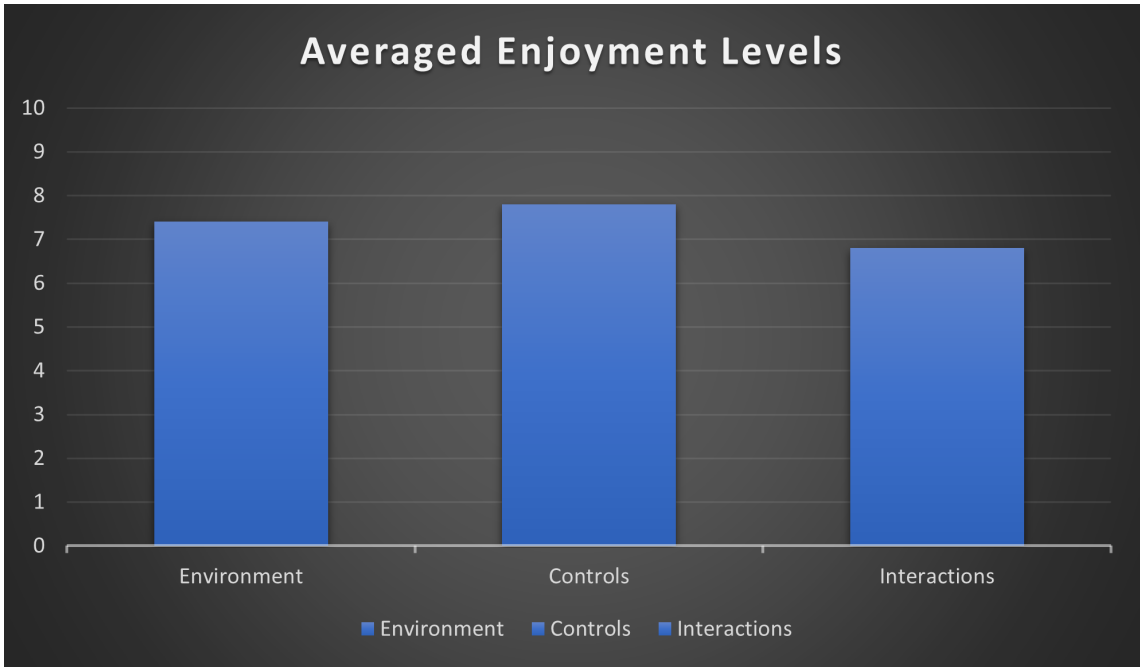


Figure 7.1: Bar Chart representing the averaged enjoyment levels for Alpha Test 1.

7.2 Alpha Test 2 Results

There were 5 participants in this test. In Table 7.2 it follows the same procedure as conducted for Alpha test 1, Table 7.1.

	P1	P2	P3	P4	P5	TOTALS	AVERAGES
Player Age	25	19	26	50	30	-	19-50
Player Game Skill	Normal	Normal	Expert	Novice	Beginner	-	-
Proportion of Enjoyment (%)							
Gameplay: Environment	8	10	9	8	8	43	8,6
Gameplay: Controls	8	8	9	7	9	41	8,2
Gameplay: Interactions	6	5	7	7	7	32	6,4
TOTAL						116/150	23,2/30

Table 7.2: Table representing Alpha Test 2 results.

Figure 7.2 shows that the interaction enjoyment was slightly lower and slightly higher in the environment criteria. These values are still within 10 points of each other. Therefore, this still evaluates to an almost even spread of enjoyment across the criteria.

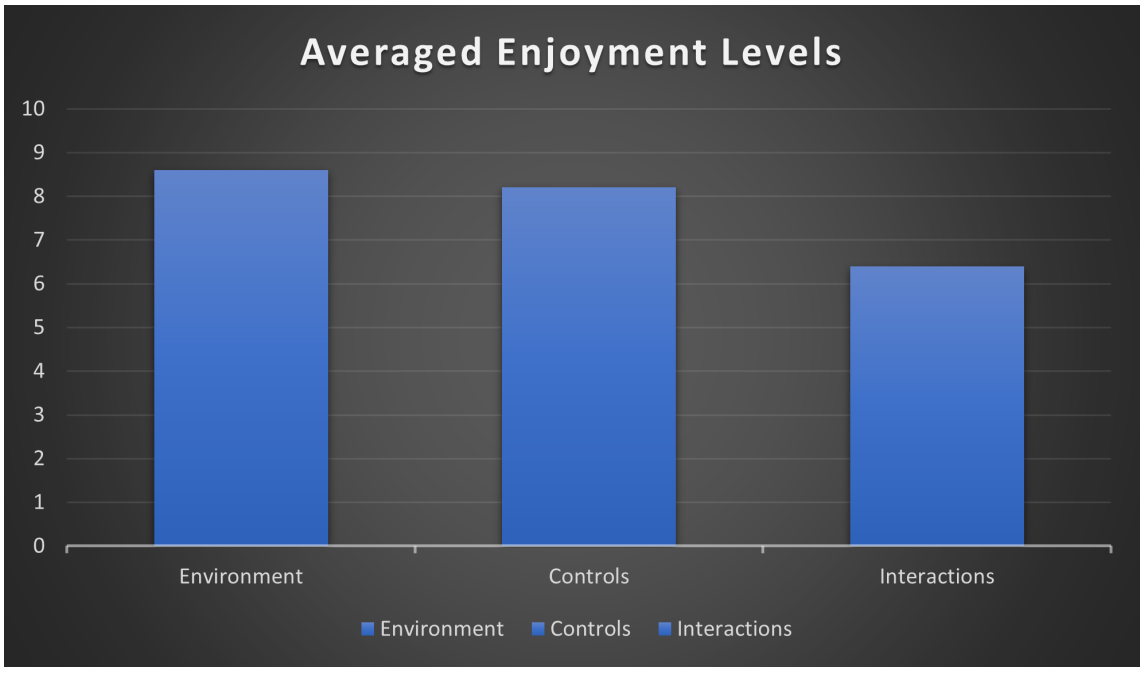


Figure 7.2: Bar Chart representing the total valued enjoyment for Alpha Test 2.

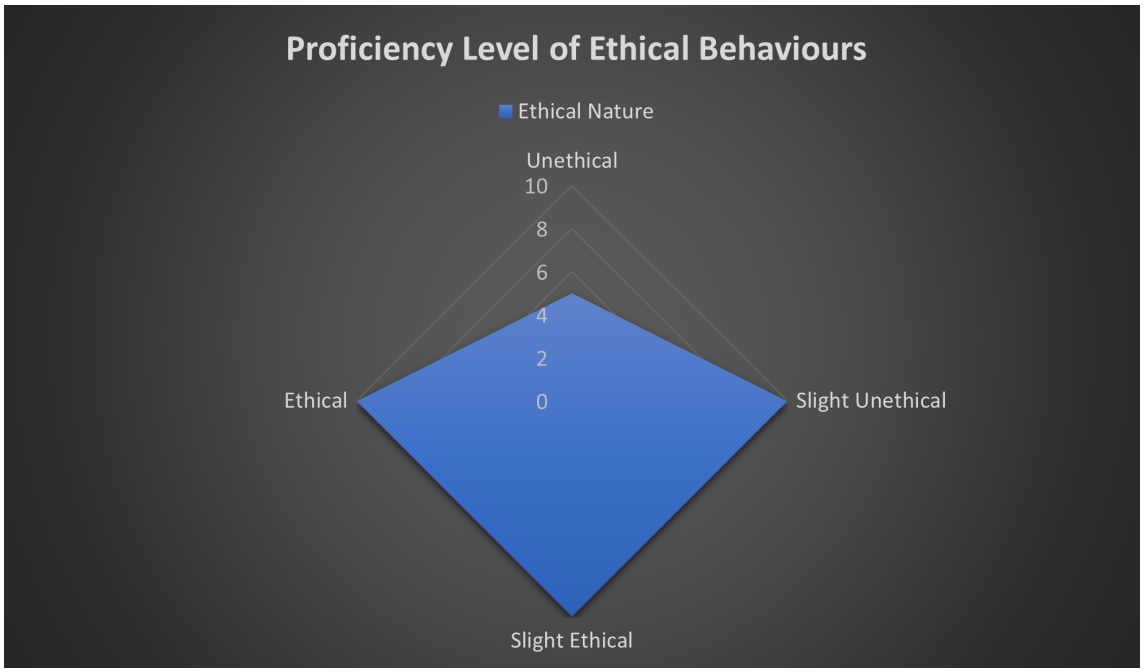


Figure 7.3: Radar Chart representing the proficiency of ethical natures presented in Alpha Test 2.

In Figure 7.3 all the actions of the AI are evaluated into a radar chart. In this test the AI behaviour could not be adjusted by the player through their interactions. It shows that the AI decisions were evenly spread between slight unethical, slight ethical and ethical decisions being taken. Unethical decisions by the AI were the least taken.

7.3 Beta Test Results

There were 6 participants in this test. In Table 7.3 it follows the same procedure as conducted for Alpha test 1, Table 7.1. However a fourth criteria was added to the gameplay results: Final Event Outcome.

	P1	P2	P3	P4	P5	P6	TOTALS	AVERAGES
Player Age	26	27	33	29	50	27	-	26-50
Player Game Skill	Novice	Normal	Normal	Beginner	Novice	Expert	-	-
Proportion of Enjoyment (%)								
Gameplay: Environment	10	9	7	8	9	9	52	8,7
Gameplay: Controls	8	8	7	7	9	9	48	8
Gameplay: Interactions	7	8	6	8	9	7	45	7,5
Gameplay: Final Event Outcome	8	5	7	7	8	7	38	6,3
TOTAL							183/240	30,5/40

Table 7.3: Table representing the Beta Test results.

Figure 7.4 shows that the interaction, controls and environment criteria are weighted almost evenly. Final event outcome criteria is within 8 percent difference of the highest rated enjoyment of criteria. These values show that the final event outcome is still highly valued amongst the criteria. However, there is still some adjustments needed.

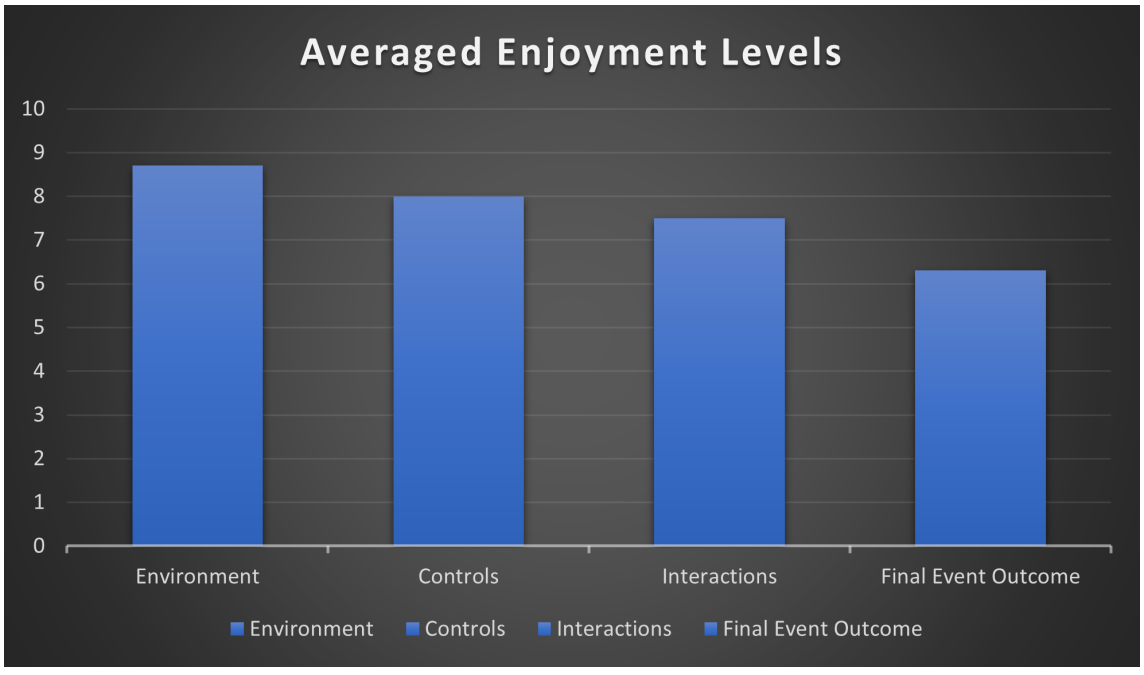


Figure 7.4: Bar Chart representing the total valued enjoyment for the Beta Test.

In Figure 7.5 all the actions of the AI are evaluated in a radar chart. In this test the AI behaviours are modified through their interactions with the player and their own solo decisions. It shows that the AI decisions were almost evenly spread between slight unethical, slight ethical and ethical decisions being taken. Unethical decisions by the AI were the least taken and slightly unethical decisions were on the decline.

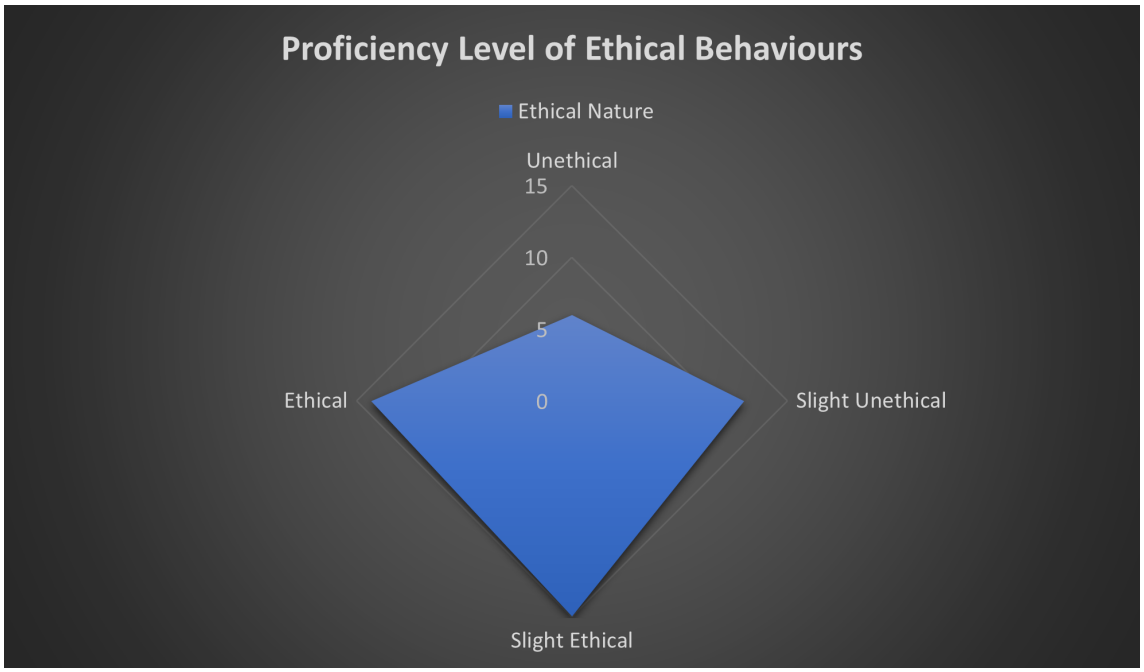


Figure 7.5: Radar Chart representing the proficiency of ethical natures presented in the Beta Test.

7.4 Release Test Results

There were 13 participants for this test. In Figure 7.6 an attribute rating system of 1 - 5 was used for each criteria. For answers provided within summarised bar charts, see Appendix F a voting system was used. For "yes" or "no" pie chart results, then 2 votes for the larger half of the pie chart and 1 vote for the lower half of the pie chart. "Maybe" results on pie charts were counted as half votes to "yes" portion if positive and if negative then half votes to "no" portion. The votes are added to the 1 and 5 scales, 1 representing negative responses, 5 representing positive responses. For example, “Did you find the map useful for navigation”, yes was larger than no, therefore 2 votes for yes, and 1 vote for no. The 1 vote will be given to 1 on scale and the 2 votes to the 5 on the scale for environment criteria. If a pie chart is an even split, then 1 vote is added to both 1 and 5 on the scale. Any data from the questionnaire unsuitable for the attribute rating are detailed in Table 7.4.

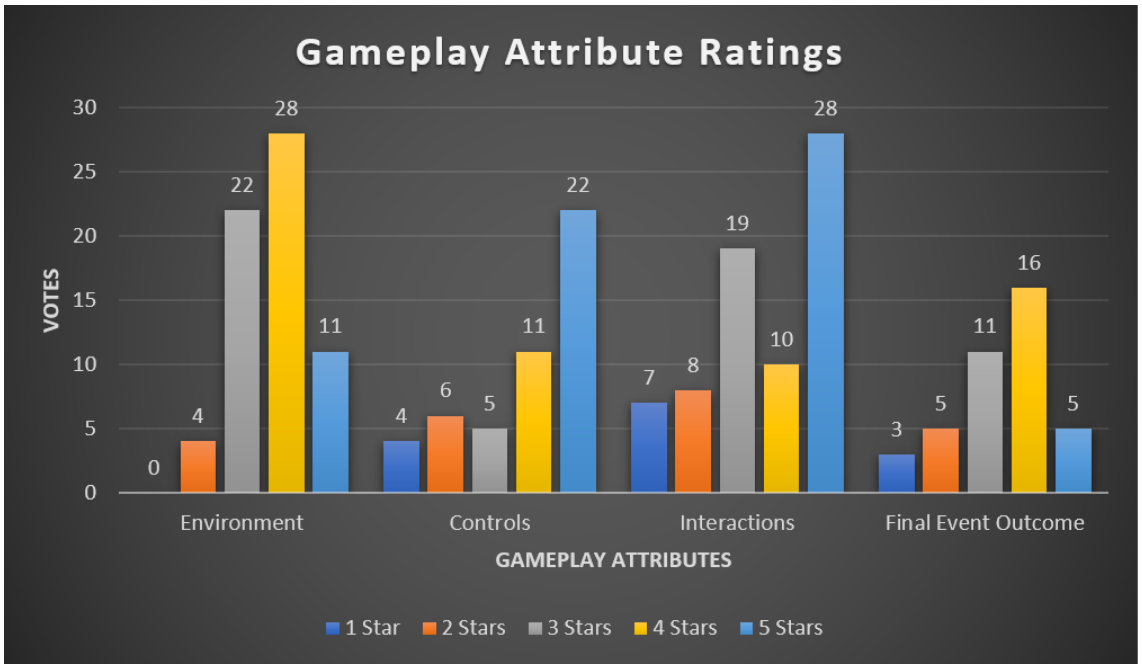


Figure 7.6: Rating chart displaying each attributed votes within the scale of 1 - 5, 5 is the best rating.

Figure 7.7 shows the total value enjoyment of the release test. In each other test a pie chart was used to show this information however, for this test the bar graph was more suitable. The chart shows an almost even rating of each gameplay criteria. The lowest rated is the final event outcome, the highest rated is the controls. This charts' values are between 0 - 10, the same as in Tables 7.1 - 7.3.

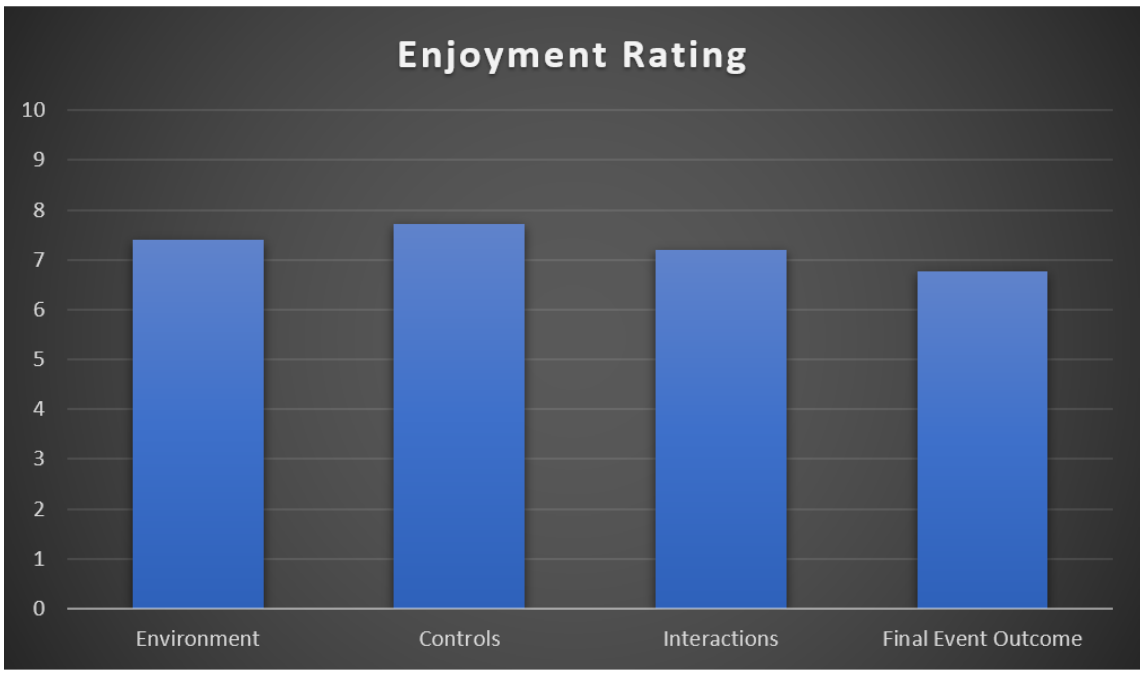


Figure 7.7: Bar chart showing the total valued enjoyment for the Release Test.

In Figure 7.8 all the actions of the AI are evaluated into a radar chart. In this test the AI behaviours are modified through their interactions with the player and their own solo decisions. It shows that the AI decisions were more inclined toward slightly ethical and ethical decisions. Unethical and slight unethical decisions were valued evenly and were the least taken by the AI.

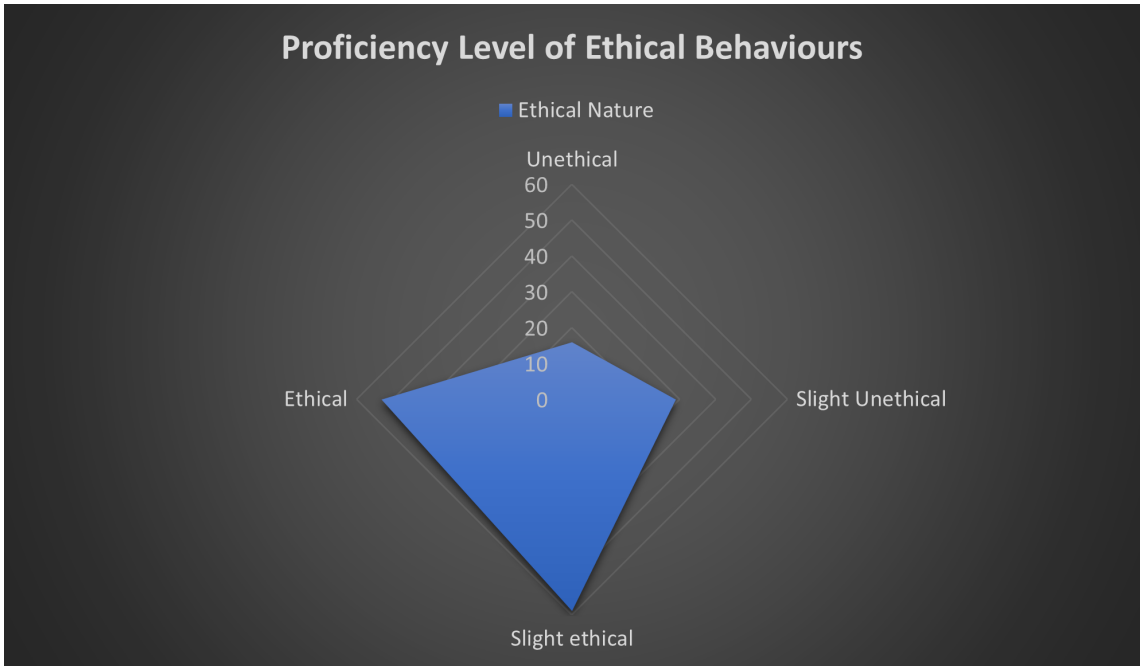


Figure 7.8: Radar Chart representing the proficiency of ethical natures presented in the Release Test.

7.4.1 Other Results

Table 7.4 highlights the data collected which could not be entered into the attribute voting in Figure 7.6.

Results Removed from Attribute Voting		
Content	**Result**	**Comment**
Player Game Skills		
Novice	7,7%	Most participants felt that their total gaming experience fell under the Normal evaluation.
Beginner	7,7%	
Normal	69,2%	
Expert	15,4%	
Gameplay: Environment		
Explored World	53,8%	Most were focused on interacting with AI and quest completion.
Gameplay: Controls		
Toggled the UI	46,2%	Most users felt it unnecessary to turn off the UI, felt natural to have on.
Wanted control over filtering map content	15,4%	Most participants did not want to change any map content.
Primarily used Controller	38,5%	Most players used the keyboard to play the game, while a small few preferred controller mapping.
Gameplay: Interactions		
Found Fish (Alive)	7,7%	1 participant out of 13 was more attentive while playing. Observing and exploring the environment more thoroughly.
Read Thought Bubbles	76,9%	10 participants read the bubbles, 1 participant answered maybe, 2 answered no.
Felt they Missed Quests	76,9%	Most participants felt they missed quests due to how they interacted, their result (being let in the village), they were too quick to play.
Want to do more	84,6%	Most participants wanted to do more in the game. Different transport options, more quests, able to go inside houses, and find out what happened to the village.
Correctly chosen villager names	61,5%	Only 5 answers were guessed incorrectly on names used for the villagers. John, Alex, Chief, and Rocky were the highest guessed names with 61,5%, 46,2%, 84,6%, 46,2% votes respectively. (Note: votes were added to the attribute scores for this content, since all names were at least guessed once, with low incorrect guesses made).
Game as a Whole		
Most selected time spent playing	10 – 15 min (38,5%)	15.4% of participants played for more than 20 min. Upon evaluation of gameplay recorded videos, the average play time was 10 -15 minutes, for participants who were recorded.
Participants whose gameplay was recorded.	76,9%	A random seed of participants was selected to not be recorded while playing.
Would play or try this game if sold commercially	53,9%	15,3% of participants stated that they play other kinds of games so they would not play it, or that they do not often play games. 30,8% participants would not play this game if sold commercially.

Table 7.4: Table showing the rest of the important data collected during the Release Test.

7.5 Summary Results

Figures 7.9 and 7.10 display the summarised comparison between all tests conducted within this study.

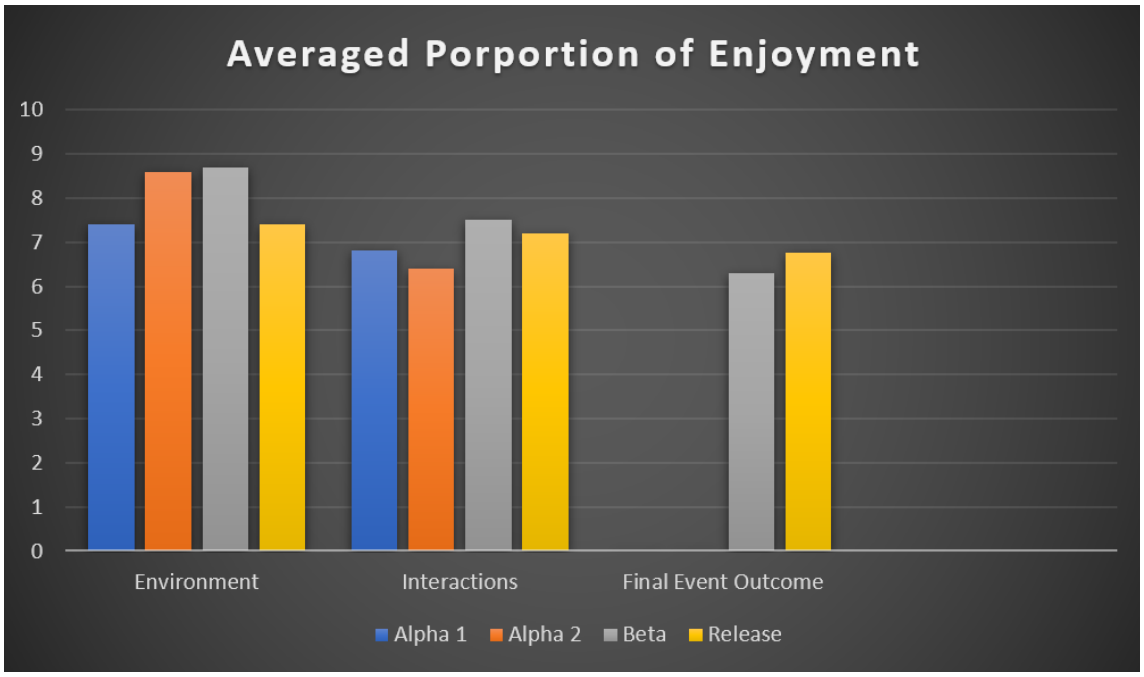


Figure 7.9: Bar graph showing the AI comprised criteria comparison between all tests of this project.

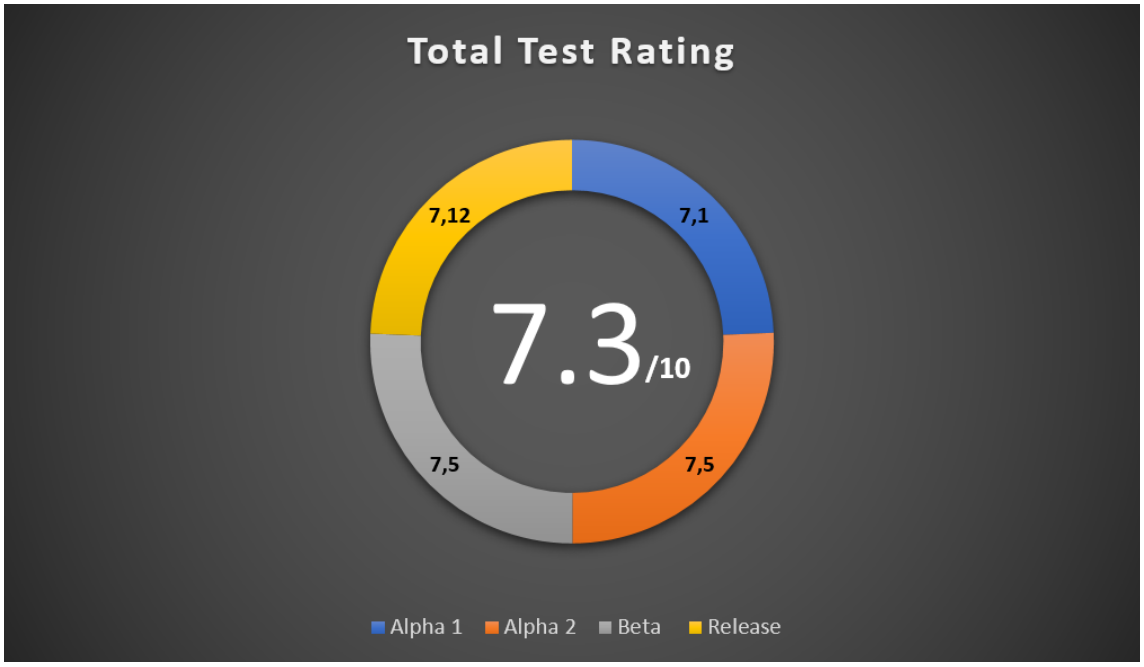


Figure 7.10: Rating system showing the total rating of the prototype game during individual tests and sums them up into an overall game enjoyment rating.

In Figure 7.9 the "Environment" and "Interactions" attributes were lower than the Beta test results. The "Final Event Outcome" attribute was higher than the previous test conducted.

In Figure 7.10 it shows that the Alpha 2 and Beta ratings are the highest. While Alpha 1 and Release test had the lowest rating.

7.6 Discussion of Test Results

A total of 29 participants tested and evaluated this projects' prototype game. The chapter is divided into five sections: Alpha 1, Alpha 2, Beta, Release and Summary test result discussions. Each section aims to discuss a) what the results mean, b) how they relate to the literature, and c) how it answers the research question posed at the beginning of the research: *What are some of the gameplay implications of integrating ethical and autonomous vehicle AI principles into a game environment?*

7.6.1 Alpha 1

The primary focus of this test was testing the core mechanical and environmental gameplay with the exclusion of AI ethical behaviours. The goal was to design a world in which players were satisfied with only the basic gameplay features to interact with. This opens the doors for the prototype gameplay to be built upon a good foundation.

Table 7.1 shows that the participants ranged from Novice to Expert levels of game skills, with slightly more expert players in the mix. In analysing this role of the player and how they could approach the gameplay, the results show the game was equally received between four players. A1P1 the "Expert" player had experience in creating similar styled simulations which showed a more thorough approach in analysing the current gameplay, and felt that the game was lacking in some areas, i.e., like graphics and shadow aliasing. A1P3 and A1P4 from this test were on opposite sides of the spectrum in how they approach games, their experience in the area, and the types of games they enjoy. However, these two participants showed equal levels of enjoyment between all attributes of this test. With this in mind the current gameplay shows potential for any "expertise" level player to pick up this game and be able to play it with almost equal levels of enjoyment. Table 7.2 also shows that the ages of the participants are in line with the Target audience in appendix A.

Figure 7.1 shows the almost even spread level of enjoyment across all three attributes. The attribute with the least level of enjoyment is "Interactions". Interactions is solely based on the player interacting with AI characters in this world. Because their core behaviours were not implemented yet, the AI behaved as any ordinary NPC's that are used in current games on the market. This means NPC's who were not involved in quests simply walked around and could not be interacted with. NPC's who were quest related could not be interacted with again once their quest was given, and their responses were simple instructions to the player. However since these types

of NPC's are well known or common in the gaming world most of the players had highly rated thoughts and emotions on their interactions with these NPC's. These kinds of reactions are to be expected due to their commonality in games.

The gameplay at this point in the testing interaction followed the following research:

For the design and implementation of mechanics, dynamics and aesthetics, Hunicke et al. (2004) and Björk, Lundgren and Holopainen (2003) provided the means of creating the base of the gameplay.

For the design of UI implements, Spence's (2014) visualisation techniques were incorporated. These techniques involved placements of UI elements, sizes and colour schemes appropriate for the gameplay. This meant prioritising more important information within a good visual cue and range for the player based on the screen parameters.

For the design of feedback elements as well as important information, Ware's (2013) involvement of appropriate use of symbols were critical. In designing the indicators for NPC's which held quest information, scroll symbols were used. This usage of scrolls is generally associated with quests or highly important information. Ware (2013) provided the core understanding of symbols and semiotic tools needed for relations between players and gameplay.

For the design of the AI, Botea et al. (2013) and Red Blob Games (2014) provided the AI with walkable destinations based on the terrain data of the game world. Champandard (2016b) provided the foundation for the NPC actions they took: "Walk" (roaming) and "Interact" (player specific).

At this point of the testing the research question could not be answered.

Evaluation: With some alterations and fixes to the gameplay, this build of the game provided a good structure and foundation to build the necessary features to be tested in the prototype.

7.6.2 Alpha 2

The primary focus of this test was to test the modified gameplay features, as well as test the incorporated core AI behaviours. The goal was to design the AI in a way that showed that their behaviours were unique to their own personalities and factor in the "right" kind of ethical behaviours which were appropriate for this game.

Table 7.2 shows that the participants ranged from Novice to Expert levels of game skills, with slightly more Normal players in the mix. In analysing this role of the player and how they could approach the gameplay, the results show the game was fairly evenly received by the players. A2P1 and A2P2 had slightly lower reactions to their interactions with the NPC's. A2P2 also stood out in the evaluation of the

attribute "Environment". Their emotions and feedback resulted in a perfect score, 10 out of 10. Even A2P3 showed an almost perfect score even though their expertise differed from A2P2. The lowest proportion of enjoyment amongst the participants scores was the 5 by A2P2 under "Interactions". In comparison with Alpha 1 results in under the "Interaction" attribute, the result was more or less the same, with A2P1 and A2P2 variants. This suggests that the inclusion of core ethical behaviours amongst the NPC's were relatively well received. By having the AI "wear their hearts on their sleeves" i.e., reveal their core thoughts to the player, this created a dynamic way of revealing the story of the village. This test also revealed that the foundation from Alpha 1 still stood strong for Alpha 2 and it is expected for players of any expertise to be able to enjoy the game at almost equal levels.

Table 7.2 also shows the ages of the participants are in line with the Target audience in appendix A.

Figure 7.2 shows the almost evenly spread level of enjoyment across all three attributes, even with some slightly lower and slightly higher attributes. The lowest evaluated attribute is "Interactions", which is in line with Alpha 1 results. Despite the extension of ethical behaviours in the NPC's, the players' interactions could not influence the behaviours of the AI. The AI solely behaved on their own principles. The interactions still followed similar principles to AI in current gameplay with the difference in core belief systems of the NPC's. In comparison to Alpha 1, one participant felt more strongly that the interaction between the NPC and themselves lacked some enjoyment. A2P1 and A2P2, with the lowest scores, had "Normal" expertise in gaming. All other participants had even scores and their expertise differed from each other. This means the participants with "Normal" expertise caused the "Interactions" attribute in the pie chart to be lower than the other attributes. There is something missing in the game from how players with "Normal" expertise expect the gameplay to feel.

Figure 7.3 shows the quantitative data collected from the NPC's decision making processes. The AI were programmed with their core belief system, incorporating ethical principles and autonomous driving principles into a unique personality trait. Based on the AI profiles, outlined in appendix 6.5, the ethical, slightly ethical and slightly unethical traits were evenly chosen by NPC's. This shows that even without player involvement the AI were more inclined to not take unethical decisions.

The gameplay at this point in the testing interaction followed the same research as in Alpha 1 with the exception of the following:

For the design of the AI, Champandard (2016b) provided the foundation for the NPC behaviour actions they took: "Walk" (roaming), "Interact" (player specific) and "Action" (decision tree based).

For the design of decisions for AI, Conitzer et al. (2017), Rossi and Mattei (2019) and Chowdary (2020) created the base used for implementing the now computa-

tional form of the principles.

For designing the ethical and autonomous driving principles into NPC behaviours, Hibbard (2015) in Wang, Wan and Wang (2017) provided the means to extract computational forms of the principles. This also provided the means to decide on which principles to incorporate with this type of game.

For designing the personality profiles of the AI, Yu et al. (2018) provided the means and base for placing the correct type of principle to belong to a particular personality trait.

In terms of the research question posed, one important experimental implication was found from this test: AI created whether from ordinary gameplay cores or ethical gameplay cores, without changing the interaction steps, showed an almost even result of enjoyment in players.

Evaluation: The NPC core ethical natures are stable. This means that the next iteration can move forward with implementing player influences to AI behaviours.

7.6.3 Beta

The primary focus of this test was to test the modified gameplay features, as well as test the now modifiable AI behaviours. The goal was to implement varying gameplay and NPC decisions based on player interactions and behaviours, which would affect the final outcome for the gameplay.

Table 7.3 shows that the participants ranged from Novice to Expert levels of game skills, with slightly more Normal players in the mix. In analysing this role of the player and how they could approach the gameplay, the results show the game was fairly evenly received by the players, with three outlier results. The first outlier is BP2 with a score of 5 under the "Final Event Outcome" attribute, with others ranging from 7 upwards. The second outlier is BP3 with a score of 6 under the "Interactions" attribute with others ranging from 7 upwards. The third outlier is BP1 who scored a perfect 10 under the "Environment" attribute, the others ranged from 7 to 9. The second and third outliers are evaluated as slightly out of the ordinary while the first outlier showed a more significant impact to the results. All outliers are from participants under "Normal" expertise. BP1 had high ratings across the four attributes with more emphasis on the impact the environment had on them. BP2 had high ratings across three of the attributes, the fourth being the outlier rating. BP3 had even ratings between three attributes with the third being the outlier rating. These results show the individuality of each "Normal" expertise participant. None of the outliers fall on the same attribute. In comparison with Alpha 2 results the ratings were much higher in each category. With the exception of outliers the "Normal" expertise participants are now on even terms with the rest of the participant expertise levels. The "Interactions" attribute showed a greater increase of player enjoyment than previously found in both Alpha tests. This suggests that

ethical gameplay had a greater influence on player enjoyment.

Figure 7.4 shows the almost even spread level of enjoyment across all three attributes, with one slightly lower than the other attributes. The "Environment" and "Final Event Outcomes" attributes stand out amongst the attributes. The players show that their effect on the "final event outcome" was not as well received. However, "Interactions" are at an all time high between AI and the players. The "Environment" attribute showed that players were more affected by its design and the AI's involvement in it.

Figure 7.5 shows the quantitative data collected from the NPC's decision making processes. With the alterations made to AI behaviours and the players' influence on them, this caused the AI to turn toward more ethical and slightly ethical behaviours. This means that players in this test were likely more kind, helpful, and tried to work in collaboration with the AI instead of against them.

The gameplay at this point in the testing interaction followed the research as outlined in Alpha 1 and 2. Any alterations with gameplay and impact from the research were done in accordance with the previously mentioned research.

In terms of the research question posed, one important experimental implication was found from this test: AI when actively influenced by player decisions, without players knowing, causes a far greater positive reaction in the enjoyment levels of the game.

Evaluation: The NPC core beliefs and gameplay are well structured however modifications are still needed. Hidden quests can now be incorporated as rewards and consequences to player and AI decision making. This version of the game is now a good foundation for the addition and modification of final features for the prototype.

7.6.4 Release

The primary focus of this test was to test for concluding implications of designing a game utilizing autonomous vehicle and ethical principles. The goal was to evaluate the final test under a harsher evaluation criteria and points system. This was to find a more conclusive result for the prototype game.

Figure 7.6 shows the total votes distributed between rating of 1 star to 5 stars for each gameplay attribute. The "Environment" attribute shows that there are far more votes placed under the 4 Star rating. There were also quite a few votes placed on the 3 Star rating. This means that although there are above 10 votes on the 5 Star rating (best rating), most players felt good about the environment and how they navigated through it. The "Controls" attribute shows a significant amount of votes were placed in the 5 Star rating. This means with adjusts and modifications the controls were well received by the players in terms of look, feel, intuitiveness and overall control. The "Interactions" attribute also had a significant amount of votes

under 5 Stars. However, there were quite a few votes under "Normal" rating for interactions with and surrounding the AI. This means although interactions were very positive, some players had a "Normal" reaction to it. Meaning that although they enjoyed the interactions they did not feel too strongly in either direction, i.e. most negative or most positive. The "Final Event Outcome" attribute shows high voting under the 4 Star rating. Most of the votes in the attribute were under "Normal" and positive enjoyment levels.

Figure 7.7 shows what the votes under the "5 Star voting system" are evaluated to, i.e., calculating the average result under each attribute and displaying it under the same conditions as the previous tests. The results show an almost even distribution of enjoyment between all attributes. The "Final Event Outcome" rated slightly lower than the others. In comparison to previous tests the "Environment" attribute was more well received while in this test the "Controls" stood out amongst the attributes. This means that with the fix or modification to the controls, players had a more even spread of enjoyment.

Figure 7.8 shows the quantitative data collected from the NPC's decision making processes. The AI took slightly less ethical and more slightly ethical decisions in the game. This means gameplay between the participants varied more in terms of some going more kind routes while others chose to stick with more rude options of playing the game. There were significantly more AI in this version of the game. Not all AI had a chance to make ethical decisions, some AI were only activated upon revealing hidden quests. The effect this had was giving players more varied gameplay and provided more branching routes for players to enjoy or not enjoy.

Table 7.4 displays all the results which could not be added to the results outlined above. As with Alpha 2 and Beta test, there were more participants with "Normal" expertise in gaming. The players had more focus in interacting with AI, causing them to not explore the environment as much. This means that they valued their interactions far more than previous tests. Under controls the players felt that the UI fit with the game as well as the content displayed to them. Under interactions the players enjoyment was hugely impacted by the AI. It also showed that players had an easier time remembering the villagers of this game. In other games this is not the case and more often than not any NPC's who are not on the "main characters roster" are often forgotten. This is a very positive outcome for this game prototype as the NPC's had a lasting influence on the players. Under the game as a whole the participants results were evenly spread whether they had their gameplay recorded or not. For a short game prototype which can easily be completed in under 5 minutes, most players played between 10 - 20 minutes. This means players spent more time playing the game, keeping more of their attention. Players were also asked if they would play this game if it were "taken further" and sold commercially. Most testers wanted to play it. There were some testers however who did not understand the wording, and thought that the game would be sold "as is" commercially. The question was meant to mean "if it was developed more, then sold". However, since most players voted "yes" it means that whether they understood the question correctly or

not, they wanted to play the game again, "in their own home".

The gameplay at this point in the testing interaction followed the research as outlined in the Beta test.

In terms of the research question posed, important experimental implications found in this test are:

- AI and gameplay designed in an ethical and autonomous vehicle principle context create more varied gameplay.
- Players who experience this kind of play show high levels of enjoyment.
- The idea of a commercial game holding this kind of gameplay is a good market choice and decision for the future.

Evaluation: The game when evaluated purely on the harsh rating system still stands quite highly enjoyed and rated. However, with the addition of how valuable the "other results" were, this game has a much higher rating of enjoyment than is currently being shown. The Release version was more highly rated and valued than the other tests that were conducted.

7.6.5 Summary Results

This section explains the final summarised results of the prototype game.

Figure 7.9 shows all the ratings of the tests in each attribute in pure relation to the Human-AI interactions. In the "Environment" attribute each test showed an increase in rating, however the release saw a decrease in rating. As found out in the "other results" this was due to players being more absorbed in the interactions with the NPC's, with a small percentage as the consequences of AI decisions. In the "Interactions" attribute, Alpha 2 rating was lower than Alpha 1 as a result of players not liking the "unethical" side to AI decisions. The Beta test rating saw a significant increase to enjoyment by players, with Release test with a slightly lower rating. This Release test result is a consequence of the harsher rating system and the removal of the "other results". If we add a vote for every valuable outcome in "other results" this rating would approximate to 8/10. In "Final Event Outcome" there was an increase in rating in the Release test. This means players had more enjoyment in how their behaviours and decisions effected this game world and their result at the end of the game.

Figure 7.10 takes in the total rating from all tests, with the exception of "other results" in the Release test, and shows the total game rating. This rating shows that all tests of this prototype were well received and enjoyed by the participants. However the Release test result shows a slightly lower rating than it would if "other results" were excluded from that rating. In an approximation of adding the value of "other results", this rating would instead be at least 7.6/10. This rating is the concluding game rating since it was evaluated from the final test conducted.

Finally, to clarify the enjoyment levels of the results, the Alpha tests were more focused on gameplay features than the ethical gameplay while the others solely focused on it. Therefore, the increases in enjoyment between the alphas and the beta or release test show how much impact the ethical natures of the AI had on the player's enjoyment in this game. Even with the addition of a few AI between the tests, they were inconsequential to the impact of the gameplay results. With dividing up their enjoyment in terms of four different attributes (Environment, controls, interactions, final event outcome) the levels of enjoyment were more focused and showed in which areas of the game the players found more satisfactory. In terms of human-AI interactions in descending order of priority: the final event outcome, interactions and environment were the attributes in focus. From the results it is more noticeable that the ethical natures of AI agents had a larger and more impactful presence on the testers of this game.

7.6.6 Answering the Research Question

After examining the results, the following statements were found:

- AI, created whether from ordinary gameplay cores or ethical gameplay cores, without changing the interactions, showed an almost even result of enjoyment in players. This can be seen from the less than 0.5 point difference of both the Alpha's "Interactions" attributes from the tests.
- AI, when actively influenced by player decisions, without players knowing, causes a far greater positive reaction in the enjoyment levels of this game. This was clearly shown in the increased levels of the Beta attribute scores. The main attributing factor was the consequence ethics.
- AI and gameplay designed in an ethical and autonomous vehicle principle context create more varied gameplay when implemented as a value system.
- Players who experienced this kind of play in the playtests showed a higher level of enjoyment than those who tested the version of this game without any ethical and consequence ethics being implemented.
- The idea of a commercial game holding this kind of gameplay is a good market choice and decision for the future. The release test shows the value of this game on the market. This helps show that games under similar construction and conditions should do well on the market.

The implications revealed from these statements which answer the research question are:

Ethically built AI structures can be used in almost any game system, under similar constraints and premise. From the results between the alpha tests it showed that even with inclusion of ethical value systems in AI agents, the players experienced very similar levels of enjoyment. This means without changing or consequence ethics this gameplay is relatively the same and therefore does not impact the ability for other game systems, under similar constraints, to implement them.

Dynamic ethical natures provide a more stimulating gameplay environment, based on the current gameplay presented. From the results between the alpha tests and the beta and release test it showed that by implementing consequence ethics in AI agents the gameplay became more dynamic and players found it to be a more stimulating experience.

Based on the previous implication and games under similar constraints, variant gameplay is shown to be a consequence and a welcome necessity to future unpredictability in gameplay.

Forming human values into computational forms and then applying them to NPC behaviours, is effective in soliciting enjoyment in players within the constraints of this research. This has been shown with the increasing levels of enjoyment per test per implementation of ethical value systems.

Varying, unpredictable and dynamically changing gameplay within this study shows to be positive for future market opportunities and gameplay experiences. This is based on the direct player feedback found throughout the tests and specifically outlined in Release Test's other results.

Other implications of implementing ethics and autonomous vehicle AI principles in gameplay are:

- Deriving human values from autonomous vehicle AI can be difficult when the autonomous principles follow more data and statistical forms of requirements.
- There are many forms of ethics and ethical constructs. It is easier to decide on which ethical or unethical principles to use by primarily utilizing AI profiling to filter results.

8

Conclusion

AI in games has become an important gameplay aspect to increase immersion, realism, and enjoyable player experiences. Even though some innovative strides have been taken, the AI-Human relationship in modern games is still “set in stone” (Fuchs & Sudmann, 2019). The following statement is a conclusion made based on the research conducted throughout this thesis:

“Enemy AI will always be an enemy”

This statement still holds true even to AI who have been story scripted to change their behaviour. This is often the cause of shallow karma systems in games. Therefore, this project utilizes autonomous vehicle principles distilled into ethics and ethical principles to design a game with AI who think in terms of ethical natures. Which means AI follow a Value system constructed under the influence of ethical and autonomous vehicle principles. This gives a new experience to players where their decisions and behaviours interact with AI on a level fundamental to gameplay. i.e., the player is helpful and polite, so the AI responds in kind. In dynamically experiencing these changes during play the player receives these signals and may choose to change their behaviours, in order to reach an outcome suitable to them.

This is promising for the future of AI and ethics as gameplay can adapt and change based on player interactions and influences. In the future, the AI can change sides in conflicts based on how the player has approached "enemies" in the past. For example, if the player has been "knocking out" instead of killing, or if the enemy boss has been more ruthless in "killing", the AI will consider these factors and change their behaviour, leading to "Enemies are not always enemies", or in latency terms of effect "The enemy of my enemy is my friend". "Middle-Earth: Shadow of Mordor" (Monolith Productions, 2014) has a similar system called, "Nemesis System". Where AI enemies would be less or more ruthless based on the player’s previous encounters. However, the gameplay still leads to the statement of "Enemy AI will always be an enemy" as enemies in the game do not change their "I am going to kill you" behaviour.

The incorporation of behaviours in the game, which link to the above statement, utilized these techniques: BDI (Yu et al, 2018), Human values (Hibbard, 2015; Wang, Wan& Wang, 2017), Decision Trees (Conitzer et al, 2017; Chowdary, 2020), Finite State Machines (Champandard, 2016b) and A* Pathfinding (Botea et al, 2013; Red Blob Games, 2014). To measure the success of this study’s implementation of AI the evaluation criteria (explained in the methodology section) were used. The main

findings from this implementation of the game show that players have higher levels of enjoyment when faced with consequences, and dynamic AI behaviours. Although players were not told of the ethical natures behind AI decisions, the players still felt connected to the AI. Their choices and decisions affecting the AI's decisions and resulting in different outcomes to the conclusion of the game. The affects of these findings on the research question proposed can be simply summarised as:

- Ethically built AI structures can be used in almost any game system, under similar constraints and premise.
- Dynamic ethical natures provide a more stimulating gameplay environment, based on the current gameplay presented.
- Based on the previous implication and games under similar constraints, variant gameplay is shown to be a consequence and a welcome necessity to future unpredictability in gameplay.
- Forming human values into computational forms and then applying them to NPC behaviours, is effective in soliciting enjoyment in players within the constraints of this research.
- There are many forms of ethics and ethical constructs. It is easier to decide on which ethical or unethical principles to use by primarily utilizing AI profiling to filter results.
- Varying, unpredictable and dynamically changing gameplay within this study shows to be positive for future market opportunities and gameplay experiences.

The summary above clearly shows the implications of implementing ethics and autonomous AI principles into gameplay. However, there is still room for improvements.

8.1 Suggestions for Improvement

The current AI structure involves combining uncommon and common AI building techniques, one major improvement to the current system would be to implement some reinforcement learning habits to the AI behaviours. This would mean that player involvement with drastically changing the ethical behaviours of AI would no longer be needed. This will also change the system from a manual approach to an autonomous approach. This solicits more varying ethical natures in the AI agents. With the current state of AI in games, more are inclined to work with machine learning or reinforcement learning agents. Therefore, it is important to factor in ethics within these fields. One tool for this which would be good to use for future iterations is the Unity ML Agent toolkit (Juliani et al, 2020).

Further refinements in the gameplay should also be considered. By providing AI and players with different modes of transport and different interaction mechanics. This will open the possibility of the AI changing how the player chooses to interact with the world.

Finally, throughout this project Unity has been proven to be unstable when utilizing many tools and implementation methods. Future iterations should preferably use Unreal Engine or an engine which gives a more stable working environment. This will lead to fewer hours of "bug fixing" on behalf of engine failures and more focus on "your own coding".

8.2 Future Work

Based on the results of the tests games which utilize these implications and principles have a high possibility of "taking the market by storm" or in other words do very well on the market. It was also intriguing to see that different experience levels have altering effects on how the testers perceived the gameplay. Based on this the future work of this project involves:

Use GPT-3 (OpenAI, 2022) language models to define the conversational dialogues between the AI and the player. Natural language processing has given us the opportunity to converse with AI on a more familiar level. Some current research trends have brought these natural language processes into a game environment. One GPT-3 test showed that NPC conversations with the player were more human-to-human. This differs greatly than what previous language models could achieve. The goal of this future work would be to implement ethical natures into the GPT-3 language model. Then use this updated model as the conversational dialogue for the already existing game from this research.

The ethical and autonomous vehicle findings from this project also provide the possibility to continue into a PhD study. This study would focus on the implementation of ethics into a vehicle safety system. This would help the advancement of autonomous technologies, especially with the current implementations of autonomous vehicle AI. As well as provide a suitable environment to filter out unwanted AI ethical behaviours. The goal of this research would be the implementation of these AI ethics constructs into actual autonomous vehicles, which are ready for public use.

For future iterations of this project into other similar studies, the following could be tested: Ethics into other types of AI systems within gameplay like Weather Management, and Procedural Environment Creation; And Ethics in the implementation of accessibility controls of a game.

8.3 Concluding Remarks

The original plan for the game was to create an environment modelled after the African plains. The story would have been centered around the life of a young meerkat. The advantage of using non-human entities or characters was to remove the influence of human-to-human relations, such as the known human errors of polluting the environment. There is an innocence involved with creatures in the animal kingdom. Therefore, it creates a stigmatic environment where players could more

easily ask themselves, "why would a Gazelle be harming the environment?". Unfortunately, some humans do harm the environment, and this is known amongst global communities. By removing the human element, it may have given more variances in the results and involved more creativity in ethical considerations. The main reasons that this kind of game was not created were due to: Time constraints, animation difficulties, available assets and available tools provided by Volvo Car Corporation. However, the use of human based characters did provide a different kind of environment for testing. Where players could simulate themselves into the character they were playing. Which meant they were able to perform actions and decisions which more closely resembled how the human player would react to the ethical behaviours of AI agents. The game also supported non-human characters in the form of dogs. Which still gave the game the impressions and stigmatic expressions that a full non-human character based game would have given.

In conclusion, there is still work which can be done that follows the findings found in this study. If this project could have had more time for development, then it may have been possible to implement the reinforcement and machine learning constructs. This does not discredit the procedures followed in this study but is merely a good foundation to build upon from this study's work. The ethical changes in AI were designed to augment into AI behaviour frameworks more easily. Therefore, it is possible to use the AI profiles in this study within other AI constructs, like machine learning. The main reason behind combining more simple AI constructs not only created more flexibility for building the AI but it shows that these ethical natures work in a "simpler environment". That way more complex environments should have little difficulties in implementing these ethical natures. Finally, in terms of Open-ended games this project has the potential to solve issues involving forced story-driven content in games. This would mean that decisions made by players will ultimate change the story arcing content of the gameplay. For example, AI agents decide to help the player fight their boss, the story ends with peace throughout the lands instead of the original forced narrative of "revenge" of the "bosses" underlings.

Bibliography

8.4 Research Papers, Documents and Articles

[1] Abt, C. C. (1970), "Serious Games." New York, Viking Press.

[2] Akula, R. and Garibay, I. (2021), "Audit and Assurance of AI Algorithms: A framework to ensure ethical algorithmic practices in Artificial Intelligence," arXiv:2107.14046v1[cs.CY]

[3] Banerjee, S. (2020). "A Framework for Designing Compassionate and Ethical Artificial Intelligence and Artificial Consciousness." Interdisciplinary Description of Complex Systems, 18 (2-A), 85-95. https://doi.org/10.7906/indecs.18.2.2

[4] Barocas, S., Hardt, M., and Narayanan, A. (2019). "Introduction. In Fairness and Machine Learning Limitations and Opportunities." Fairmlbook. Retrieved November 2021, from https://fairmlbook.org/pdf/fairmlbook.pdf

[5] Barrera, R. & Aversa, D. (2018), "Unity 2017 Game AI Programming," Third Edition: Leverage the power of Artificial Intelligence to program smart entities for your games, Packt Publishing, Limited, Birmingham.

[6] Bhakti, S. O. (2014), "Data identification and data collection methods in simulation: A case study at ORH Ltd," Journal of Simulation.

[7] Bosman, F. G. (2019), "There Is No Solution!: "Wicked Problems" in Digital Games," Games and Culture, 14(5), pp. 543–559. doi: 10.1177/1555412017716603.

[8] Botea, A., Bouzy, B., Buro, M., Bauckhage, C. and Nau, D. (2013), "Pathfinding in Games", Dagstuhl Follow-Ups, vol. 6.

[9] Björk, S. (2018). "Design Pattern Wiki." [ONLINE] (Last Updated: March 2018) Available at: http://virt10.itu.chalmers.se/index.php/Category:Patterns

[10] Björk, S., Lundgren, S. and Holopainen, j. (2003). "Game Design Patterns." DiGRA '03 - Proceedings of the 2003 DiGRA International Conference: Level Up, Volume: 2. ISBN / ISNN: ISSN 2342-9666. http://www.digra.org/digital-library/publications/game-design-patterns/

[11] Champandard, A. (2016a), "Top 10 Most Influential AI Games | AiGameDev.com", Aigamedev.com. http://aigamedev.com/open/highlights/top-ai-games/.

[12] Champandard, A. (2016b), "On Finite State Machines and Reusability | AiGameDev.com", Aigamedev.com. http://aigamedev.com/open/article/fsm-reusable/.

[13] Chiles, Todd & Crawford, Brett & R. S. T. A. Elias, Sara. (2021). "Mind, Body, and Soul: A Spiritual Perspective on the Entrepreneurial Imagination". Organization Theory. 2. 1-20. 10.1177/26317877211005786.

[14] Chowdary, D.H. (2020), "Decision Trees Explained With a Practical Example." Towards AI. https://towardsai.net/p/programming/decision-trees-explained-with-a-practical-example-fe47872d3b53

[15] Conde, M. V. (2021), "An Embarrassingly Pragmatic Introduction to Vision-based Autonomous Robots Applications," Datasets and State of the Art. arXiv:2112.05534v2[cs.RO].

[16] Conitzer, V., Sinnott-Armstrong, W., Schaich Borg, J., Deng, Y., and Kramer, M. (2017). "Moral Decision Making Frameworks for Artificial Intelligence." Proceedings of the AAAI Conference on Artificial Intelligence, 31(1). Retrieved from https://ojs.aaai.org/index.php/AAAI/article/view/11140

[17] Evans, 0., Cotton-Barratty, O., Finnveden, L., Bales, A., Balwit, A., Wills, P., Righetti, L. and William Saunders, W. (2021), "Truthful AI," arXiv:2110.06674v1[cs.CY].

[18] Fuchs, M. and A. Sudmann A. (2019), "Game and AI: Paths, Challenges, Critique," vol. 10, no. 01.

[19] Goldman, A. and O' Connor, C. (2019), "Social Epistemology." (E. N. Zalta, Ed.) The Stanford Encyclopedia of Philosophy.

[20] Hansson S. O., Belin M. and Lundgren, B. (2021), "Self-Driving Vehicles - an Ethical Overview," Philosophy & Technology 34:1383–1408, https://doi.org/10.1007/s13347-021-00464-5

[21] Heron, M. (2012), "Inaccessible through oversight: the need for inclusive game design," The Computer Games Journal, 1(1):29-38. DOI: 10.1007/BF03392326

[22] Hibbard, B. (2015). "Ethical Artificial Intelligence." Retrieved from https://arxiv.org/ftp/arxiv/papers/1411/1411.1373.pdf

[23] Hunicke, R; LeBlanc, M; and Zubek, R. (2004). "MDA: A Formal Approach to Game Design and Game Research." Press Release in Proceedings of the Challenges in Games AI Workshop, Nineteenth National Conference of Artificial Intelligence.

[24] Juliani, A., Berges, V., Teng, E., Cohen, A., Harper, J., Elion, C., Goy, C., Gao, Y., Henry, H., Mattar, M., Lange, D. (2020). Unity: A General Platform for Intelligent Agents. arXiv preprint arXiv:1809.02627. https://github.com/Unity-Technologies/ml-agents.

[25] Kantian Ethics (2001), https://www.csus.edu/indiv/g/gaskilld/ethics/kantian%20ethics.htm

[26] Lankoski and Björk (2015), "Game Research Methods."

[27] Long Y. K. (2020), "Video Game Diegesis and Ethics of Artificial Intelligence in Nier: Automata," The Education University of Hong Kong, For the degree of Bachelor of Education (Honours).

[28] Loreggia, A., Mattei, N., Rossi, F. and Venable, K. B. (2018a). "Preferences and ethical principles in decision making." In Proc. of the 1st AAAI/ACM Conference on AI, Ethics, and Society (AIES).

[29] Loreggia, A., Mattei, N., Rossi, F. and Venable, K. B. (2018b) "Value alignment via tractable preference distance." In Yampolskiy, R. V., ed., *Artificial Intelligence Safety and Security.* CRC Press, chapter 18.

[30] Mangan, N. (2021). "Pac-Man" in "Portfolio". https://natashamangan.wixsite.com/portfolio/pacman. Accessed May 2022.

[31] Mangan, N. (2022). "Ethical Gameplay Trailer". https://youtu.be/NmqvChEDIos

[32] Maré, A. (2018). "Pac-Man Patterns — Ghost Movement (Strategy Pattern)" https://dev.to/code2bits/pac-man-patterns--ghost-movement-strategy-pattern-1k1a.

[33] Miller, D. (2017), "Justice." (E. N. Zalta, Ed.) The Stanford Encyclopedia of Philosophy. Retrieved November 2021, from https://plato.stanford.edu/entries/justice/

[34] Ndu, I. K., Ekwochi, U., Di Osuorah, C., Asinobi, I. N., Nwaneri, M. O., Uwaezuoke, S. N., Amadi, O. F., Okeke, I. B., Chinawa, J. M., & Orjioke, C. (2016). Negative Marking and the Student Physician–A Descriptive Study of Nigerian Medical Schools. Journal of medical education and curricular development, 3, JMECD.S40705. https://doi.org/10.4137/JMECD.S40705

[35] Noothigattu, R., Bouneffouf, D., Mattei, N., Chandra, R., Madan, P., Varshney, K., Campbell, M., Singh, M. and Rossi, F. (2018). "Interpretable multi-objective reinforcement learning through policy orchestration". arXiv preprint arXiv:1809.08343[cs.LG].

[36] OpenAI (2022). GPT-3 Language Model. https://openai.com/api/

[37] Pac-man museum (2019). https://pacmanmuseum.com/.

[38] Parasuraman R., Sheridan T. B. and Wickens, C. D. (2000), "A model for types and levels of human interaction with automation," in IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans, vol. 30, no. 3, pp. 286-297, DOI:10.1109/3468.844354..

[39] Philosophy Basics, "Utilitarianism". https://www.philosophybasics.com/branch_utilitarianism.html

[40] Quandt, T. and S. Kröger, S. (2014), "Multiplayer: The Social Aspects of Digital Gaming." New York: Routledge.

[41] Quinn, W. S. (1989). "Actions, Intentions, and Consequences: The Doctrine of Doing and Allowing." The Philosophical Review, 98(3), 287–312. https://doi.org/10.2307/2185021

[42] Rahwan, I. (2018), "Society-in-the-loop: programming the algorithmic social contract." Retrieved from Ethics of Information Technology: https://arxiv.org/pdf/1707.07232.pdf

[43] Red Blob Games (2014), "Introduction to A*." http://www.redblobgames.com/pathfinding/a-star/introduction.html/.

[44] Roble D.(2019), "Digital Humans that look just like us," [Online]. Available : https://www.youtube.com/watch?v=nJd_2mJ4u-I. [Accessed November 2021].

[45] Rossi, F. and Mattei N. (2019), "Building Ethically Bounded AI," in Proceedings of the AAAI Conference on Artificial Intelligence.

[46] Saberi, M. (2022), "The human factor in AI Safety," School of Computer Science, University of Technology, Sydney, NSW, Australia, arXiv:2201.04263[cs.HC]

[47] Schwab, K. (2017), “This Game Forces You to Decide One of the Trickiest Ethical Dilemmas in Tech,” Fast Company.

[48] Seif El-Nasr, M. and Kleinman, E. (2020), “Data-Driven Game Development: Ethical Considerations,” in FDG ’20 International Conference on the Foundations of Digital Games.

[49] Spence, R. (2014), "Information Visualization. An Introduction," 3rd Edition. Springer.

[50] Srinivasa, S. and Deshmukh, J. (2022), "AI and Sense of Self," International Institute of Information Technology, Bangalore, Karnataka, India, arXiv:2201.05576v1[cs.AI]

[51] Surbhi, S. (2017). "Difference Between Ethics and Values". https://keydifferences.com/difference-between-ethics-and-values.html#:~:text=Key%20Differences%20Between%20Ethics%20and%20Values&text=Value%20is%20defined%20as%20the%20principles%20and%20ideals%2C%20which%20helps,the%20stimuli%20of%20our%20thinking.

[52] Vakkuri, V. and Abrahamsson, P. (2018), "The Key Concepts of Ethics of Artificial Intelligence," 2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC), 2018, pp. 1-6, DOI: 10.1109/ICE.2018.8436265.

[53] Wang, Y., Wan Y., and Wang Z. (2017), “Using experimental game theory to transit human values to ethical AI”, arXiv:1711.05905v1[cs.AI].

[54] Ware C. (2013), "Information Visualization Perception for Design," 3rd Edition. Elsevier.

[55] Yu, H., Shen, Z., Miao, C., Leung, C., Lesser, V. R., and Yang Q. (2018), "Building Ethics into Artificial Intelligence," in Proceedings of the 27th International Joint Conference on Artificial Intelligence (IJCAI’18), pp. 5527-5533. arXiv:1812.02953[cs.AI].

8.5 Video Games

[56] Bethesda Game Studios, (2011). Elder Scrolls V: Skyrim.[Video Game] United States: Bethesda Softworks.

[57] Core Design, (1996). Tomb Raider. [PC Game]. Europe: Eidos Interactive.

[58] Ember Lab, (2021). Kena: Bridge of Spirits. [Video Game]. America: Maximum Games.

[59] Monolith Productions, (2014). Middle-earth: Shadow of Mordor. United States: Warner Bros, Interactive Entertainment.

[60] Platinum Games, (2017). Nier: Automata [Video game]. Tokyo: Square Enix.

[61] Quantic Dream, (2018). Detroit: Become Human. [Video Game]. United States: Sony Interactive Entertainment.

[62] SIE Santa Monica Studio, (2005). God of War. [PS2 Game]. Europe: Sony Computer Entertainment (SIE).

8.6 Tools

[63] Adobe Mixamo (2022). Mixamo Animation Library. https://www.mixamo.com/#/?page=1&type=Motion%2CMotionPack

[64] B.G.M (2019). Achievement SFX FREE. https://assetstore.unity.com/packages/audio/sound-fx/achievement-sfx-free-91639

[65] Blender (2022). Blender. https://www.blender.org/download/

[66] CineTracks (2018). Premium Fantasy Music Pack 1. https://assetstore.unity.com/packages/audio/music/premium-fantasy-music-pack-1-119264

[67] Creature's Goodies (2021). Enchanted World. https://assetstore.unity.com/packages/audio/music/orchestral/enchanted-world-197452

[68] Dustyroom (2019). Free Casual Game SFX Pack. https://assetstore.unity.com/packages/audio/sound-fx/free-casual-game-sfx-pack-54116

[69] F3jry (2020). Sleek Essential UI Pack. https://assetstore.unity.com/packages/2d/gui/icons/sleek-essential-ui-pack-170650

[70] Girardot, O. (2020). Outdoor Atmospheric Sound Effects Pack. https://assetstore.unity.com/packages/audio/ambient/nature/outdoor-atmospheres-sound-effects-pack-155671

[71] Granberg, A. (2021). A* Pathfinding Project Pro. https://assetstore.unity.com/packages/tools/ai/a-pathfinding-project-pro-87744

[72] IgniteCoders (2021). Simple Water Shader URP. https://assetstore.unity.com/packages/2d/textures-materials/water/simple-water-shader-urp-191449

[73] Iglesias, K. (2021). Villager Animations Free. https://assetstore.unity.com/packages/3d/animations/villager-animations-free-157920#description

[74] inkle (2021). ink. https://assetstore.unity.com/packages/tools/integration/ink-unity-integration-60055#descriptionand https://github.com/inkle/ink

[75] Juliani, A., Berges, V., Teng, E., Cohen, A., Harper, J., Elion, C., Goy, C., Gao, Y., Henry, H., Mattar, M., Lange, D. (2020). Unity: A General Platform for Intelligent Agents. arXiv preprint arXiv:1809.02627. https://github.com/Unity-Technologies/ml-agents

[76] LushkinR (2021). URP Vertical Fog. https://assetstore.unity.com/packages/tools/urp-vertical-fog-175935

[77] Gonzalez-Franco, M., Ofek, E., Pan, Y., Antley, A., Steed, A., Spanlang, B., Maselli, A., Banakou, D., Pelechano, N., Escolano, S.O., Orvahlo, V., Trutoiu, L., Wojcik, M., Sanchez-Vives, M.V., Bailenson, J., Slater, M., and Lanier, J., "The Rocketbox library and the utility of freely available rigged avatars." Frontiers in Virtual Reality DOI:10.3389/frvir.2020.561558.

[78] Microsoft Corporation (2019). Xbox Game Bar. https://apps.microsoft.com/store/detail/xbox-game-bar/9NZKPSTSNW4P?hl=en-us&gl=US

[79] PULSAR BYTES (2021). Bark PBR Textures. https://assetstore.unity.com/packages/2d/textures-materials/wood/bark-pbr-textures-191305

[80] Quixel (2022). Quixel Bridge. https://quixel.com/bridge

[81] Red Deer (2021). Dog Golden Retriever. https://assetstore.unity.com/packages/3d/characters/animals/dog-golden-retriever-187111

[82] Synty Studios (2020). Polygon Pirates Low Poly 3D Art. https://assetstore.unity.com/packages/3d/environments/historic/polygon-pirates-low-poly-3d-art-by-synty-92579

[83] TriForge Assets (2021). Real Landscapes Valley Forest. https://assetstore.unity.com/packages/3d/environments/real-landscapes-valley-forest-194338

[84] Unity (2022). Unity Pro Game Engine. https://unity.com/

[85] Unity Technologies (2021). Viking Village URP. https://assetstore.unity.com/packages/essentials/tutorial-projects/viking-village-urp-29140

[86] Zhu, E. (2017). Open Source Pause Menu. https://assetstore.unity.com/packages/tools/gui/open-source-pause-menu-59478

A

Appendix: Game Design Document

A.1 Game Name

TBA

A.2 High Concept

In today's world AI in games are scoped and designed for specific purposes whether ethical or non-ethically inclined. This game promotes and designs its AI in the ethical AI standards from autonomous vehicles, to change the behaviours we have come to expect from game AI. Imagine a game where the AI decide for themselves if they wish to change from the standard "I'm an enemy therefore I kill" to "I'm an enemy but I feel sympathetic to their cause and decide to join them".

A.3 Game Overview

A.3.1 Gameplay Concept

A third-person casual game where players learn and grow into a new society.

A.3.2 Genre

Casual, Open World

A.3.3 Target Audience

Casual gamers between the ages of 20 and 50 years old.

A.3.4 Target Platform

Any modern standard computer

A.3.5 Unique Selling Point (USP)

Artificial Intelligence in the game are designed to follow ethical principles and have a possibility to choose their decisions based on being ethical or not.

A.3.6 Game Flow Summary

The player starts the game by waking up in a log within a forest. They explore their surroundings and encounter other people going about their business. The player will interact with these people and learn the "rules of the forest". By interacting and learning they grow and become a full member of the community.

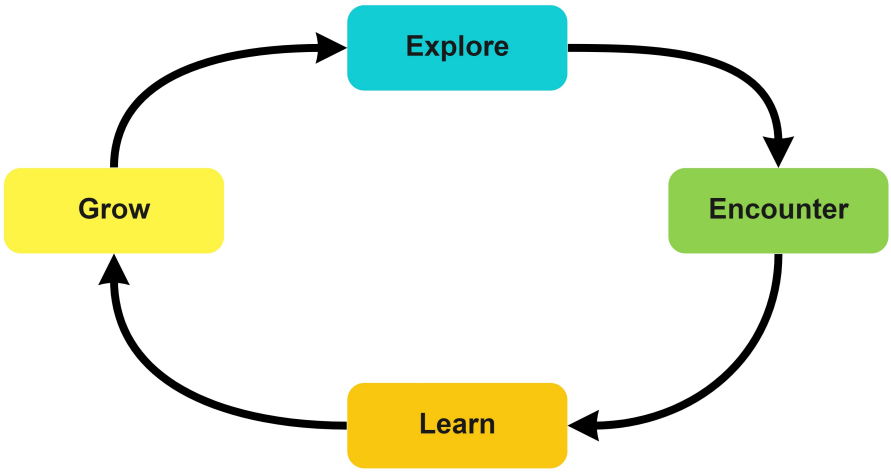


Figure A.1: Core Loop of the Game

A.3.7 Aesthetics

Fellowship: Social and interaction framework.
Discovery: Exploration of an unknown world.
Expression: Journey through self-discovery

A.4 Gameplay and Mechanics

A.4.1 Gameplay

A.4.1.1 Game Progression

Level 0: For people unfamiliar to games, that primarily functions as a tutorial. The atmosphere is light and fresh like the crisp morning air after rain the evening before, the sun's golden glow slowly heating up the land leading to a warm and beautiful day. Scenery is a forest in the early morning, green and full of life.

Level 1: Main level of the game. Atmosphere is light full of discovery depending on the actions taken by the player. The scenery is a forest village where the townsfolk are the inhabitants of the forest.

A.4.1.2 Objectives

The objective of the game is to become a member of the village. To do so they need to interact with the townsfolk, learn from them and grow into a member of the society. The game ends once they have become a member of the village.

A.4.2 Mechanics

Walk: WASD or arrow keys
Camera: Mouse movement.
Jump: Space Bar
Interact: E

A.4.2.1 Movement

When the player presses 'W' or 'S' the character will move in the forward or backward direction. When the player presses 'A' or 'D' the character will move left or right respectively, strafing based on the forward or backward movement. When the player presses 'Space bar' the character will jump vertically upwards, angling based on directional movement.

A.4.2.2 Camera

Third person, behind the player. Player is able to move the camera freely in order to look around and it in a similar style to Figure A.2.

Figure A.2: Camera View from Kena: Bridge of Spirits (Ember Lab, 2021)

A.5 Game Options

Before or during play the player can press 'ESC' to pause the game. From here the options menu will open and allow the player to either exit the game or change the following game settings.

A.5.1 Gameplay

Colour blindness
Controls sensitivity
Font Size and Colour

A.5.2 Audio

Sound and Music Volumes

A.6 Replay and Saves

Game auto saves at checkpoints.

A log of the player's actions and NPC's actions are saved in real-time as the player progresses.

A.7 Story, Setting and Characters

A.7.1 Story and Narrative

The player is on a journey to find a home. They come across a seemingly peaceful village. This particular village used to pillage anyone they came across as they travelled the world, now they found their home and have since left those days behind them, or so they say.

A.7.2 Player Character

The young traveler lost their family years ago in a landslide. They have spent the last few years looking for a place to call home.

A.7.3 Non-player Characters (NPC) and their AI

For details on the framework of the AI, please see Appendix B.

A.8 SFX and Music

A.8.1 SFX

Movement
Interaction
Positive and Negative Feedback from actions taken

A.8.2 Music

Light, peaceful, and atmospheric.

A.9 User Interface

Immersive, clean design with little to no UI elements on the screen. Everything the player needs to know will be diegetic with the gameplay.

A.10 Visual Design

In Figure A.3 represents the mood, visual style and concept of the game.

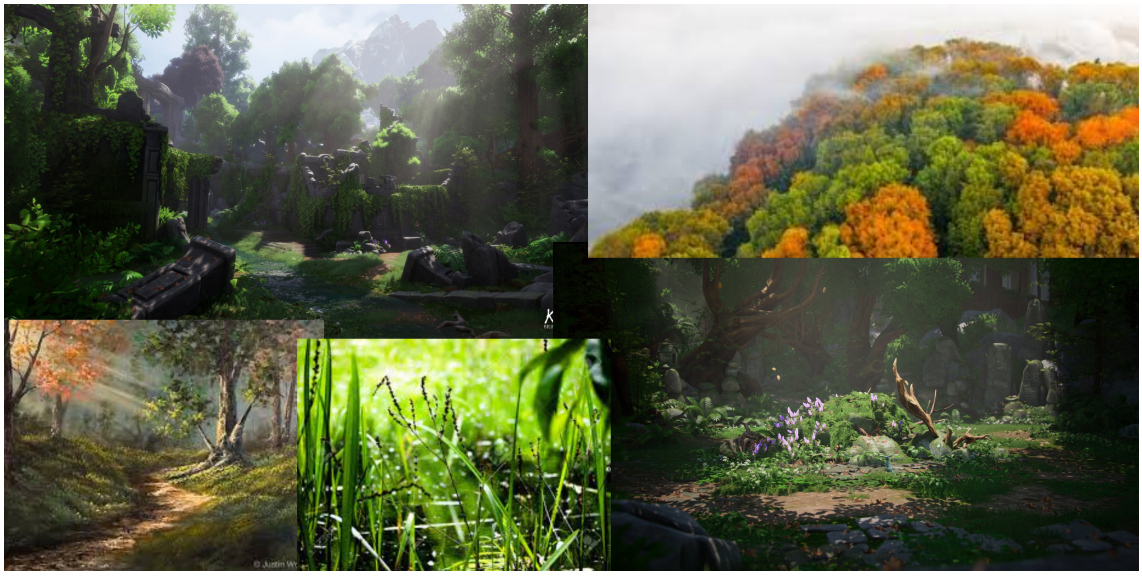


Figure A.3: Moodboard for the game.

B

Appendix: Volvo Car Corporation's Autonomous Vehicle Safety

Redacted Content.

C

Appendix: Participant Consent Form

Participant Consent Form

Consent to media documentation & processing

Researcher
Natasha Bianca Mangan
Master Thesis in Game Design and Technology, DIT910/DATX05
405 30 Gothenburg University

Supervisor
Romit Godi
Dep. 90220 Innovation Arena Team 2, Volvo Torslanda PV
418 78 Gothenburg

Dear Participant,
Thank you for taking the time and participating in our test. This test is performed by Natasha Mangan (natasha.mangan@volvocars.com) as a Master Thesis Study on behalf of Volvo Car Corporation to collect important information about your experiences of the gameplay. The results from this user study will generate important input to future development of these features in Volvo Cars and new academic contributions within User Experience research in AI and Game Development.

During the test, we are going to conduct audio and/or video recordings. Hereby the focus lies on documenting the discussions to be used for further analysis afterwards, where the results, quotes, pictures or video might be used in academic publications.

During the test your gameplay and interview will be recorded for documentation purposes and to help the evaluation. It will only be used internally VCC or sole for the stated purpose. The collected data will be handled confidentially and not used for commercial purposes. Any personal data such as your name, age and contact details will be kept strictly confidential and comply with EU GDPR related policies. These details will only be used to find your data and will be removed from the study if you ever wish to remove your consent to use your playtest data for the study.

We want to keep your contact details, to be able to get in contact with you for follow up questions or invitations to take part in future user studies or workshops with Volvo Cars. If you have any questions about the test after it is conducted, please email: gusmangana@student.gu.se

Please, check the boxes you agree with.

☐ I hereby agree to audio recordings of the gameplay during the session.

☐ I hereby agree to video recordings of the gameplay during the session.

☐ I hereby agree that the recorded files may be used for demonstration and academic publication purposes.

I hereby declare that I have read the information notice and understood the conditions and purpose on media documentation and processing of my personal data.

Date and Place	Name in Print
Signature of Participant	Signature of Researcher

Information Notice

Controller
Volvo Car Corporation, hereinafter referred to as "VCC", "we", "our" and "us", will as controller process your personal data as described below.

Purpose and legal basis for processing
VCC will process the personal data that you provide to us in connection with you signing up for participation in the study such as contact details for administration of your participation. VCC will furthermore process the personal data that we collect as a result of your participation in the study (audio and video recordings – collected both during gameplay sessions and interview) for research and development of ethical design in AD car functions and game development. The legal basis for our processing of your personal data for research and development and for contributing to research questions is that it is necessary for the purposes of legitimate interests pursued by us.

Disclosure / Recipients of your personal data / Transfer
Your personal data may be disclosed to the general public as part of the publication of the research report. Furthermore, your personal data will be transferred to companies within the same group of companies as Volvo Car Corporation which are located outside of the EEA with the basis of Standard Contractual Clauses adopted by the European Commission-safeguarding your personal data.

Retention time
We will process all the data in relation to study for a period of 3 years, after which all records will be removed.

Your rights and contact information
You have the right to request a copy of the personal data that we store about you. If you would like a copy of some or all of your personal data, please send us an e-mail to romit.godi@volvocars.com.

We want to make sure that your personal information is accurate and up to date. Please do not hesitate to ask us to correct or remove information you think is inaccurate. You also have the right to have your personal data deleted and to have our processing of your personal data restricted in certain circumstances. In addition, you have the right to object to our processing of your personal data as well as to receive your personal data, which you have provided to us, in a structured, commonly used, and machine-readable format and to have these transmitted to another controller. For more information on your rights please contact our Data Protection Officer by sending an e-mail globdpo@volvocars.com or sending a letter to Volvo Car Corporation, Attention: The Data Protection Officer, HB3S, 405 31 Göteborg, Sweden.

D

Appendix: Interview Questions

Interview Questions: Alpha Test 1

Personal

What is your name?

What is your age?

Have you played games before?

If so how would you describe your gaming? (casual, hardcore etc.)

What type of games do you usually play? (genre or actual game titles)

Gameplay

What were your first thoughts when the game started?

How did you find the controls in the game? (easy to use etc.)

What were your thoughts on the camera movement?

Was there anything that stood out to you in general?

How difficult did you find figuring out who you could interact with?

How long did it take you to find the village?

Was the chief someone who you could easily pick out from a crowd? If so why?

If you could change anything in the game what would that be?

If you could interact with the people in the game in another way what would you like to do with them? (go flower picking etc.)

Interview Questions: Alpha Test 2

Personal

1. What is your name?
2. What is your age?
3. Have you played games before?
4. If so how would you describe your gaming? (casual, hardcore etc.)
5. What type of games do you usually play? (genre or actual game titles)
6. When you meet someone what is the main thing you have a tendency of remembering?
7. Have you been a play tester for this research project before today?

Gameplay

8. What were your first thoughts when the game started?
9. How did you find the controls in the game? (easy to use etc.)
10. What were your thoughts on the camera movement?
11. Was there anything that stood out to you in general?
12. How difficult did you find figuring out who you could interact with?
13. Did you toggle the map on or off while playing?
14. How did you feel about the size of the map?
15. Did you come across someone who you could read their inner thoughts?

a. How did you feel about what they were thinking?

b. How did you feel about not being able to interact with their thoughts?

c. What was your biggest impression from reading their thoughts?

16. If not, if you could read someone's thoughts how would you like to go about it?
    a. Could be via on screen in personal notes to you etc.

17. If you could change anything in the game what would that be?

Interview Questions: Beta

Personal

1. What is your name?
2. What is your age?
3. Have you played games before?
4. If so how would you describe your gaming? (casual, hardcore etc.)
5. What type of games do you usually play? (genre or actual game titles)
6. When you meet someone what is the main thing you have a tendency of remembering?
7. Have you been a play tester for this research project before today?

Gameplay

8. What were your first thoughts when the game started?
9. How did you find the controls in the game? (easy to use etc.)
10. Did you toggle the UI on or off while playing?
11. Did you come across someone who you could read their inner thoughts?
    a. How did you feel about what they were thinking?
    b. How did you feel about not being able to interact with their thoughts?
    c. What was your biggest impression from reading their thoughts?

12. If not, if you could read someone's thoughts how would you like to go about it?
    a. Could be via on screen in personal notes to you etc.

13. Did you complete the game?

    a. What are your thoughts on the ending?

    b. Was there something that confused you?

    c. Did you feel that the outcome co-insided with how you played the game?

14. If you could change anything in the game what would that be?

15. If given the choice would you play the game with a controller instead of keyboard?

Master Thesis Final Playtest Questionnaire

Thank you again for taking the time to participate in this research project as a playtesting participant!

*Required

1. Name *

2. Email *

3. Please upload the data log file here. You can find it in the game exe folder ("Release Test v_", on Desktop) in a folder called "Thesis Project_Data" in that folder find the file called "DataLog_(your unique file name you entered when starting the game).txt". An example of this file: I entered "I love games" in the unique file name section when starting the game. In the "Thesis Project_Data" folder my file is called "DataLog_I love games.txt". *

   Files submitted:

Skip to question 4

Personal Questions

4. Have you played games before *

   Mark only one oval.

   - Yes
   - No

5. If you answered Yes, How often do you play?

   Mark only one oval.

	1	2	3	4	5	
Very little, maybe once every couple of weeks						Play everyday

6. How would you rate your gaming experience?

   Mark only one oval.

   - Novice
   - Beginner
   - Normal/Average
   - Expert

7. If you have played games before, what genre of games have you played?

Tick all that apply.

- [ ] Role Playing
- [ ] Sports
- [ ] Adventure
- [ ] First Person Shooter
- [ ] Third Person Shooter
- [ ] Narrative/Story Driven
- [ ] Casual
- [ ] Hack n Slash
- [ ] Multiplayer Online
- [ ] Co-operation
- [ ] Puzzle
- [ ] Strategy
- [ ] Other: _____

8. Have you been a playtester for this research project before today? *

Mark only one oval.

- ◯ Yes
- ◯ No

Gameplay Questions: Environment

9. How did you find the environment? On a scale of 1 - 5, in terms of MOVING in the environment. *

Mark only one oval.

	1	2	3	4	5	
Hard to move around	◯	◯	◯	◯	◯	Easy to move around

10. How did you find the environment? On a scale of 1 - 5, in terms of STYLE of the environment. *

Mark only one oval.

	1	2	3	4	5	
Messy and Unclear	◯	◯	◯	◯	◯	Clean and Coherent

11. How did you find the environment? On a scale of 1 - 5, in terms of FEELING the environment. *

Mark only one oval.

	1	2	3	4	5	
Stressful	◯	◯	◯	◯	◯	Calm, Relaxing

12. How did you find the environment? On a scale of 1 - 5, in terms of EXPERIENCING the environment. *

Mark only one oval.

	1	2	3	4	5	
Low Immersion	◯	◯	◯	◯	◯	Great Immersion

13. How did you find the Music or Atmosphere? On a scale of 1 - 5. *

Mark only one oval.

	1	2	3	4	5	
Did not fit the theme.	◯	◯	◯	◯	◯	Fit the theme perfectly.

14. Did you spend some time exploring the environment? *

Mark only one oval.

- ◯ Yes
- ◯ No

15. Based on your answer in the previous question can you tell me why or why not? *

16. How long do you think you spent playing the game? (minutes) *

Mark only one oval.

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20+

Gameplay Questions: Controls

17. How did you find moving your character? On a scale of 1 - 5. *

Mark only one oval.

	1	2	3	4	5	
Hard to control, Lagging at times.						Easy to control, Intuitive

18. How did you find moving the camera? On a scale of 1 - 5. *

Mark only one oval.

	1	2	3	4	5	
Hard to control, Lagging at times.						Easy to control, Intuitive

19. Did you toggle the UI off/on? *

Mark only one oval.

- Yes
- No

20. If yes in previous answer, can you explain why?

21. How did you feel when you navigated the menu's in the game? *

Mark only one oval.

	1	2	3	4	5	
Hard to select correct options, not intuitive.	◯	◯	◯	◯	◯	Easy to move and select correct options, very intuitive.

22. Did you find the map useful for navigating the environment? *

Mark only one oval.

- ◯ Yes
- ◯ No

23. Did find the compass a useful feature? *

Mark only one oval.

- ◯ Yes
- ◯ No

24. Would you have liked to turn on/off different parts of the map? *

Mark only one oval.

- ◯ Yes
- ◯ No

25. If yes, can you explain further?

_____

_____

_____

_____

_____

26. Did you use the controller or keyboard while playing? *

Mark only one oval.

- ◯ Keyboard
- ◯ Controller
- ◯ Both

Gameplay Questions: Interactions

27. How feel about the conversations you had? On a scale of 1 - 5. *

Mark only one oval.

	1	2	3	4	5	
Little control in the conversation	◯	◯	◯	◯	◯	Lots of control in the conversation

28. Do you think that your choices impacted their decisions (The people you spoke to)? *

Mark only one oval.

- ◯ Yes
- ◯ No

29. Can you explain why or why not? *

30. How many quests did you do in the game? *

Mark only one oval.

1	2	3	4	5	6	7	8
◯	◯	◯	◯	◯	◯	◯	◯

31. Do you feel that you missed out on some quests? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

32. If maybe, can you explain?

33. Did you want to do more in the game? *

Mark only one oval.

- Yes
- No
- Maybe

34. If yes, what would you have liked to do?

_____

_____

_____

_____

_____

35. Did you try interact with everyone in the game? *

Mark only one oval.

- Yes
- No

36. Did you try interact with the animals in the game? *

Mark only one oval.

- Yes
- No

37. Did you find any fish? (alive) *

Mark only one oval.

- Yes
- No

38. Do you remember the first person you met? *

Mark only one oval.

- Yes
- No

39. If yes, then describe them below.

40. Which of the names below were given to some of the villagers? *

Tick all that apply.

- [ ] John
- [ ] Alex
- [ ] Chief
- [ ] Jill
- [ ] Rocky
- [ ] Buddy
- [ ] Joshua
- [ ] George
- [ ] Holly
- [ ] Peter
- [ ] Julia
- [ ] Clive
- [ ] Haley
- [ ] Anna
- [ ] Ava
- [ ] Michelle
- [ ] Gilly

41. There were thought bubbles above the heads of the villagers, did you read them? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

42. If yes or maybe, then how did reading them make you feel?

Mark only one oval.

	1	2	3	4	5	
Uncomfortable	◯	◯	◯	◯	◯	Pleasant, Cool

43. If yes or maybe, then did reading what they were thinking make you want to talk to them?

Mark only one oval.

- Yes
- No

44. How did the thought bubbles make you feel? *

Mark only one oval.

	1	2	3	4	5	
Intrusive, Invading						Powerful, Awesome

Gameplay Questions: Wrap up

45. Did you feel like you contributed something to the village? *

Mark only one oval.

- Yes
- No
- Maybe

46. If maybe can you explain further?

47. How did you feel about the ending? On a scale of 1 - 5, in terms of STORY. *

Mark only one oval.

	1	2	3	4	5	
Confusing						Great

48. How did you feel about the ending? On a scale of 1 - 5, in terms of YOUR CONTRIBUTION. *

Mark only one oval.

	1	2	3	4	5	
Confusing						Great

49. How would you rate the game? *

Mark only one oval.

	1	2	3	4	5	
Not worth my time	◯	◯	◯	◯	◯	Great experience

50. If this game prototype were to be taken further and sold commercially, would you play the game (possibly buy it too)? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Other: _____

E

Appendix: Game Controls

E.1 Controls Version 1

Game Controls

W – walk forward

S – walk backwards

A – walk left

D – walk right

Left-Shift (fn lock) – Sprint

E - Interact

Space bar – Jump

Mouse movement – moves camera to look around

Mouse left-click – Click on UI Elements.

E.2 Controls Version 1.2

Game Controls

W – walk forward

S – walk backwards

A – walk left

D – walk right

Left-Shift (fn lock) – Sprint

E - Interact

Space bar – Jump

Spacebar – move forward in conversations.

Mouse movement – moves camera to look around + A/D

Mouse left-click – Click on UI Elements. (Menu only!)

M = close/open Map

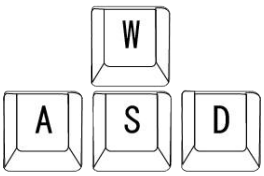
please wait until a time appears on the top right side to make sure recording is happening

Please press  + ALT + R to start recording.

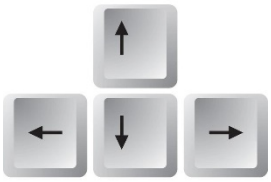
E.3 Controls Version 2

Game Controls Keyboard

Movement



OR



W/Up Arrow – walk forward

A/Left Arrow – walk left

S/Down Arrow – walk backwards

D/Right Arrow – walk right

Left-Shift (fn lock) – Sprint- (Hold to run)

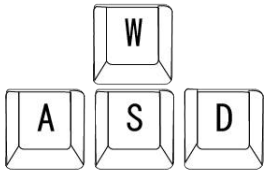
E – Interact

M – Toggle UI

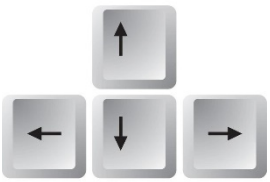
Space bar – Jump / Dialog (or Menu) select and/ or continue

Mouse movement – moves camera to look around

OR



OR



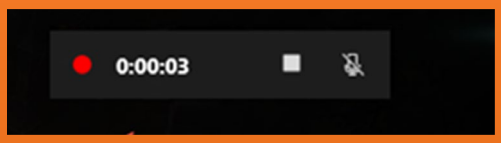
Mouse left-click /WASD/Arrow keys – Menu Options

IMPORTANT!

Please turn on the recording before pressing play in the game main menu!

Start recording by pressing the keys below:

Once you see this:



On the right hand side then press Play on the main menu to begin!

Game Controls Ps4 Controller

IMPORTANT!

Please turn on the recording before pressing play in the game main menu!

Start recording by pressing the keys below:

Once you see this:

On the right hand side then press Play on the main menu to begin!

F

Appendix: Test Results

A1 COMPILED RESULTS

KEY CODE

A1 represents the first Alpha Test

P represents the Participant

P1 represents the first participant, P2 would represent the second participant and so forth.

Any participants mentioned outside this document would be given the test code and participant number as identification, i.e., P1 from A1 would be given A1P1 as identification.

RPG represents a Role Playing Game.

MMO RPG represents a Massive Multiplayer Online Role Playing Game.

FPS represents First-person shooter games.

Free-to-play represents game which can be played for free however players can purchase things like upgrades through incorporated in-game purchases and in-game currency.

Ps2 represents PlayStation 2 console which was released in March 2002 in Japan, discontinued in January 2013 with units being shipped until March 2012.

PARTICIPANTS

Ages: 26 – 37

Gaming Experience Levels: Novice – Expert

Games and Game Genre's:

- P1: Fighter games, like Street Fighter, Tekken, FIFA, Mortal Kombat. Plays GTA and Mario kart too. Plays Shooter games with friends only.
- P2: Solo RPG's, Story-driven. Played a lot of Marvin when they were little. More Story-driven than Competitive games.
- P3: Racing, Shooter, Strategy, Story-driven. Plays Call of Duty (Capture the flag), Red Dead Redemption, Counter-strike. Prefers to pay for a game instead of playing free-to-play games.
- P4: MMO RPG, FPS, RPG, Sports, Simulators.
- P5: Ps2 games like Crash Bandicoot, Spyro and Lord of the Rings.

CONTROLS

CAMERA

Lag of camera when looking around

Was swift just the mouse pad was an issue (P3).

RUN, JUMP, MOVE, INTERACT

Smooth, Easy to Control, Very Good.

Running could be faster (P2).

Jump felt good when climbing rocks, felt natural and useful (P3).

Easy to access controls, as they are close together.

DIALOG UI INTERACTIONS

Bug with clicking continue.

OUTLIERS

Usually bad at controls therefore found it difficult to control the character and move around (P5).

The character was hard to control not so intuitive (P1).

GRAPHICS AND SHADERS

Material Shader on the character in some lighting situations tends to have an outline or glow.

Good (P3).

ANIMATIONS

Running animation looks weird (P1)

Idle animation is unnatural when they (characters) are just standing around.

ENVIRONMENT

Boundary feels unnatural. "… would be walking and suddenly I cannot move further" (P1).

Collision on Trees allowed players to walk up or stand on some of the trees.

Light and shadows based on the lighting of the sun were very good (P1).

Design of the village needs some props and more life, feels empty.

Good, love the contrast between the light and shadows in the environment (P3).

P3 notices the logs and environment aspects and assumes gameplay aspects, like someone is living here.

Very easy to find where you need to go (P3).

Was interesting that the limitations on the landscape made it easier to find where to go (P4).

Environment looks amazing. “It was clear what to do, I was just bad at it,” (P5).

MUSIC AND SOUND

A bit high and harsh.

Music was quite nice.

Was interesting that the sound on the landscape made it easier to find where to go (P4).

FUTURE POSSIBILITIES

- Use music to indicate quest information and other gameplay aspects.

CHARACTERS

CHIEF

- Found the chief immediately because of the indicator on their head.
- Felt that the chief was a male character even after speaking to them (P1).
- Chief not someone easily picked from the crowd.
- Not immediate that the chief was a girl, “so when I saw she was a girl, I was surprised and happy, because usually you assume the dominant character is masculine. Nice to see a female being represented,” (P3).
- First thought was a tribal type of chief, but it depends on what you’re looking for in terms of chief as most of the time they are represented as masculine (P5).

FUTURE INTERACTIONS

- Talk to them multiple times
- Random conversations. Can give them something to initiate conversation.
- Punch someone (P1)
- May be fun to ask them random questions (P2).
- Do activities together (P4).
- A VR experience would be really cool (P5).

I think shorts for all characters would mean more flexibility when moving around the forest area (P3).

Tried to use position of where Buddy was facing in order to ascertain where Alex was (P3).

Liked the use of they/them/their instead of using gender pronouns (P5).

GAMEPLAY

No Introduction the game starts immediately. No clue what the game is about.

Nice jump straight into the environment, likes that the game lets you explore first before you start engaging into the story, “To me that makes more sense,” (P3).

Participants P1, etc. would like an introduction or backstory before playing the game.

Thought it was luck to find the sign to the village (P1).

Alex the farmer was hard to find, the instructions from Buddy were unclear to some participants. Participants wished to talk to “quest” givers again in order to double check information.

Open world game would be good to have a map to help with navigation (P1)

First thought, “What was my objective?” (P4).

Do not know the village so participants do not know where the “famous village hill is”. This instruction is given by buddy in order to find where Alex is.

Super cool, and super excited to see how the game develops (P2).

No health lost when jumping off rocks (P3).

Would like a map on the upper-right hand side in order to see where they are. Boundary shown on the map would be good (P3).

Know that the scroll people were the ones to talk to (P3).

Was hard to find the first character, once you find the person with the first marker it was not hard to find where the other characters were (P4).

Like some kind of objective in the beginning (P4).

Got lost quite easily, needed more help with navigation (P5).

Simple to find who you needed to talk to because of the marker over their head (P5).

Wording of they/them/their instead of using gender pronouns sometimes confused non-first language speakers as they would assume there were more of them.

“I liked that you put they instead of a gender profile,” (P5).

“Really cool,” (P5).

PAUSE AND MAIN MENU SETTINGS

No participant attempted to adjust game settings, whether it was in the main menu or during gameplay via the pause menu.

BUGS AND BUILD NOTES

Build 1 of the Alpha Test was tested by the researcher and found that pausing the game while talking to someone caused mouse locked issues and the dialog would not be removed from screen.

Participants 1 and 2 played build 2 of the Alpha test. The mouse constantly unlocked from the game due to the game not being in full screen mode.

Participant 3 played build 3 of the Alpha test. A bug persisting in all builds thus far presented that if players communicated to someone they had talked to before then the current available quests would be hidden in the game. Thus, not allowing them the ability to end the game or even progress in it.

Participants 4 and 5 played build 4 of the Alpha test. No more bugs were found.

Hit box on “Click to Continue” is small therefore forcing players to have correct mouse position over the button to press it.

Music and Sound suddenly appeared for P3.

A2 COMPILED RESULTS

KEY CODE

A2 represents the second Alpha Test

P represents the Participant

P1 represents the first participant, P2 would represent the second participant and so forth.

Any participants mentioned outside this document would be given the test code and participant number as identification, i.e., P1 from A2 would be given A2P1 as identification.

FPS represents First-person shooter games.

Nintendo represents the gaming company, console and games made for the console produced by Nintendo games.

Nintendo Move represents a specific collection of games that require physical movement from players as input for the game.

PARTICIPANTS

Ages: 19 – 50

Gaming Experience Levels: Novice – Expert

Gaming Lifestyles: Everyday – Casual play.

Games and Game Genre's:

- P1: Competitive, Casual games. Played Company of Heroes, Counter Strike: Global Offensive, Witcher 3.
- P2: FPS, Sports. Played Modern Warfare, Battlefield 1.
- P3: Strategy, Adventure, Story Learning/Driven games. Played Crash Bandicoot, Call of Duty, Destiny, Uncharted, Red Dead Redemption, Spec Ops, Counter Strike, Nintendo Move.
- P4: Nintendo, Mobile games. Super Mario, Hayday, Pixel games.
- P5: -

Participants who have been a playtester for this research project before:

- P3

REMEMBERING SOMEONE ON FIRST MEET

- P1: Look, dress, conversation including environment and context, and deductions on their behaviour based on conversation.
- P2: Interesting fact or story about themselves.

- P3: How clean their shoes are, check to see through their eyes if they are reciprocating, make deductions on a person by their fingernails, i.e., cut or not.
- P4: How firm or loose their handshake is, gut feeling or reaction for a person.
- P5: Energy level, i.e., happy energetic or more laid back.

CONTROLS

CAMERA

Camera lagged, not smooth movement.

The mouse camera movement was so laggy I used keyboard instead (P2).

Not much lag this time, the mouse on the mousepad helped (P3).

Made sense but a bit unsmooth (P5).

Camera perspective was a big problem (P2).

RUN, JUMP, MOVE, INTERACT

Smooth, Intuitive, Made Sense, Easy to Control, Top Notch.

Used to strafing on A and D movement, so had to get used to it (P1).

I just accidentally skipped the E as Interact button (P3).

I didn't feel like I was making the most of the controls (P4).

DIALOG UI INTERACTIONS

Bug with AI walking away from the conversation.

MAP

Players generally toggled the map on and off to see what would happen. Found it difficult to navigate without it. Size of map was decent, seemed right and balanced. Good if it can zoom out or get bigger.

I thought the map would become a bigger map if I toggled it on or off (P1).

Size was a little too big, very close to me, I am used to it being in the top-left of the screen. I liked that it showed obstacles (P3).

Moves the map out of the way to see characters in the game. I wish I could zoom in or out or make it bigger (P4).

GRAPHICS, SHADERS AND ENVIRONMENT

Material Shader on the character in some lighting situations tends to have an outline or glow.

Good, nice forest, nice environment. (P1, P2, P5).

Was very nice and natural, except when I walk through trees (P4).

MUSIC AND SOUND

Ambient sounds were very good (P1).

Bird sounds really helped (P2).

CHARACTERS INNER THOUGHTS AND INTERACTIONS

INNER THOUGHTS AND INTERACTIONS

Inner thoughts, concept was not clearly understood by participants therefore re-wording was required during interview to collect the correct information and data.

It gave you some sort of rough estimation on the situation in the village. Did not know the background so it gave a promise of something coming, keeps you thinking about how the village operates and what the villagers are up to (P1).

Saw some stuff like the village needs help, while interacting with people it was not a deep conversation so I felt I could not read their thoughts. Nothing really special (P2).

At first, I thought it was a change of how conversations take place, maybe clouds would alleviate the confusion. I felt like the villagers did not like the village that much. Seeing the villager's thoughts was good for getting a bigger picture. I need a reward for trying to understand the villagers (P3).

Felt a bit standard, like what you would expect from a game like this. The dialog was pre-scripted, would have liked if they could give more information. Not sure about the purpose of this game (P4).

No, I did not capture what it is (P5).

READING SOMEONE THOUGHTS, HOW WOULD YOU LIKE TO DO IT IF YOU COULD (GAMEPLAY OR REAL LIFE):

- P1: -
- P2: If they could read my thoughts, I would not hesitate to read theirs. Good for society.
- P3: People talking out loud, voices fading in and out. Just like every day, its more natural.
- P4: Tune in mentally, use your own mind to read their thoughts, be a conscious thing.
- P5: A bubble to make clear that it is thought, walk by and see it (P5).

GAMEPLAY

The NPCs were scripted, the player was expected to speak to them in a certain order. Hard to see NPCs in the distance. NPC would walk away during conversation (P1).

Not possible to interact with all characters. Exclamation point on map was a good addition (P2).

Navigation was very easy, could easily spot out the new features in the game, clear set out tasks, looks like a game I would go back and play again. Exclamation points was very good on the map. I wish I got acknowledgment and was able to pick up the tool (P3).

A bit of confusion, felt like the world was spinning around, problems orienting myself. Do not know how my son knows where to go when they play Fornite. Sometimes it did not feel natural, some people had zombie expressions and that made me not want to talk to them (P4).

Confused when exclamation points disappeared, text boxes were mirrored and struggled to read it before it went away. Confused by the tool, got close then it went away (P5).

FUTURE POSSIBILITIES

- Options when talking to NPC's so that you could steer the conversations.
- Change mouse controls.
- Go inside houses.
- Make the dog bigger.
- Branching storyline, I want to make decisions.
- Ability to climb.
- Ability to grab things.
- Get player to stand still while talking.
- Save tasks to show everything still unsolved.

PAUSE AND MAIN MENU SETTINGS

No participant attempted to adjust game settings, whether it was in the main menu or during gameplay via the pause menu.

BUGS AND BUILD NOTES

Build 1 of the Alpha Test 2 was tested by the researcher and found to be suitable for all playtester's to play, even if some bugs were apparent.

Bug found where player movement did not halt when in conversation or dialog instances.

Bug found where the AI walking away during conversations.

Bug found where tool did not disappear on contact.

Bug found in input system where key presses would be saved between presses which allowed for interactions to activate even when player had not pressed E to interact, i.e., pressing E before getting to interaction areas activated them due to save of button pressed state.

Bug found on inner thought bubbles where text was mirrored in some instances.

Some areas of the map still hold collision errors and players could get stuck in falling motion due to bIsOnGround being false.

BETA COMPILED RESULTS

KEY CODE

B represents the Beta Test

P represents the Participant

P1 represents the first participant, P2 would represent the second participant and so forth.

Any participants mentioned outside this document would be given the test code and participant number as identification, i.e., P1 from B would be given BP1 as identification.

FPS represents First-person shooter games.

Nintendo represents the gaming company, console and games made for the console produced by Nintendo games.

PC represents Personal Computer games.

Xbox represents the console and games associated with the XBOX series of consoles, produced by Microsoft.

RPG represents a Role Playing Game.

FPS represents First-person shooter games.

Boardgames presents games which are played in a non-digital context with physical game pieces.

Multiplayer presents which are generally played online in a global context with players from all around the world.

Cooperative is a gameplay state where players play together to complete tasks or objective or just to have fun.

I represents an NPC receiving an interruption from the player in their thoughts.

PARTICIPANTS

Ages: 26 – 33, 50

Gaming Experience Levels: Novice – Expert

Gaming Lifestyles: Everyday – Casual play, as a child.

Games and Game Genre's:

- P1: Childish games.
- P2: RPG, Racing, Adventure, and Strategy. Played World of Warcraft, Motor Cross, Age of Empires.

- P3: PC, Xbox, Sports, Driving simulators, FPS. Played GTA, Counter Strike, Call of Duty, Tom Clancy.
- P4: Sports, Adventures.
- P5: Boardgames, Sofa games, Strategic games. Played Go.
- P6: Action, RPG, Multiplayer in Cooperative form, FPS. Played Final Fantasy, Counter Strike.

Playtester's Background/Current occupation:

- Volvo employees (P1 – P5).
- Chalmers students (P2, P4, P6).

Participants who have been a playtester for this research project before:

- P1

REMEMBERING SOMEONE ON FIRST MEET

- P1: General vibe.
- P2: Their appearance and energy.
- P3: Take more time to get to know them before making initial judgements. Their faces, extremes between their likes to dislikes.
- P4: Faces maybe, their bodies or presence, vibe, or general energy they give off.
- P5: Interests and demeanour
- P6: Facial expressions, annoyed or happy to be interacting with me. Doing an activity that makes it memorable or stick out.

CONTROLS

CAMERA

I did not like that I could not control the camera (P2).

RUN, JUMP, MOVE, INTERACT

More what I am used to, just had to get used to the new controls (P1)

Common, normal, and easy. Would have liked mouse to move camera. Chill to play with one hand, but I wanted to use both hands (P2).

Fine, normal. Would like more options when using the arrow keys over WASD keys. I want stronger connections on button assignments. Size matters as well as muscle memory proximation (P3).

Obvious when I knew how to do it, M and E need to be learned over time (P4).

Pretty standardised, intuitive. I figured out that i could sprint even without checking the controls (P6).

MAP AND QUEST UI

In general participants toggled the UI off and on to see what it did.

I like that there was a map, cool to see quest thing in the corner, was easier to find than last time (P1)

UI placements cover each other, would have liked to see all UI with dialog (P3).

Took me a while to figure out that it gave me sense of direction. I needed it for navigation, usually I would have liked to not have it and just explore (P5).

I turned it off just to see what would happen, realized I liked the map so kept it on (P6).

MUSIC AND SOUND

I like the ambience and sound (P2).

CHARACTERS INNER THOUGHTS AND INTERACTIONS

INNER THOUGHTS AND INTERACTIONS

That would be cool, maybe if they could turn and face me, showing different colours or shapes to display different emotions (P1).

I did not pay attention to the bubbles, from far it was hard to see (P2).

Unclear, did not pay too much attention to it. Main focus was on quests than to just explore, I want to provoke these systems (P3).

Gave off a sketchy vibe, maybe a little bit hippy. Was skeptical at first because the village was a little empty, some villager said something about proving yourself, was like am I supposed to kill someone, reminded me of a cult scene a movie (P4).

Their demeanor made me think about whether I should approach and engage or not (P5).

I got the impression that they were thinking due to the thinking bubbles on their head. It did not affect what I was doing, it did not change my objective. I was upset by Alex, I was told I had to talk to people, I was the one taking orders not you. Like they were victimized themselves and didn't want me to live there. I ran into someone with an interesting thought bubble, I felt confused. I ran into john later; I think it was someone in the village I was confused by it didn't make sense. In hindsight that makes sense why Alex treated me like that. Oh, I probably came from the wrong way, he was facing me when I met him. I did lose track of my surroundings. (P6).

READING SOMEONE THOUGHTS, HOW WOULD YOU LIKE TO DO IT IF YOU COULD (GAMEPLAY OR REAL LIFE):

- P1: -
- P2: Focusing then you could hear thoughts, toggling on or off.
- P3: So many privacy aspects to consider. Want to be given an option when to hear them. Visual change in people based on their thoughts.
- P4: Through audio and want to control whether it's on or off.

- P5: What game would it be if I could, it would be like being given God powers. GUI wise bubbles were fine.
- P6: I wouldn't want to read people thoughts, it would be annoying if I could not choose when to see it. Depends on if I have a choice or not.

GAMEPLAY

Did not know if I would be let into the village, I wanted everyone to let me in. For quests the chief quest stayed on the quest board, when I got the tools, I didn't know what to do with them. There were so many people I wanted to talk to, I expected more tasks, Now I want to go back and choose mean answers (P1).

Fun to be lost. I got voted into the village, was not too satisfactory, wanted to do more with the dogs, be able to return the tools, reward for quest completion. Got frustrated when the bubble disappeared before I could read them (P2).

Would have liked more feedback. Was not clear on what actions I could take. More stressful when I do not know what to do. Did not feel like I achieved something, was more focused on what my character can do and what they were trying to achieve. I would be less curious in a non-research game setting. I did not immerse myself enough (P3).

Sudden surprise when I walked into an obstruction, i.e., invisible wall. Felt that the game pretty much played itself, I clearly made the wrong decision once, she disappeared so I thought I did something wrong, was not very clear (P4).

I got a respect of other's opinions. First interaction gave mixed messages, the dilemma was set right there and then, i.e., what John thought and what they were saying. A dilemma in and of itself (P5).

I was helping people and thought if I helped them then they would accept me. George accepted me, why am I voting then it said nay. Was it only George and me? I am not sure I helped all the people I could. Everyone got sent to the village centre before I could do much, only did something with the dog. I felt the choice on being accepted into the village depended on my choice. Maybe it would make more sense if I would have interacted with more people, that could probably change the voting (P6).

FUTURE POSSIBILITIES

- Would like the mouse to control the camera movement.
- Thinking voice of the main character, on button press hear her thoughts.
- Place stronger connections on button assignments
- Clear up interactions to make it clearer
- Improve usability of some of the actions. Possibly would be good in a VR setting.
- More auditory feedback.
- More control in the conversations I have.
- Guide the player into a certain direction a bit more, would have liked to help more people (P6).

CONTROLLER VS KEYBOARD CONTROLS

Keyboard (P2)

Controller (P3)

Controller (P4)

Keyboard due to playing on Laptop, if on big screen then controller (P6)

PAUSE AND MAIN MENU SETTINGS

One participant decided to check out the settings in the main menu. They experienced a bug where the display changed to a different format making them unable to see anything in the game.

AI DATALOG

P1

John – Slight unethical

Alex – Unethical, *I*

Josef – Slight ethical

George – Slight Unethical, *I*

Chief – Ethical, *I*

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

P2

John – Slight unethical

Alex – Unethical, *I*

Josef – Slight ethical, *I*

George – Slight Unethical, *I*, Slight ethical

Chief – Ethical, *I*

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

P3

John – Slight unethical, *I*

Alex – Unethical

Josef – Slight ethical, *I*

George – Slight Unethical, *I*, Slight ethical

Chief – Ethical

Buddy – Ethical, *I*

Julia – Slight ethical, ethical

P4

John – Slight unethical

Alex – Unethical, *I*

Josef – Slight ethical, *I*

George – Slight Unethical, *I*

Chief – Ethical, *I*

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

P5

John – Slight unethical, *I*

Alex – Unethical

Josef – Slight ethical, *I*

George – Slight Unethical, *I*, Slight ethical

Chief – Ethical

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

P6

John – Slight unethical, *I*

Alex – Unethical

Josef – Slight ethical, *I*

George – Slight Unethical, *I*, Slight ethical

Chief – Ethical

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

BUGS AND BUILD NOTES

Build 2 of the Beta test was tested by the researcher and found to be suitable for all playtester's to play, except P6 played Build 3.

Build 3 had some adjustments for controller mapping otherwise the code was the same as Build 2.

Chief quest item in the quest board bug where it does not disappear on completion, sometimes some other quests also do not disappear.

Settings bug where pressing cancel sets some settings in the "GameSettings.json" file. This caused the screen display settings to change in a way that prohibits the players from seeing the screen. The issue was temporarily fixed by resetting the build files associated with the build.

Final event bug, where not all dialog choices come up for the player to read.

RELEASE COMPILED RESULTS

KEY CODE

R represents the Release Test

P represents the Participant

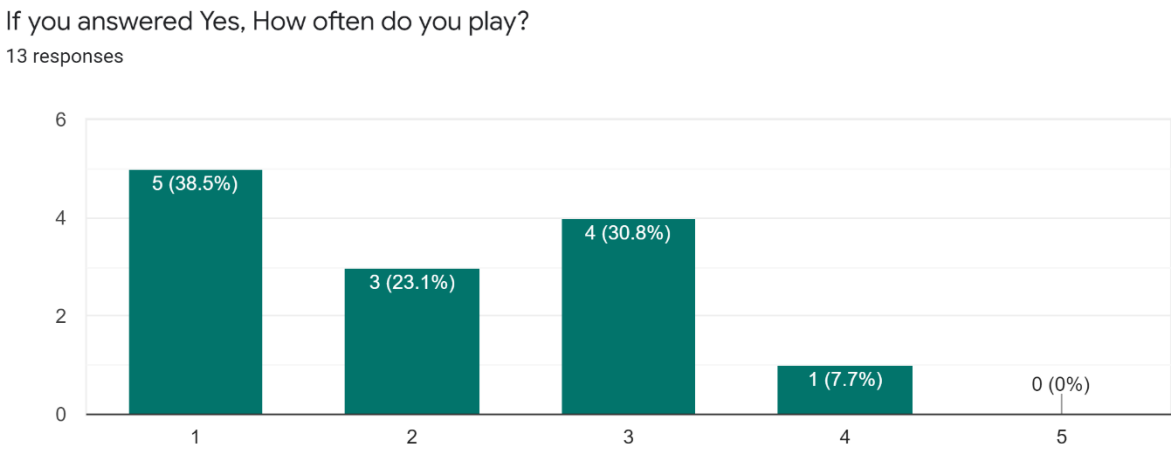
P1 represents the first participant, P2 would represent the second participant and so forth.

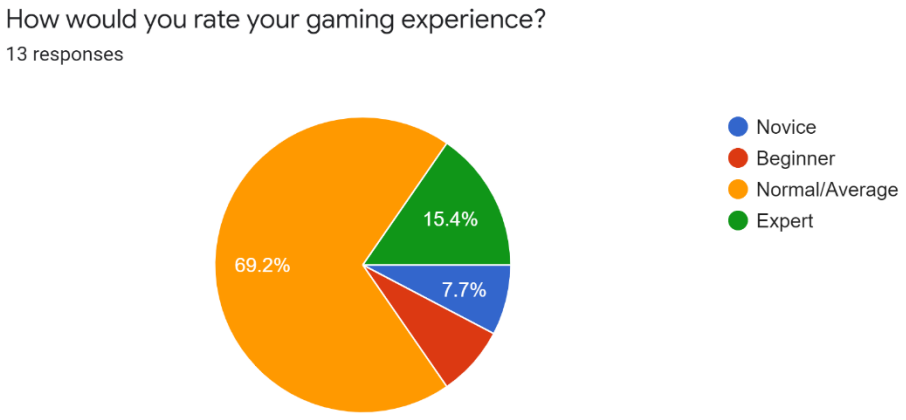
Any participants mentioned outside this document would be given the test code and participant number as identification, i.e., P1 from R would be given RP1 as identification.

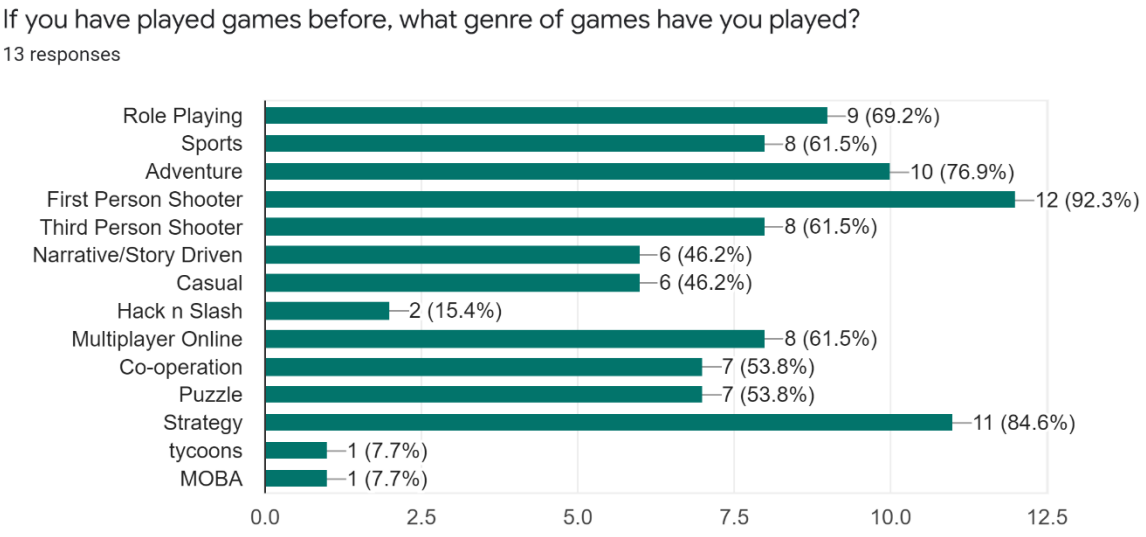
I represents an NPC receiving an interruption from the player in their thoughts.

PARTICIPANTS

GAMING EXPERIENCE LEVELS







PLAYTESTER'S BACKGROUND/CURRENT OCCUPATION

- Volvo employees, graduate students, thesis students, interns, public (P1 – P11).
- Chalmers/Göteborg Universities public (P12, P13).

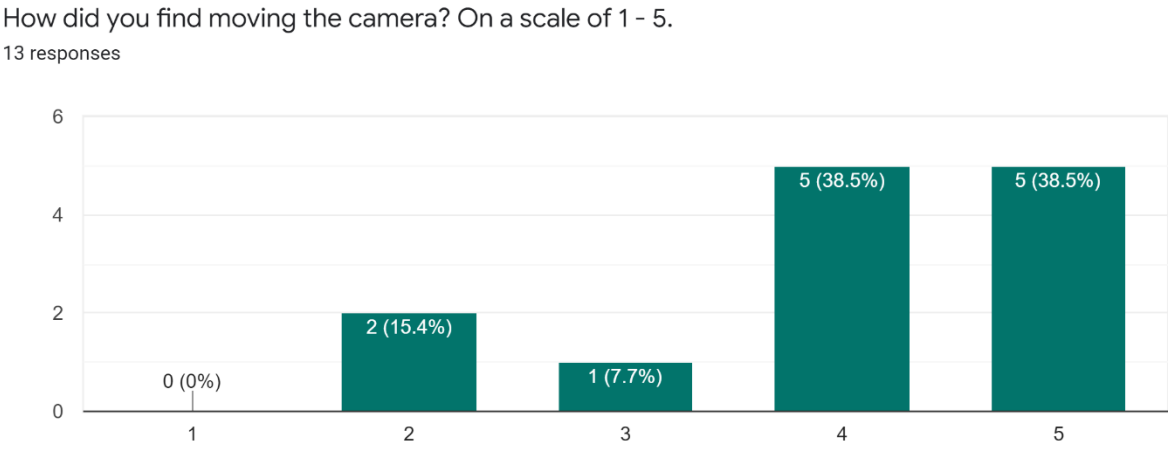
Participants who have been a playtester for this research project before:

- P1, P11, P13

Outlier: P6, responded yes to this question however upon analysing previous participants, this participant had not been playtester for this project before.

CONTROLS

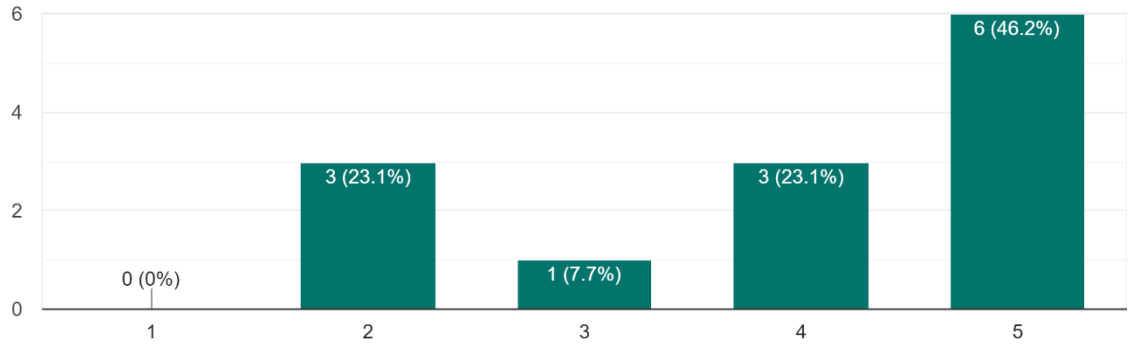
CAMERA



RUN, JUMP, MOVE, INTERACT

How did you find moving your character? On a scale of 1 - 5.

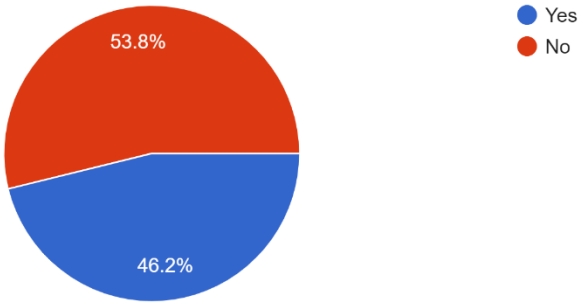
13 responses



MAP AND QUEST UI

Did you toggle the UI off/on?

13 responses



Just to see what happened. (P2)

I was focusing on exploring the game and complete the different quests (P4)

Felt clean and natural to have on (P5)

Toggled just once to try out the functionality. (P8)

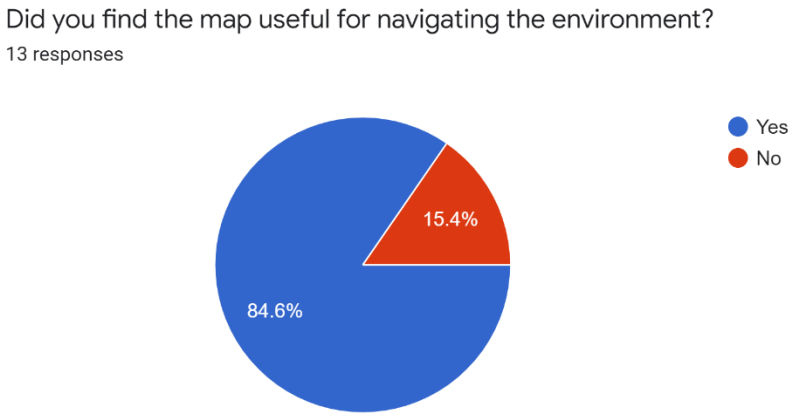
Did it once to try out the controls (P9)

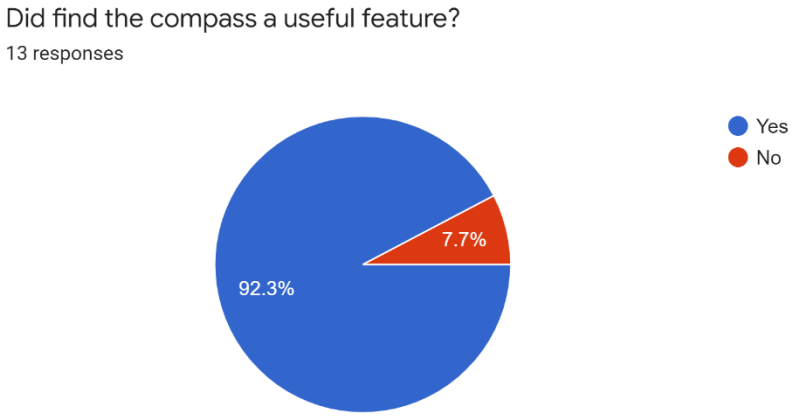
To try it out ;) usually I play with the UI open (P10)

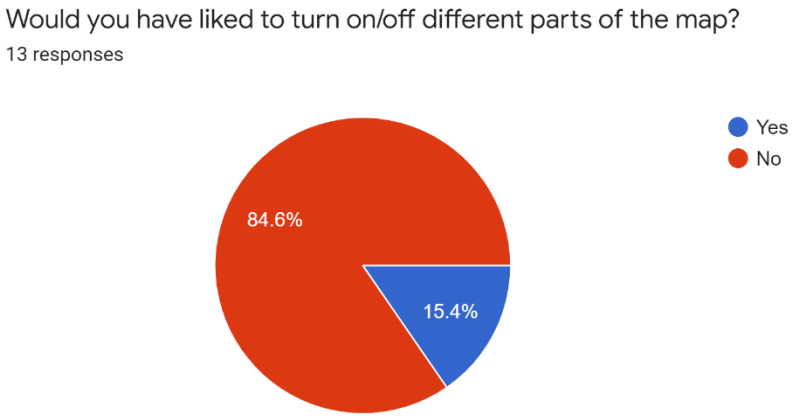
No need to toggle off (P11)

To test what would happen (P12)

I was aware of the feature; however, I chose to keep the map visible so I could see the available quests (P13).







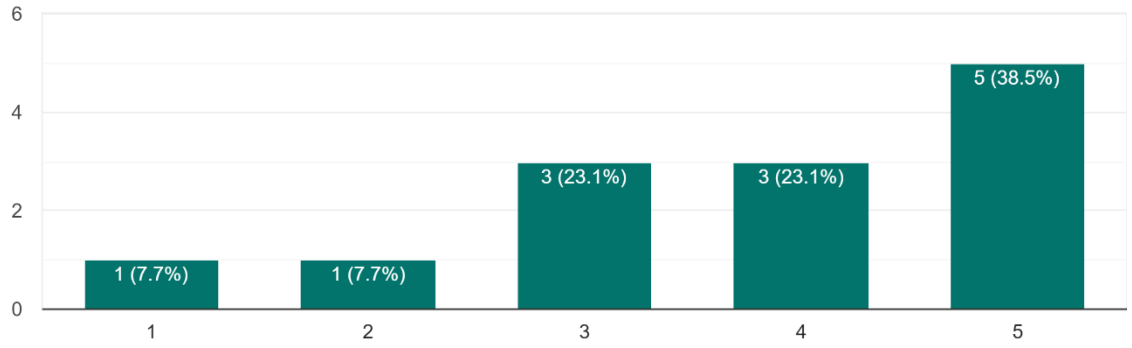
I didn't see the map and the compass (P7)

It is nice to look at the environment without the UI sometimes (P10)

MENU'S

How did you feel when you navigated the menu's in the game?

13 responses



KEYBOARD VS. CONTROLLER

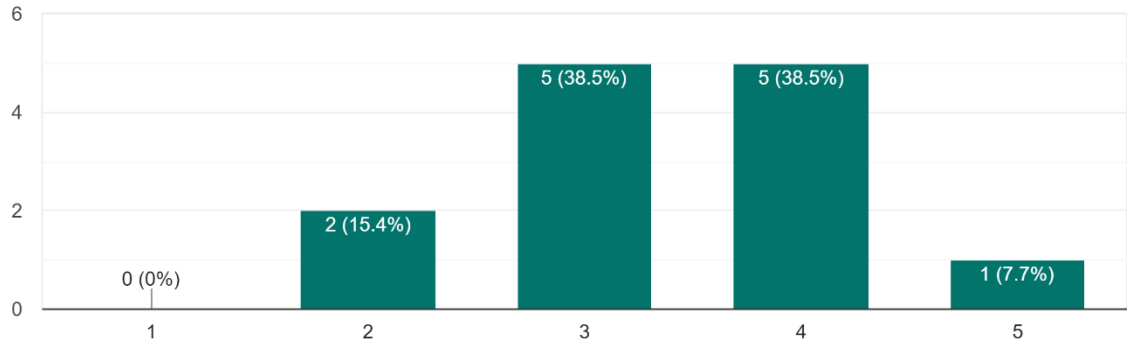
61.5% of participants primarily used the keyboard.

38.5% of participants primarily used the controller.

ENVIRONMENT

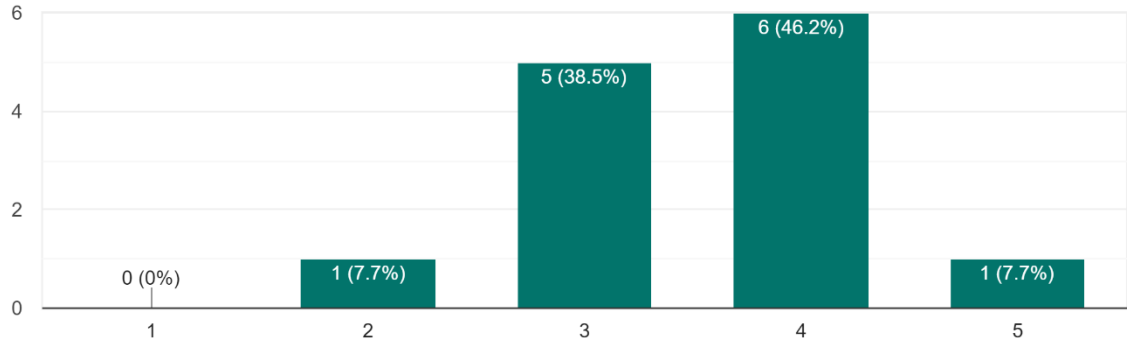
How did you find the environment? On a scale of 1 - 5, in terms of MOVING in the environment.

13 responses



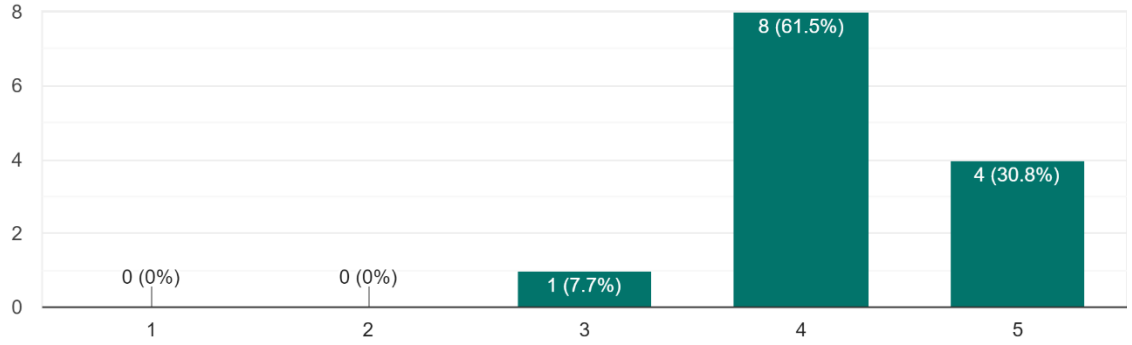
How did you find the environment? On a scale of 1 - 5, in terms of STYLE of the environment.

13 responses



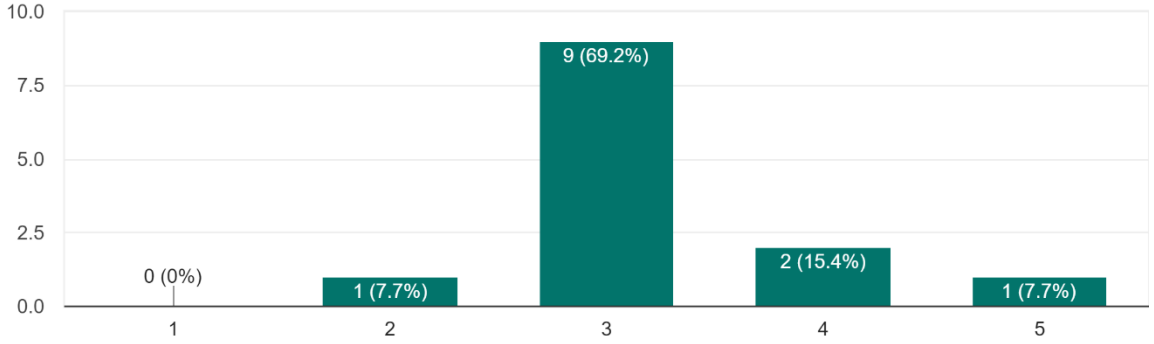
How did you find the environment? On a scale of 1 - 5, in terms of FEELING the environment.

13 responses

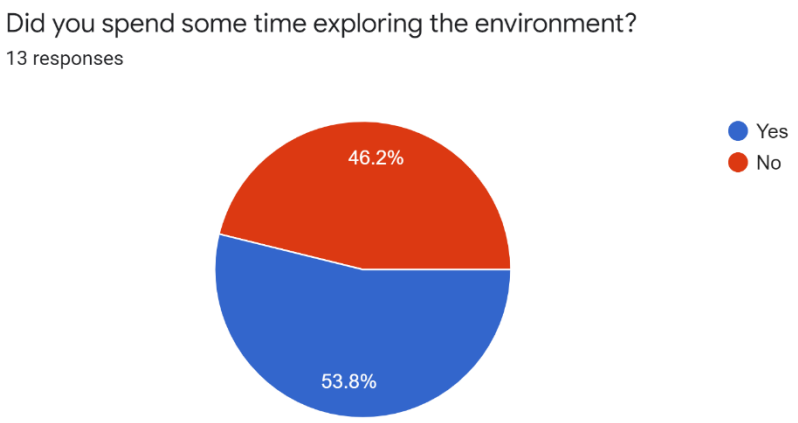


How did you find the environment? On a scale of 1 - 5, in terms of EXPERIENCING the environment.

13 responses



NAVIGATION



Was completing the quests (P1).

Was trying to complete the quests (P2)

i thought it would be fun to see how far outside the map they had made the world (P3)

Curious about the surroundings and the world (P4)

Explored a bit, but tried to focus on the objective (P5)

I didn't know how to talk to people initially and I couldn't find the quest afterward! Therefore, I thought it was a bit confusing (P6)

At the start it looked like I'm on the middle of a path so I wanted to explore both directions. At the crossing where you can go right to the village, I wanted to see what happens if I go to the left (P7).

2 reasons. 1 - because I didn't know where to go. 2 - to explore where is the limit of the game. (P8)

Ended the game too quickly. Wished I explored more before the village meeting (P9)

The environment was nice looking, and I felt like exploring to find more interesting things (P10)

Missed some ambient sound, now I just heard forest sound - it didn’t really convey any mood (P11)

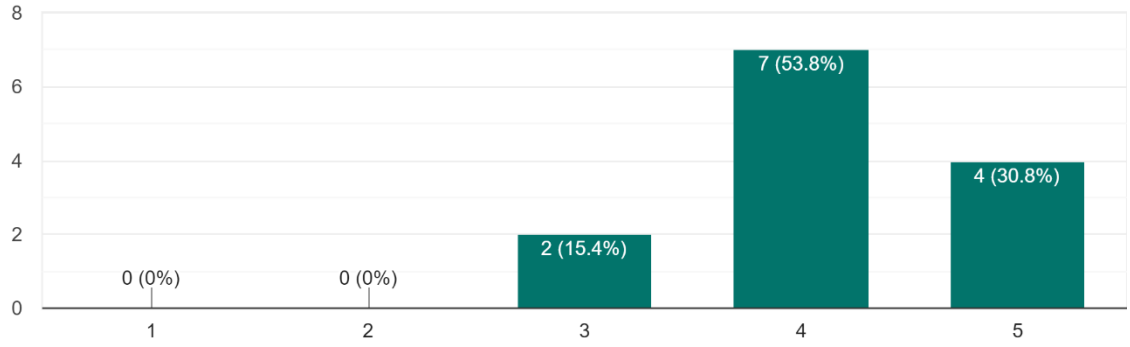
It was kind of dark so could not see much which made me not want to explore further (P12)

I had already explored a lot of the environment in my previous playtest. (P13)

MUSIC AND SOUND

How did you find the Music or Atmosphere? On a scale of 1 - 5.

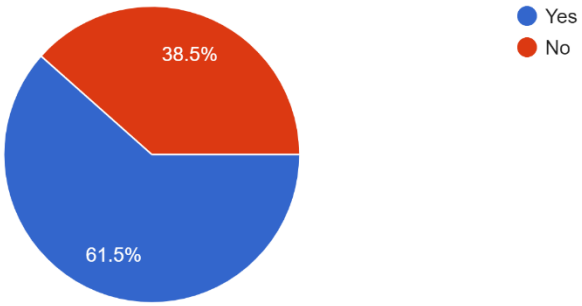
13 responses



INTERACTIONS

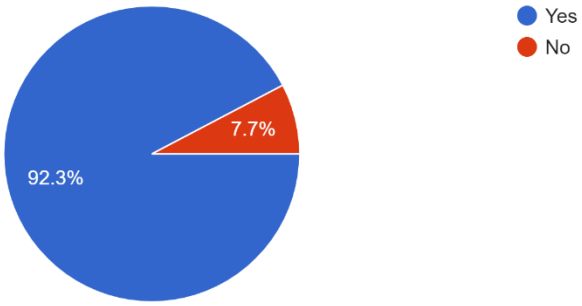
Did you try interact with everyone in the game?

13 responses



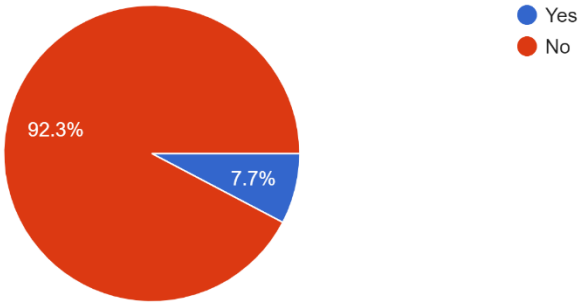
Did you try interact with the animals in the game?

13 responses



Did you find any fish? (alive)

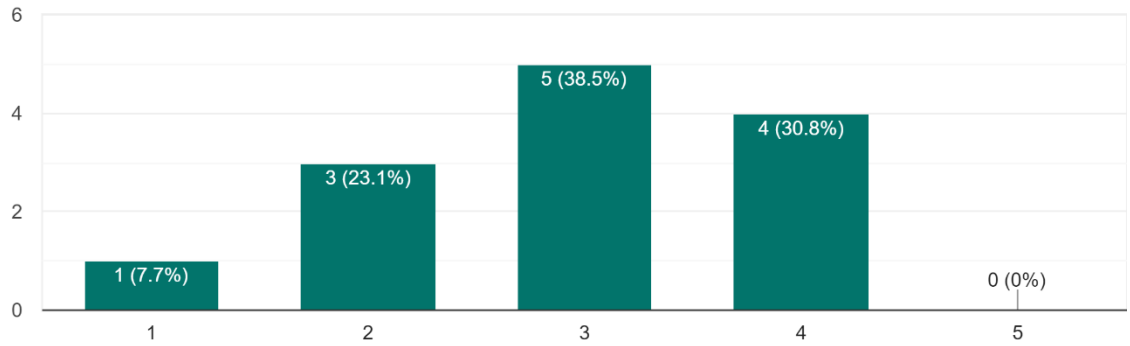
13 responses



CONVERSATIONAL

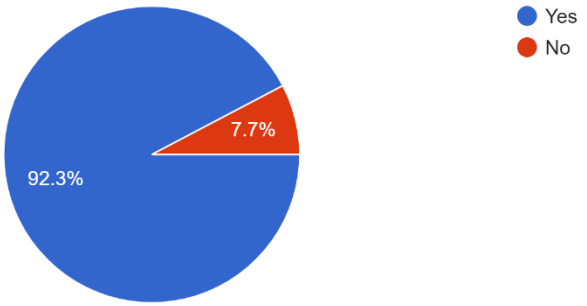
How feel about the conversations you had? On a scale of 1 - 5.

13 responses



Do you think that your choices impacted their decisions (The people you spoke to)?

13 responses



Could have asked more or completed more quests (P1)

I believe if i would have chosen to be more helpful i would have been accepted (P2)

because depending on if you helped the people or not, they might let you stay (P3)

If you would spend more time looking for people in the village to help the more likely it felt that you would be voted for in the village meeting. (P4)

I think that if I had not done enough quests, I would not join the village. (P5)

I think in the beginning they could have helped me find the quest. I could feel that my answers impact the conversation. They didn't answer me if I couldn't gain their trust. (P6)

getting only responses when I proceeded in the game (P7)

I had the feeling that if I chose one option, I would have got a task and another option, I might not get a task. (P8)

There were some "ruder" options and I guess the villagers would have interacted with me differently if I chose them. (P9)

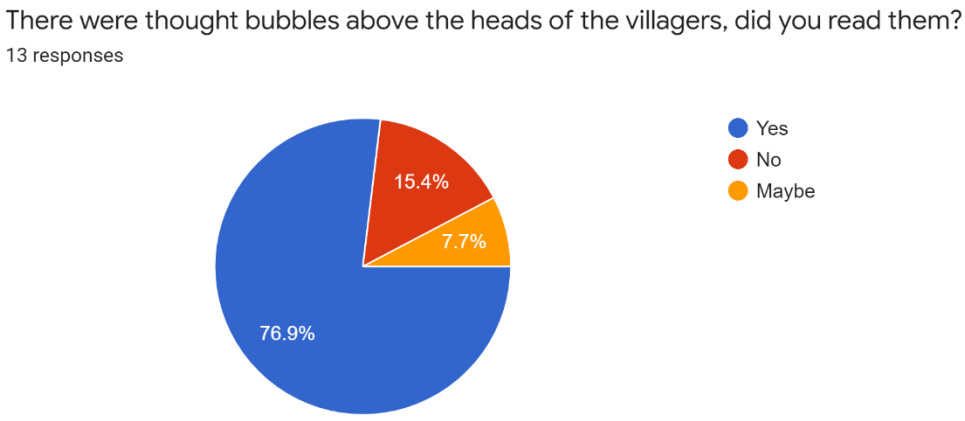
If I choice the "mean" answer, then they did not like me. (P10)

I think it did, at least I tried to select the correct option first, to be as correct as possible and not just think "oh whatever I choose I will get the same result" (P11)

Based on my experience, when there are multichoice answers in a question it will affect how the NPC reacts (think Fallout) (P12)

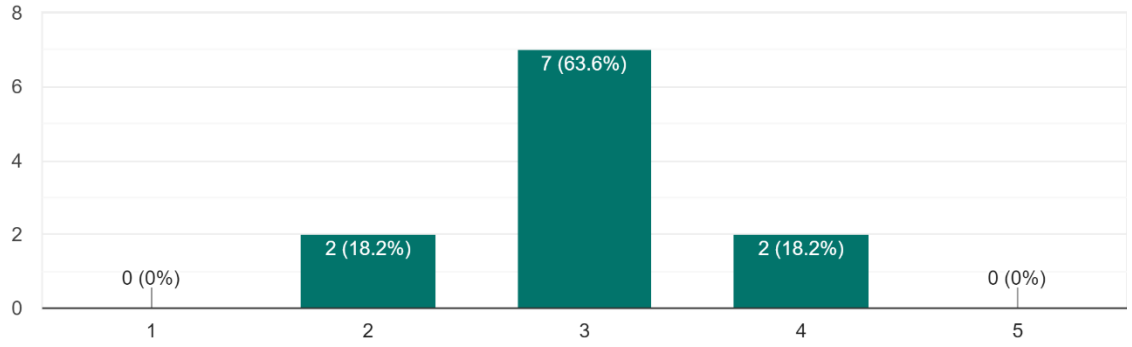
It felt like the choices I had made during the game was directly connected to if the NPCs would agree/disagree with allowing the player to stay. (P13)

READING INNER THOUGHTS



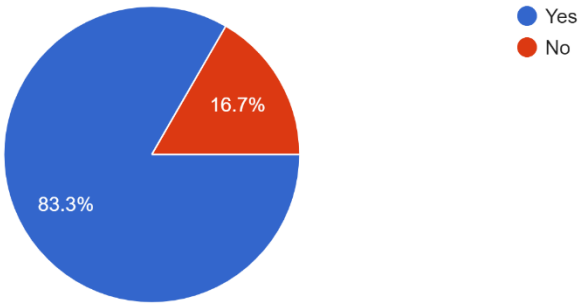
If yes or maybe, then how did reading them make you feel?

11 responses



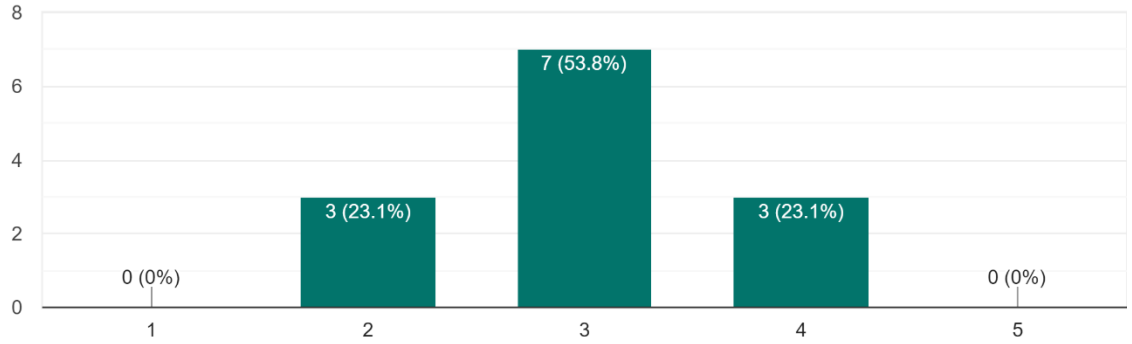
If yes or maybe, then did reading what they were thinking make you want to talk to them?

12 responses



How did the thought bubbles make you feel?

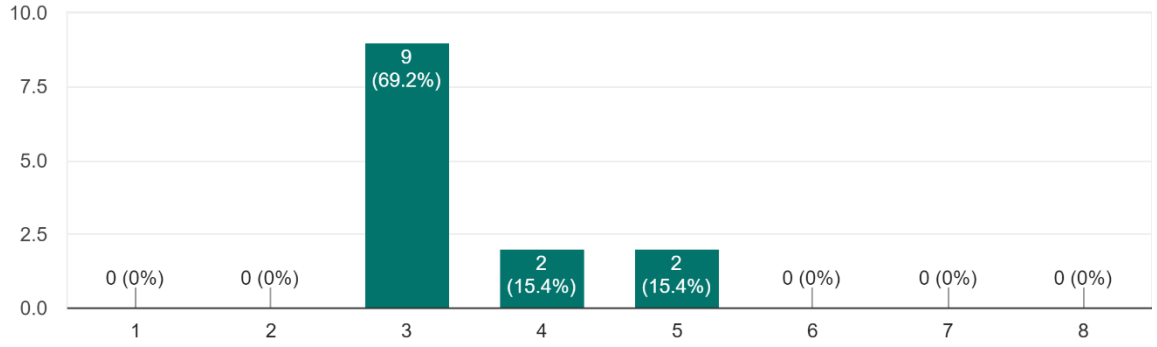
13 responses



QUESTS

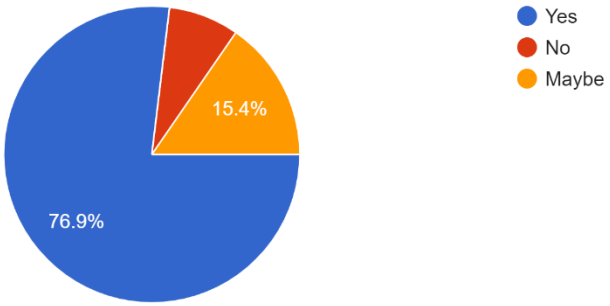
How many quests did you do in the game?

13 responses



Do you feel that you missed out on some quests?

13 responses



i was a bit too fast onto the meeting so i kind of missed a few (P3)

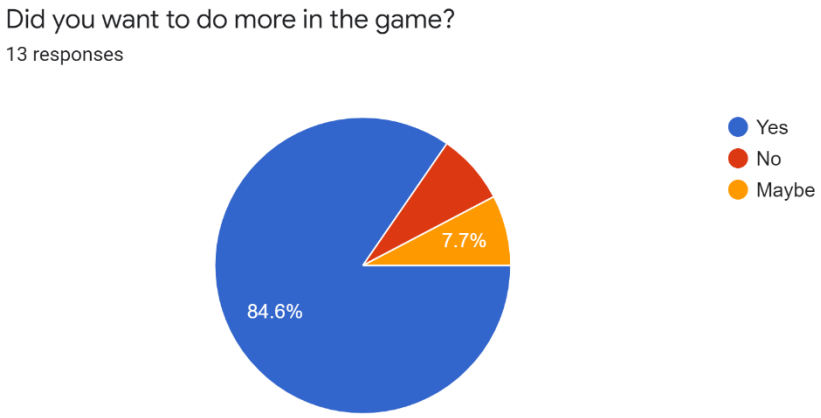
Could not find the hunter between the houses on the west, although it was not on the quests list (P5)

I though at some point of the game I had several choices so I think it could have been several quest. In addition, in the end I couldn't gain the trust of everyone in the village (P6)

I thought all the villagers have a quest and most of the quests didn't have a successful ending where they were more like pushing you away (P7)

I was not included in their village (P10)

It felt like there was more content and quests, due to talking to people in the game and then the sudden ending. (P13)



More quests, more chat (P1)

finding out what happened to the village (P3)

Explore the surroundings more, interact with tools and such, maybe other modes of transportation like bicycle, flying, cars, etc. (P4)

Swim (P5)

Interact with objects (P7)

More quests. Also, some experiences with audio depending on where I am. Some voice from the people and animals. Some intermediate reward to encourage me to talk to more people and explore more in the game. (P8)

Should have done more exploring and quests (P9)

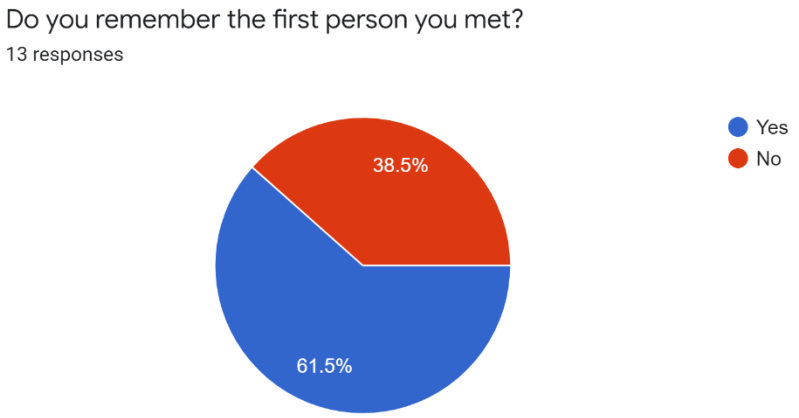
I would like to have tried out the other quests (P10)

More quests! (P11)

I would have liked to go inside of houses, and being able to take on several quests at once (P12)

Continue to discover and finish quests. (P13)

VILLAGERS



a man whom first thing he said to me was "i don't like you people" (P3)

A villager standing on the cliff giving directions to go north to the village (P5)

It was a man with white T shirt and brown pants! (P1)

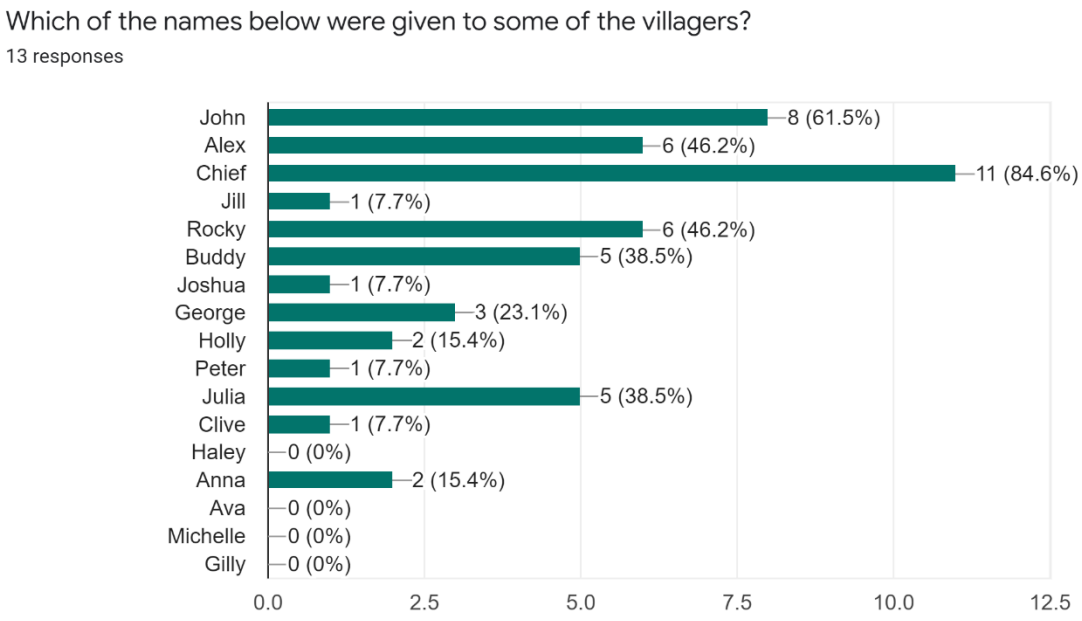
The guy at the entrance of the village (P7)

A dreamy guy (male) on top of the hill before the village. white shirt maybe. (P8)

Don't remember clearly but a male that introduced the village a little bit (P9)

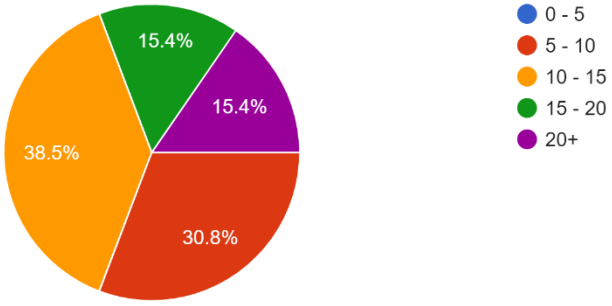
The first person before entering the village. (P11)

I think they were - a male character model. (P13)

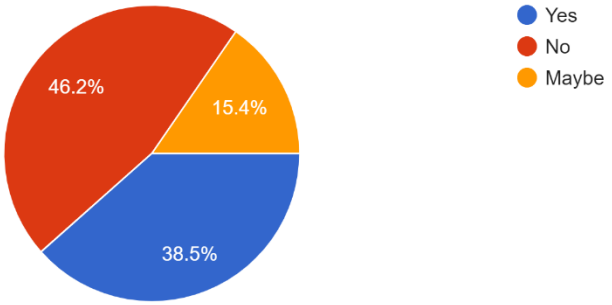


GAMEPLAY

How long do you think you spent playing the game? (minutes)
13 responses



Did you feel like you contributed something to the village?
13 responses



'the girl needed her told od o I (P3)

Trying to help out as many people in the village. Hard to get a feel for if the villagers wanted or needed help. (P4)

Tasks where finished but I was just talking to people and when there was a clear task it was not possible to really help, e.g., for the hunting task I had no tools, but the task was finished successful anyways (P7)

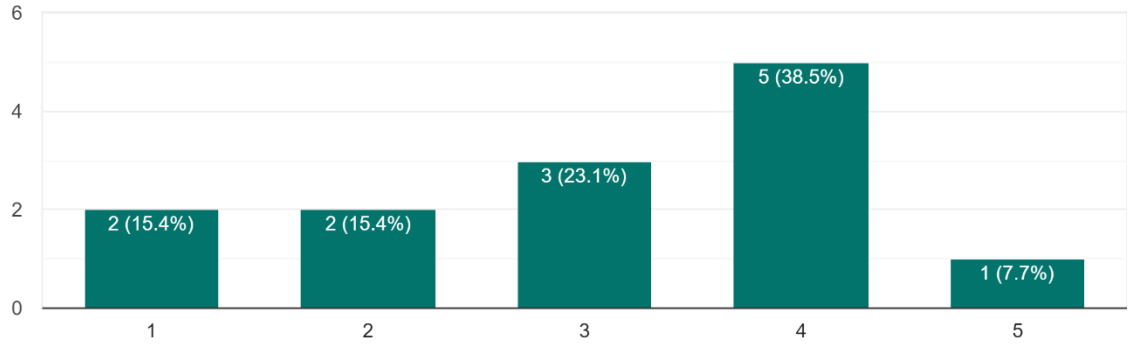
I helped (P10)

I wasn't sure if the tools I picked up in that quest was supposed to be delivered to the quest giver, since the quest ended when they were picked up. (P13)

FINAL EVENT OUTCOME

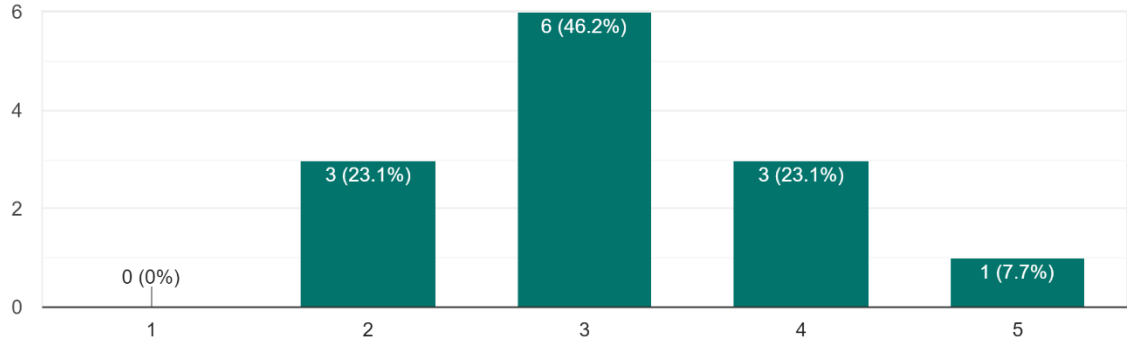
How did you feel about the ending? On a scale of 1 - 5, in terms of STORY.

13 responses



How did you feel about the ending? On a scale of 1 - 5, in terms of YOUR CONTRIBUTION.

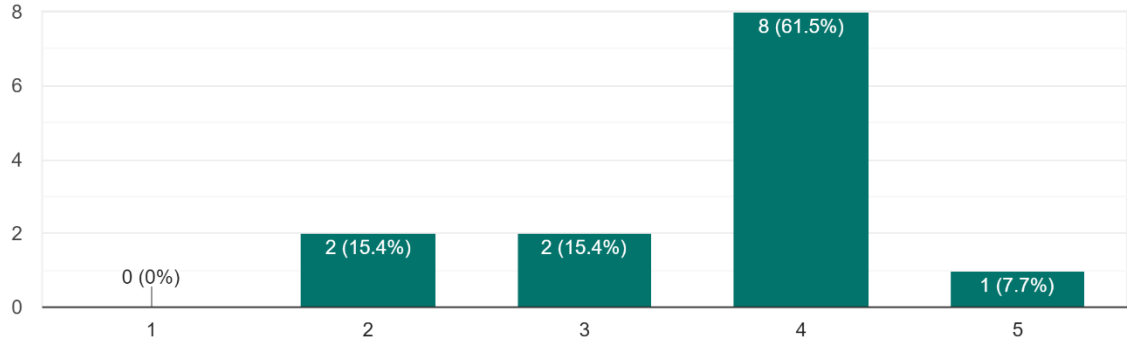
13 responses

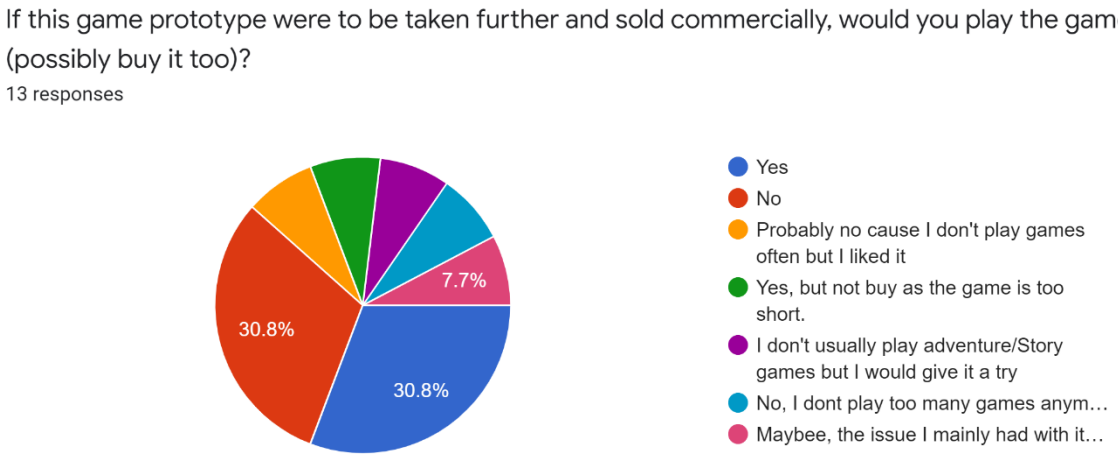


GAME RATING

How would you rate the game?

13 responses





Probably no cause I don't play games often but I liked it (P1)

Yes, but not buy as the game is too short. (P8)

I don't usually play adventure/Story games, but I would give it a try (P9)

No, I don’t play too many games anymore unfortunately. (P11)

Maybe, the issue I mainly had with it was that it did not feel very finished, the quest bubble did not have all of the quests that I think I was supposed to do (for example there was one quest where I was supposed to meet someone in a cabin, but it did not pop up on that quest list, so I just ignored it) (P12)

Note: In the last comment about finding someone in a cabin, that is not an actual quest in the game, it merely points you toward someone who could have a quest for you.

AI DATALOG

P1

John – Slight unethical, *I*,

Alex – Unethical, *I*

Josef – Slight ethical

George – Slight Unethical, *I*, slight ethical

Chief – Ethical, *I*

Buddy – Ethical,

Julia – Slight ethical,

Jill – slight Ethical,

Gen – slight Ethical

Rocky – slight Ethical, *I*,

P2

John – Slight unethical, slight ethical

Alex – Unethical, *I*,

Josef – Slight ethical

George – Slight Unethical, slight ethical, *I*, slight unethical

Chief – Ethical, *I*

Buddy – Ethical, *I*,

Julia – Slight ethical,

Jill – slight Ethical, *I*, ethical

Gen – slight ethical

Rocky – slight Ethical, *I*, ethical

Holly - unethical

P3

John – Slight unethical,

Alex – Unethical,

Josef – Slight ethical

George – Slight Unethical, *I*

Chief – Ethical,

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

Jill – slight Ethical,

Gen – slight ethical

Rocky – slight Ethical,

P4

John – Slight unethical,

Alex – Unethical, *I*

Josef – Slight ethical, *I*

George – Slight Unethical,

Chief – Ethical,

Buddy – Ethical,

Julia – Slight ethical,

Jill – Ethical, *I*

Gen – slight ethical

Rocky – ethical,

P5

John – Slight unethical,

Alex – Unethical, *I*

Josef – Slight ethical

George – Slight Unethical, *I*, slight ethical

Chief – Ethical, *I*

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

Jill – Ethical,

Gen – slight ethical

Rocky – ethical, *I*,

P6

John – Slight unethical, *I*

Alex – Unethical, *I*

Josef – Slight ethical, *I*, ethical, *I*

George – Slight Unethical, slight ethical

Chief – Ethical,

Buddy – Ethical, *I*

Julia – Slight ethical, *I*, ethical, *I*

Jill – Ethical,

Gen – slight ethical, *I*, ethical, *I*

Rocky – ethical, *I*

P7

John – Slight unethical, ethical,

Alex – Unethical, *I*

Josef – Slight ethical, *I*, ethical

George – Slight Unethical, slight ethical, *I*

Chief – Ethical,

Buddy – Ethical,

Julia – Slight ethical, ethical, *I*,

Jill – Ethical, *I*

Gen – slight ethical

Rocky – ethical, *I*

Holly - unethical

P8

John – Slight unethical,

Alex – Unethical, *I*

Josef – Slight ethical, *I*

George – Slight Unethical, slight ethical

Chief – Ethical,

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

Jill – Ethical, *I*

Gen – slight ethical, *I*

Rocky – ethical, *I*

P9

John – Slight unethical, *I*

Alex – Unethical, *I*

Josef – Slight ethical

George – Slight Unethical, ethical

Chief – Ethical,

Buddy – Ethical, *I*

Julia – Slight ethical, *I*

Jill – Ethical, *I*

Gen – slight ethical

Rocky – ethical, *I*

P10

John – Slight unethical,

Alex – Unethical, *I*

Josef – Slight ethical

George – Slight Unethical, slight ethical

Chief – Ethical,

Buddy – Ethical, *I*,

Julia – Slight ethical, *I*

Jill – Ethical,

Gen – slight ethical, *I*

Rocky – ethical,

P11

John – Slight unethical,

Alex – Unethical, *I*

Josef – Slight ethical, *I*

George – Slight Unethical, slight ethical

Chief – Ethical,

Buddy – Ethical,

Julia – Slight ethical,

Jill – Ethical, *I*

Gen – slight ethical, *I*

Rocky – ethical, *I*, unethical, ethical, *I*

P12

John – Slight unethical, *I*

Alex – Unethical, *I*

Josef – Slight ethical, *I*

George – Slight Unethical, ethical

Chief – Ethical, *I*

Buddy – Ethical,

Julia – Slight ethical,

Jill – Ethical, *I*

Gen – slight ethical

Rocky – ethical, *I*

P13

John – Slight unethical, *I*

Alex – Unethical, *I*

Josef – Slight ethical, *I*

George – Slight Unethical, ethical, *I*

Chief – Ethical,

Buddy – Ethical,

Julia – Slight ethical, *I*

Jill – Ethical, *I*

Gen – slight ethical, ethical

Rocky – unethical, *I*, ethical

BUGS AND BUILD NOTES

Build 0 of the game broke the editor and game exe once completed. Unity started compiling the script files incorrectly therefore caused some game objects to hold null values even though those values were already initialized. This also created the bug in Build 1.

Build 1 a bug was found where most of the AI did not go to village meeting during the final event phase, although not game breaking this was not something that could go unfixed.

Build 2 a game breaking bug was found, where the hidden quests overwrote current active quests. This meant AI were not informed of their quests being complete and opened the possibility for the player to talk to them about the quest again, this caused the story now to set as completed to open, have no data to use, and cause the player character to freeze. One playtester found this bug.

Build 3 was the main used build for the tests, P5 onwards used this build without issues.