MASTER'S THESIS

Game Simulation of Police-Offender-Bystander Conflict

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GAME SIMULATION OF POLICE-OFFENDER-BYSTANDER CONFLICT

by

Koen Van den Steen

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Contents

SUMMARY

In a world where people are becoming more and more critical, the police force is also encountering an increasing amount of less lenient people during their interventions. One of the problems they increasingly encounter are conflicts caused by people standing near the perpetrator who are not part of the original intervention, a bystander conflict. Although these conflicts are proven to have an increased chance of physical harm for the police officer (PO) and increase the drop out rate of the force, training on how to handle these conflicts is limited to non-existent.

In this research, we develop a training method using a virtual reality (VR) simulation of a police bystander conflict. VR-training is growing bigger and becomes more relevant every year, there are multiple studies that have proven it to be a meaning full tool for this purpose. VR provides a high sense of immersion for the trainee, and so it increases the rate of how quickly and how well an individual can learn a new technique. Another good reason is that VR is not limited to physical constraints or resources compared to scenario based training, this makes it possible to construct multiple scenarios and environments without having to switch locations or actors during training.

We used the Design Science Research Methodology for this research, as we had a problem which still had to be designed before it could be developed and it has a societal impact. Following the 6 steps proposed by this methodology we were able to identify the problem, define a solution, design the solution, create a demonstration moment, evaluate the data and communicate our results.

During the research, we were able to determine many promising factors for a VR-training tool that could be of use for further training of the POs within bystander conflicts. However, to truly unlock the potential of the tool there is still need for more specialized future work. We determined one of the main reasons for the limited effectivity was the limited means of input the PO had during the scenario's. Because of this, they did not see the training to be very use-able for themselves. However they did seem to recognize the use-fullness of a tool like this if used during Police school training.

Overall this research has a societal impact as bystander conflicts are a real problem for the society. Currently, there is little research done about this subject and even less specifically about bystander conflicts and possible training in ways to handle a conflict like this. This research was a first step to show that VR could be used as a meaningful training tool for the POs. Given the appropriate follow-up steps and future research, we believe it is possible to provide a training tool exactly for this purpose.

SAMENVATTING

In een wereld waar mensen meer en meer kritisch zijn, krijgt de politie ook meer en meer te maken met minder bereidwillige mensen tijdens hun interventies. Eén van de problemen dat ze vaker tegenkomen zijn conflicten waar er mensen die nabij de overtreder staan gaan ingrijpen tijdens de interventie, een conflict zoals dit noemt men een omstander conflict.

In dit onderzoek verkennen we een trainingsmethode die gebruik maakt van een virtuele realiteit (VR) simulatie van een politie omstander conflict. VR-training is groter en groter aan het worden en wordt elk jaar relevanter. Er zijn ondertussen ook verscheidene studies die aantonen dat VR gebruikt kan worden als een nuttig opleidingshulpmiddel.
Eenderzijds geeft VR de gebruiker een hoog gevoel van onderdompeling deze zorgt mede voor het efficienter leren van een nieuwe techniek. Anderzijds is men ook niet gelimiteerd door fysieke grenzen of middelen in vergelijking met scenario gebaseerde trainingen. Hierdoor is het mogelijk om meerdere scenario's en omgevingen te bouwen zonder te moeten wisselen van locatie of acteurs tijdens deze trainingen.

Voor dit onderzoek hebben we de Ontwerpwetenschappelijke Onderzoeksmethodologie gebruikt. Door de 6 stappen te volgen die door deze methodologie werden voorgesteld waren we de mogelijk om ons probleem te identificeren, een oplossing te definiëren, deze te ontwikkelen, een demonstratie op te stellen, onze data te evalueren en uiteindelijk de resultaten te communiceren.

Tijdens het onderzoek hebben we verschillende beloftevolle factoren vastgesteld die gebruikt kunnen worden voor toekomstige training van agenten in verband met omstander conflicten. Echter om de echte potentie van de simulatie te laten werken is er nog nood aan meer gespecialiseerd toekomstig onderzoek. We hebben geconcludeerd dat één van de hoofdredenen die de effectiviteit van de training verminderde was het feit dat politie agent slechts een beperkte manier van invoer tijdens de scenario's. Hierdoor zagen ze deze training niet als erg nuttig voor hunzelf. Niettemin zagen ze wel het nut van deze simulatie in, wanneer het gebruikt zou worden tijdens de politieschool opleiding.

In het algemeen had dit onderzoek een maatschappelijke impact vermits omstander conflicten een hedendaags probleem vormen voor de maatschappij. Momenteel is er weinig onderzoek gedaan omtrent omstander conflicten en meer specifiek nog minder omtrent mogelijke training zodat de agent een conflict zoals dit beter zou kunnen afhandelen. Dit onderzoek was een eerste stap om aan te tonen dat VR kan gebruikt worden als een betekenisvol opleidingshulpmiddel voor de agent. Mits de geschikte opvolging en toekomstig onderzoek geloven wij dat het mogelijk is om een trainingshulpmiddel te maken dat exact werkt voor dit doel.

1

INTRODUCTION

Violence against Police officers (POs) is at an alarming high level. For example, the Dutch police force has seen over 12 000 cases of violence against officers on duty for two years in a row now Politie.nl [2022]. Furthermore, during the recent COVID outbreak, violence against POs further increased as stated in Verhaeghe et al. [2020]. This causes not only physical harm to the PO, but also has a big impact on the psychological state of the officer, which may lead to post-traumatic stress and an increase in drop-outs within the police organization, as stated by van Erp et al. [2013]. Because of this, the police organization made the reduction of violence against POs of high importance Adang et al. [2006].

POs also reported an increasing number of obstruction by bystanders NOS [2020]. Police union VSOA shared a video of an intervention gone bad as a cry for help. Bystanders become aggressive while the POs try to arrest a subject. This can be described as a bystander conflict van Erp et al. [2013]. It is a conflict caused by a bystander, obstructing the intervention of the intervening PO or other emergency responders. As in this case, the bystanders attempted to hinder the arrest of the suspect, creating a conflict which ended in the use of violence against the POs. The problem in Brussels is not a case on its own as we see in ANP [2022]; Depauw [2020]; Matyn [2020]; Voskuil [2020].

Todak and James [2018] revealed that, a PO handles a bystander conflict mostly based on previous experiences and best practices. POs who use proper de-escalation techniques are more successful in their interventions and are able to encounter less violence during interventions. On this behalf Todak and James [2018] stated that currently there is no specific training offered to the POs that focuses on de-escalation techniques only. The experts stated that there is little to no training about this subject, even though they recognized the importance of this subject. By providing a proper training tool and environment where the POs can practice de-escalation techniques is therefore of high importance for all the involved parties and implicitly for its societal impact and role. We hypothesize that by providing a tool that stimulates utilizing the appropriate de-escalations techniques in the right situations, the amount of escalated conflicts against POs could be reduced. Consequently, decreasing the amount of stress the PO endures in the hope that the drop out rate of the police organization gets minimized.

According to Di Nota and Huhta [2019], scenario-based training is one of the best ways to train POs, but providing a wide range of scenario's can be challenging due to limited resources and variables. Therefore, Giessing [2021] considers Virtual Reality (VR) training as a valuable alternative as it overcomes many of these issues. We believe that VR-training could be utilized compared to real-life interventions to train POs in managing bystander conflict. VR is a technology where an environment is created with computer-generated graphics. In this environment, it is possible to interact or experience everything through utilizing additional electronic tools like a helmet with a widescreen inside or gloves with additional sensors Burdea and Coiffet [2003]. Firstly, Lindgren [2012] showed that, training in a virtual environment from a first-person perspective leads to a stronger transfer of knowledge compared to training from a third-person experience. Secondly, Bertram et al. [2011] found that more complex training settings lead to higher training results in a virtual environment over real-life simulations, since bystander conflict is a complex phenomenon that is dependent on many factors it is considered to be complex to be trained in. Thirdly, Garcia et al. [2019] showed that, while training in VR, the feeling of presence will increase for the trainee, which further increases the transfer of knowledge. Therefore, we propose to develop a VR Game simulation of a police-offender-bystander conflict that answers the main research question: How to design a VR-Game simulation to train Police Officers in bystander conflicts?

This simulation will use both quantitative and qualitative data collected by ongoing research carried out in this field considering a multidisciplinary perspective e.g. technological, psychological, and criminalistic. Additionally, more data is collected by interviewing several experts about the subject.

The outline of this research is structured as follows. Firstly, we summarize relevant research already conducted in the Related Work section. The research is multidisciplinary and uses a software engineering research methodology. Secondly, the Research Context goes deeper into everything related to the research. This chapter starts with a problem analysis where we describe an escalated intervention, from there on we explain all the relevant terminology for this research. Thirdly, in the Research Methodology chapter the main research question (RQ) is stated and split into multiple sub research questions, so the main RQ can be solved in chronological and logical order. Next, the methodology used is further discussed. Fourthly, the Solution Implementation is discussed, here the solution design and development can be found in detail. Fifthly, we state how we want to evaluate the solution and then we analyze how our results match these evaluation criteria. Sixthly, our final chapter will discuss these results and provide concluding remarks. After that, we suggest in what ways future research on this topic could be conducted.

2

Related Work

This section will focus on multiple facets of relevant scientific research from the disciplines involved in this research project. These disciplines include software engineering, psychology, VR, criminology, police science and serious gaming.

A bystander conflict can be defined to a situation where bystanders who are present around an intervention but are not part of the primary process involve them in a negative way and even obstructing the intervention van Erp et al. [2013]. An escalated bystander conflict can be caused or enhanced by multiple aspects. One of the biggest reasons for escalated conflicts can be based on the Construal-level theory of psychological distanced as defined by Trope and Liberman [2010]. According to Trope et al there are multiple differences in psychological distance. This is based on the here and now of the subject in the presence. The closer a person psychologically can place themselves in a situation the more this person will understand visions of peoples live and sense of it. They proposed that this distance can exist of social, temporal, physical and hypothetical distance. For this reason it is of importance to consider the psychological distance between PO, perpetrator and bystander as this will impact how quickly a situation can escalate.

Some research concerning handling Bystander conflicts has already been conducted, however most of them did not research PO-bystander conflicts specifically. For example van Erp et al. [2018] focused on bystander conflicts with public service workers like fireman or health workers. They focused on providing additional resources for handling these bystander conflicts. The resources were either individual based like providing additional training or team based like additional support of colleagues. One of the most important individual resources is conflict management efficacy - or convincing the trainee that he/she is able to handle the conflict effectively and constructively on his/her own Bandura [1977]. Individuals who score higher on self-efficacy are more motivated and determined to reach their goals and overcome obstructions. van Erp et al. [2018] showed that by training individuals to reach a higher self-efficacy score, they will have a less harsh time dealing with bystander conflicts. This study proves that by providing additional resources and more specifically a training intervention, the self-efficacy of the workforce increased. Therefore, the workforce can deal better with bystander conflicts and because of this a more enthusiast, engaged and effective workforce can be maintained. A second important focus was

perspective taking. Training the POs taking the perspective from the bystander teaches the PO to understand the bystanders motivations for intervention. Consequently, it prevents his own negative emotions from dominating in a reaction against the bystander. However, they do not make use of VR. They work with role play and actors to simulate the specific situation. This requires a lot of people at the same time in the same space. Such a setting during the current COVID-crisis might not be feasible. In contrary, VR is a method which offers a solution to this problem. VR interventions allow an individual to experience training similar to real-life training without the presence of others.

VR is an emerging field in simulations and training and as stated by Lele [2013] the military industry was one of the first to find practical use cases for this technology. Moreover, the possibilities to provide safe environments to train their personnel makes VR very interesting. Another industry that is adopting VR rather quickly is the medical sector. The possibility to train surgeons for risky operations in a virtual environment strikes most interesting, like Aggarwal et al. [2006]. Bartlett et al. [2018] stated that the use of VR-training does trigger skill acquisition and even improvements in an operating theatre. According to Ostrowski [2018] over 60% of VR usage within companies is for training purposes, in addition Koutitas et al. [2021] proved that they could increase accuracy and speed of execution on tasks trained in Virtual Reality.

Currently, there are multiple companies that focus on VR-training for Police officers: Apex Officer , VR training Solutions, Nsena, Virtra or in the news Stassijns [2019]. In sum, using VR for law enforcement training is not a new concept. However, all the existing solutions focus mostly on combat training. Moreover, on how to handle the actual perpetrator. However, none of these focuses on bystander conflicts. Which is problematic as Aytaç et al. [2018] considered that when bystanders are met with repression by authorities, they are more likely to join that protest. Thus, interventions should focus more on de-escalation and prevention of conflict rather than combat training.

A few studies have been conducted which prove the usefulness of using VR as a training tool rather than real-life training or training with keyboard and screen. Garcia et al. [2019] argued that training in VR provides a safer and more cost-effective way for training POs. They showed that it can be used to learn the basic of force principles to untrained civilians. The simulation was tested on two subject groups. One group used a screen and keyboard setup, the other group used a VR headset. The group with the VR headset was measured to have a larger feeling of presence during the training, which resulted in a larger transfer of knowledge Alexander et al. [2005]. However, Garcia et al. [2019] also focused on the use of force against the perpetrator and is not talking about bystander conflicts. By utilizing the greater sense of presence during a VR-training, the PO will be able to understand the de-escalation techniques better than traditional training.

Di Nota and Huhta [2019] shows that scenario-based training is considered as one of the best ways to train POs. By providing realistic and diverse scenarios, POs can learn how to better react to stressful scenario's as Baldwin et al. [2019]; Giessing et al. [2019] showed that even trained professionals are susceptible to this. POs with more stressful experience perform better even under pressure Anderson et al. [2019]; Planche et al. [2019]; Vickers and

Lewinski [2012] and Landman et al. [2016] showed us that training POs in stressful environments can increase their performance even when this training is only psychological as Low et al. [2021] states.Giessing [2021]; Xie et al. [2021] showed that training in VR overcomes many challenges like limited resources and variability. It can reduce training costs and is less time-consuming Karabiyik et al. [2019]; Koutitas et al. [2021]. Therefore, VR should be considered a valid alternative to scenario based training and further expanding the resilience to stress of POs and further improve their decision-making. Something Caserman et al. [2018] also confirms that training in VR can further complement existing training.

Finally, there are also several studies that focus on how well VR-training performs. Karre et al. [2019]; Samini and Palmerius [2017] proposed metrics which are important to track for higher presence and knowledge transfer of trainees. Based on these papers and the evaluation method proposed by Gyeonggi-Do and Gu [2018] it is clear that there are plenty of studies performed on how you can evaluate and score a VR-training.

We can conclude that these studies were able to show the effectiveness of training with their respective methods and in their respective fields. However, none of them focused on PO-Bystander conflicts nor on VR-training, which is proven to be a valuable alternative to real-life training. Reviewing both literature and conducting expert interviews shows us that there is a knowledge gap concerning Bystander conflict training for POs. It is a necessity to threat this knowledge gap. Therefore, we propose to develop a VR training to stimulate POs to use de-escalation techniques in bystander conflicts.

3

Research Context

3.1. Problem Analysis

In the footage shared in the article by Verhaeghe et al. [2020], one can see how the POs try to arrest a suspect in a problem neighbourhood of Brussels. The arrest was performed in a tumultuous period in this neighbourhood due to the death of a suspect being chased by POs (Anne Vanrenterghem [2020]).

The intervention started in the middle of the day. The POs had to arrest a suspect who had been in a knife fight. The suspect refused to go with the POs calmly and resisted his arrest. The POs start to struggle with the suspect in an attempt to subdue him for arrest. The bystanders are filming the intervention. While on the ground, the bystanders first try to pull the suspect away from the POs, thus helping the suspect in resisting the arrest. After some time the situation escalates more, while the POs wait on reinforcements. The crowd starts to grow around the POs. Some of the bystanders start to push one of the POs. In the last effort to resist the arrest, one of the bystanders then brutally hits one of the POs. At the end of the video, reinforcements arrive and the suspect can be arrested successfully.

This situation does not show how the escalation started however according to Aytaç et al. [2018] the POs should have relied only on non-violent arresting methods. They considered that bystanders are more willing to join a protest when the POs utilizes a harsh treatment against the perpetrator. Especially when the protest is targeted against the POs to start with Stott and Reicher [1998]. Given that so many people were on the street, who all were emotionally connected due to the death of the suspect earlier in this neighbourhood, one could state that these are similar circumstances as during a protest targeted against POs. Based on the Construal-level theory proposed by Trope and Liberman [2010] one could stat the bystanders feel very connected to the perpetrator. Because of this background the POs on scene should have been very aware of the escalation risk while going on this intervention and how they should have handled the situation. This shows how important it is to be able to have proper training about certain situations so that the POs can utilize proper de-escalation techniques and avoid escalation. Especially in a neighbourhood where there is a big social distance between the inhabitants and the POs. When not being able to de-escalate a situation the outcome can quickly turn and as in this intervention a PO gets physically harmed. He sustained injuries which made him unable to work for at

least a week.

We believe that if the POs on scene would have been given the appropriate training, they would have been more aware of the potential explosive situation. By knowing this they could have utilized another approach, one that utilized the appropriate de-escalation techniques. Therefore, de-escalating the situation and consequently avoiding being assaulted by the bystanders and becoming work incapacitated.

In addition to this we conducted several interviews with experts on this topic in Belgium. All of the experts confirmed that current training on this topic is lacking. The most relevant training sessions they received was how they have to handle bystanders taking video footage of interventions. They also acknowledged that having more knowledge about how to handle these conflicts would be very welcomed by them and their colleagues as lately the bystander conflict has been becoming more common.

3.2. VIRTUAL TRAINING

Virtual training has a broad definition, it ranges from classes organized over Zoom to digital copies of an environment to train a person Huggett [2018]. But one thing all of them got in common, they provide knowledge over or through a digital platform. They remove the need of travel and location hiring and therefore making this knowledge more accessible and more affordable. This is one of the reasons why virtual training is becoming more and more popular. The recent Corona epidemic also showed us that it is not always possible to organize meetups with multiple people to organize training sessions.

For this research we do not focus on the training but more on the simulation and the effect it has on the POs. Labeling this as a training would be out of scope of this thesis. However the goal is to see and understand the effectiveness of this simulation and how well the knowledge transfers to the PO. To ensure high knowledge transfer we have to increase the presence of the PO as much as possible Tichon [2007]. One part of increased presence is realistic graphics as this is still very limited to the platform we should focus as much as possible on believable events and behaviour of the agents Murakami et al. [2005]. According to Murakami et al a realistic virtual training needs multiple agents that incorporate realistic but different behaviour.

3.3. AGENT-BASED MODELLING AND SIMULATION

Agent-based modeling and simulation or ABMS is a way to model complex systems that exists of multiple agents where every agent has behaviour defined by a set of rules. These agents can then react with each-other during a simulation. When the simulation is done one can compare the end state of the simulation and all the agents and make some conclusions Klügl and Bazzan [2012]. A typical agent based simulation will consists of a set of agents, a relation between these agents and their environment Macal and North [2005].

For this research we will be also using an agent based. The perpetrator and the by-standers will be autonomous agents and the POs will be agents but these actions are decided by the input of the PO. All these agents will have a predefined relation, for example the perpetrator

might be related to the bystander and this will influence the entire simulation. There will be three defined environments which we will use for the different simulations, all these environments will also influence all the agents in its own way. Then by the end of the simulation one can make a conclusion based on all the data of the different agents and environment.

3.4. GAMIFICATION

Gamification is a term that is used when game elements are used in a non game context Deterding et al. [2011]. It can be used to provide additional motivation and drive more engagement towards a certain service, platform or activity. Multiple studies state that when applied to their specific context it can increase motivation and engagement of the user Denny [2013]; Eickhoff et al. [2012]; Hamari et al. [2014]; Thom et al. [2012].

In the context of education there are some mixed results Dichev and Dicheva [2017], although there are more positive as negative results reported most of the results are described as inconclusive. This can mostly be attributed as Dichev et al formulated a more strict approach to validate earlier performed studies and most of the studies did not include enough tests or metrics. In the context of training we can see that it can increase intrinsic motivation and engagement of the trainee Barneveld [2014]; Helms et al. [2015].

Proving that gamification does or does not work within our context is out of scope of this Master thesis, however the artefact will incorporate some gamified elements to create a motivational design. As shown by Deterding [2012]; Hamzah et al. [2015] the successful implementation of a motivational design in an educational or trainee program does increase the success rate.

3.4.1. PLAYER TYPES

According to Bartle [1996] there are 4 different base player types Achiever, Explorer, Socializer and killer. Although some state that this representation is too simple Hamari and Tuunanen [2014] argue that using these defined player types is a good base for the design.

During the design one has to take into account that these different player types will need a specific motivation to stay engaged with the artifact. The achiever will need clear goals, the explorer will need enough freedom to find things out on its own, the socializer will mostly be interested on how communication works within the simulation and the killer wants to use the game systems against other players. Although a player can drift between all four types, often a preference is found towards one type.

For this research we will mostly trigger the achiever as the goal is clear, you have to pass the simulation without escalation. There will be some interest for the explorer player type as the player can choose between different options and will have to observe the environment to succeed. The socializer will also have some points that will interest him as he will have to see how the different agents communicate with each other and based on that he will have to choose his own communication. The killer will find slightly less motivation to play the game as its not based to compete with others. There is room to implement a scoring table where you can compare with your peers to provide some additional motivation

Figure 3.1: A person playing a VR fitness game Leatham [2018]

for third player type.

3.4.2. Player Motivation Types

A player can be motivated in two ways, intrinsic or extrinsic. Where intrinsic is about doing something that in itself is fun or rewarding extrinsic is about how you do something to get a reward not directly from your behaviour Legault [2020]. An example would be when a person takes a walk outside because he enjoys nature, this is intrinsic. It gives this person nothing but enjoying the walk it self. When one would train hard for a walking competition to eventually win it. The motivation to train hard every day is extrinsic, as the task that is being done is not necessarily enjoyable on its own.

The motivation for the PO is mostly extrinsic as the reward of completing this simulation will be that he/she will be able to deal in a better way with bystander conflicts.

3.5. Virtual Reality

Virtual Reality was originally described as an advanced human computer interface. An interface capable to simulate an entire environment where a person could walk in freely Zheng et al. [1998]. These days Virtual reality is mostly used when talking about the specific usage of a Virtual Reality headset in a virtual space. A space where you can have multiple degrees of freedom for movement depending on the hardware you are using. A 3 DoF headset is a headset that can track rotational movement. These devices rely on a gyroscope chip Scarborough [1958] and an accelerometer for measuring how many degrees your headset is rotating around. This information is then applied to the camera of the virtual world and renders an image for the user as it looks like he/she is also rotating in the virtual world.

A 6 DoF headset does not only track the rotation but also the movement of the user. This device mostly relies on optical data for this movement and to some degree on the accelerometer. An example of someone playing a VR-game with full free movement can be found in 3.1.

There are two sub types of headsets in this categories: headsets that rely on inside out tracking or on outside-in tracking. If a headset requires one or more external beacons equipped with infrared cameras it uses outside-in tracking. These beacon locations are read out by the headset and then by applying triangulation the position of the headset can be calculated. The other type of headset only relies on a set of infrared cameras which are pointed outward of the headset, inside out. These cameras are capable of mapping the room that the headset is in and then use this 3D mapping of the environment to calculate the position of the headset and the movement.

3.6. Game Engine

A Game engine is a name used for a framework that you can use to create games. By using a framework like this one can speed up development tremendously as it will handle multiple complex software tasks like 3D rendering, physic simulation, AI-behaviour or sound simulations.

Game engines used to be very niche and only used for game productions but lately they are ever present in all industries. The technology behind the engines increased so much we can see them even being used in Hollywood blockbuster productions like Disney's The Mandalorian or rendering the dashboard of the latest GMC HUMMER EV.

There are multiple game engines who go from very bare bones like Monogame or Godot to engines like Epic's Unreal Engine Epic [2014b] or Unity Technologies [2005]. These provide not only a framework but also a front end with multiple tools that speed up the game creation process.

3.6.1. 3D model

A simplification of a 3D Model is that its a data structure containing a bunch of points where every point is a 3D coordinate and a list of how to connect said points to each other. When you input this data structure in any SDK like a game engine it will 3D render this by using a graphical API like OpenGL or Vulkan. These programs will make a 3D image out of this data. This image can then be output on a display. It is relevant to know that how more detailed your 3D model is the bigger the data structure and the harder it will be for your computer to translate this into an image which can be displayed by your computer. Especially if you want to create a Virtual Reality experience where you have to output 4K images at over 90 frames per second. In figure 3.2 you can find an example 3D model in the Unreal Engine editor.

3.7. Conclusion

Now that there is a more clear idea of what is behind a VR-simulation one can now start on the implementation of the artefact. This will be done in the next chapter - Research Methodology. The chapter starts by splitting the main research questions in multiple smaller

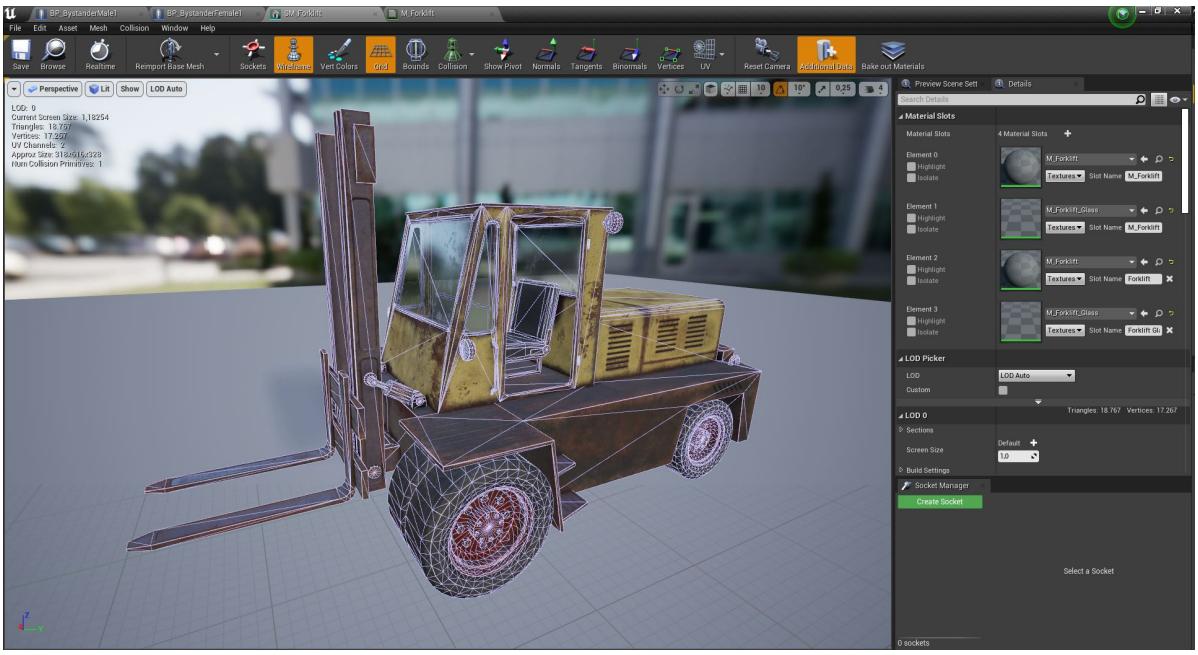

Figure 3.2: Example 3D model

ones and then based on that a research method will be proposed.

4

RESEARCH METHODOLOGY

4.1. RESEARCH QUESTIONS

The goal of this research is to create an artefact capable to simulate police bystander conflicts and their de-escalation techniques using VR-technologies. By simulating these the artefact aims to support police training. In order to achieve the objective of this research, the following main research-question is considered:

RQ: How to design a VR-game for simulating Police bystander conflicts?
The focus will be on the design of an artefact that fulfils this main purpose. The requirements will have to be set up and implemented. Finally, the artefact will have to be evaluated on how effective the training was. To provide an answer to the main research question, we have considered splitting it up into multiple sub-questions.

RQ1: What are the design requirements necessary to build the VR-game?
Design requirements are collected and documented before development of an artifact can start. For this research two sets of requirements are considered: functional and non-functional. The functional requirements will be about what the system has to do. The non-functional requirements will focus on all the points related to how the system has to do it. The non-functional ones will be based on the technological, psychological, criminology, police-related and educational aspects. This will all be connected both with literature and expert interviews.

RQ2: What are the actions describing VR-game simulation scenarios?
The design requirements from RQ1 are ready to be implemented in this phase. A template will be defined and developed for a general case scenario. This template will include all the requirements, entities, actions and contexts. Using this template we can fill in specific data. These data is collected by research, by analyzing multi source open data such as, open source video footage, news articles and further enhanced by expert interviews and their experiences. This input will then be used to create multiple different training scenarios. Every scenario will differ based on the requirements researched during RQ1.

RQ3: How to implement the VR-game?
Our artefact will be split into multiple blocks. By following a component-based architec-

ture, the artefact could be extended with more requirements if needed. For example, if the input handling of the artefact is put in a separate block, it can be changed later on from the current 'select an action' to a system that recognizes the gestures of the VR-player and performs actions based on that. First, all the different functionality of the artefact will have to be split into these different blocks. Second, all these different blocks will need to be able to communicate and operate with each other.

RQ3a: What are the software and hardware implementation blocks?

The soft and hardware blocks will be split up based on their specific responsibilities. The blocks will follow the high cohesion low coupling principle, making it easier to change, add or remove blocks during the research.

RQ3b: How to implement and connect these blocks?

The blocks will be connected with as low coupling as possible. The blocks should be able to encapsulate their functionality by requiring minimal additional functionality of other blocks. This way the artefact could be extended during later research with other ways of input, like the gesture-based one or a new way of visualization of the simulations aside from VR.

RQ4: How to evaluate the VR-game using the simulation scenarios considered?

When the artefact is developed it further needs to be tested and evaluated. Firstly, the criteria to perform the evaluation have to be considered. These criteria will be based on some of the functional requirements collected during RQ1, literature and other criteria such as stability, degree of usefulness, ease-of-use, etc. Secondly, data will be collected during both surveys before, during and after the training session and with non-intrusive analytics. This implies that we will capture and save actions and events during the trainee's play through in the background. The POs experience will not be interrupted. And thirdly, the whole data will have to be interpreted and based on these results some lessons learned and recommendations will be defined. The data will have to be made accessible through a general graphical interface which can present all the aggregated data of all the sessions and the surveys. Based on these findings, final remarks and conclusions will be considered, and further training options will be recommended to the trainee.

RQ4a: What are the evaluation criteria that should be considered to evaluate the VR-game?

Evaluation criteria will be based on the functional requirements defined during RQ1, literature and other criteria such as stability, degree of usefulness, ease of use, etc. These will be further discussed in chapter 6 - Solution Evaluation.

RQ4b: What are the results of the evaluation?

The identified criteria will have to be converted into measurable parameters which then get logged during a training session or collected by the survey. These results of the evaluation will form the data which can be aggregated to form conclusions and findings. The PO will also get the opportunity to rate the feeling of success of his training. This provides the opportunity to show the success-rate of POs in each scenario.

RQ4c: What are the lessons learned and further training recommendations?

The data collected during RQ4B will be aggregated to form a report for the trainee. It will

show what lessons the trainee learned and what further training recommendations can be made.

4.2. Research method

In the previous section we have described each sub question. Further, we will elaborate the research methodology that will be used. In each step of this methodology we will reference what specific research question is being solved by this step. The problem requires the development of an artefact with societal impact. This artefact has to be designed before it can be developed. Thus a proper research method would be the Design Science Research methodology. The problem will be further researched, analyzed and subsequently, the artefact will be created. We will follow the methodology suggested by Peffers et al. [2007]. Peffers considers that there are 6 steps to break down such a problem.

4.2.1. Step 1: Problem identification and motivation

In the first step, one has to identify the problem and motivate why it should be solved. The recent COVID outbreak learned us how critical proper handling of bystander conflicts are. Many situations escalated recently which may have turned out differently if the POs on the scene would have received the proper training to handle a situation like this. Todak and James [2018] showed that using the right de-escalation techniques can reduce the prevalence of violence. van Erp et al. [2018] provided training for public service workers and proved that after the training the subject was better able to handle these situations and also was able to properly use the techniques learned in real-life situations. By creating the solution in VR we increase the presence of the PO and can ensure a better and faster transfer of the knowledge Alexander et al. [2005].

As part of the problem identification we also conducted multiple interviews with experts about the topic. The interviews confirmed that currently there is a lack of training about bystander conflicts. There is also a rising trend in the amount of bystander conflicts the POs have to deal with. Most notable COVID and the enforcement of various lockdown rules were often met with escalating situations. This step solves some parts of RQ1 some of the functional requirements will be made during this step.

4.2.2. Step 2: Define the objectives for a solution

In this step, the objectives for the solution are defined. The end goal is to provide a training artefact for the POs to train how they handle bystander conflicts. The artefact will have to train them about proper de-escalation techniques and also how to decrease the power of social distance. The artefact has to be intuitive and has to be easily used. This means that the artefact should be usable by the PO completely individually. Furthermore, the artefact has to be able to monitor the progress of the PO and has to give meaningful feedback towards the PO on what points he/she did not use the proper technique or when he was able to make the right choices.

During this step RQ1 was solved. Furthermore some actions that are needed for RQ2 were also be described during this step. There was an exploratory interview as can be seen in 4.1. Based on these interviews (see appendix .1) certain requirements were defined as to what

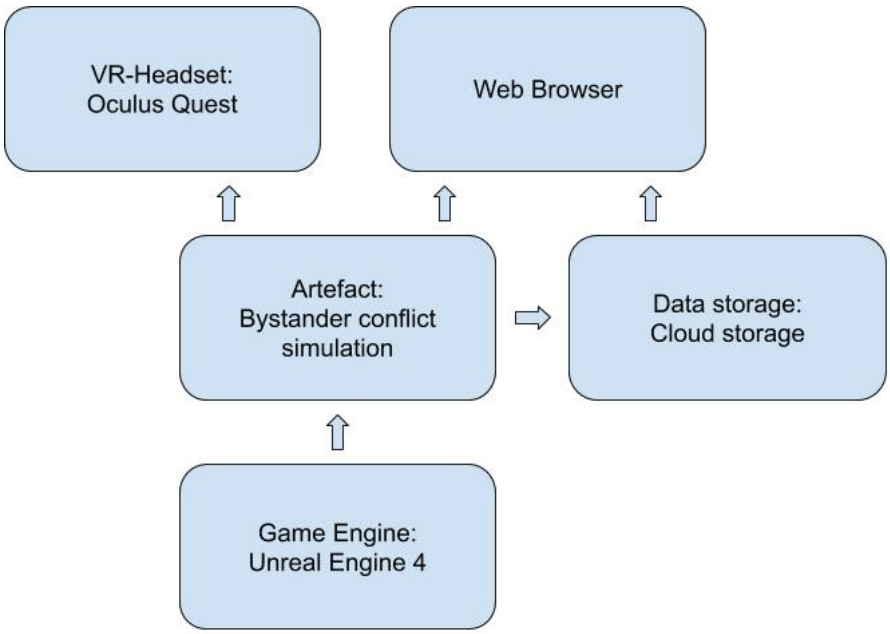

Figure 4.1: Architecture overview

is important for the artefact.

	Years of experience	**Participated in**	**Date**
PO 1	28	exploratory interview, simulation, pre/post interview, workshop	25/10/2021, 20/05/2022
PO 2	12	exploratory interview	04/10/2021
PO 3	1	exploratory interview, simulation, pre/post interview, workshop	25/10/2021, 20/05/2022
PO 4	18	exploratory interview	25/10/2021

Table 4.1: Exploratory interview

4.2.3. Step 3: Design and development

The artefact will be created in this step. All the desired functional and non functional requirements will be further described and defined. These requirements are collected from an ongoing research multidisciplinary research conducted in related research projects. This will further be enhanced by research previously done on this subject and interviews with field experts. Figure 4.1 shows the different blocks the artefact will be using. Which will be further discussed underneath.

Figure 4.2: Meta Human examples EpicGames [2020]

UNREAL ENGINE

For this research we will work with Epic's Unreal Engine Epic [2014a]. An engine that has a very advanced tool set and lots of help-full plugins. The recent acquisition of 3Lateral and integration of Meta Humans into the engine makes this also the preferred choice if you were to create something where you need realistic avatars see 4.2.

Our project will heavily rely on realistic avatars so this is one of the main reason we choice for this engine. The creation of a digital avatar normally can take up multiple man months done by a team of several specialists, you would need an artist who can model the body and the face, then create multiple blend shapes for different face expressions, then you would need to rig the entire character and skin it to the rig and eventually you would have to motion capture an actor and apply these animations on the digital avatar. By using Unreal Engine we can skip most of this process and we only have to implement the motion capturing part ourselves.

Unreal engine also comes with a custom node system for creating AI Agents as shown in 4.3, called Behaviour Trees. This system provides a framework for building complex decision trees and behaviour. It makes it easier to make robust logic and also adds a lot of debugging tools. This again will save us a considerable amount of time and lets us focus more on creating the logic behind the agents. Figure 4.4 Shows an example of a typical view within Unreal Engine. At the left side of the image you can see some Blueprint Logic and at the right side there is an example of a Behaviour Tree.

ARTEFACT: BYSTANDER CONFLICT SIMULATION

The artefact block is the part where all the functionality and usability is present. Firstly, it will produce the bystander conflict simulations and send it to either the VR-headset or a web browser for visualisation. Secondly, the user input received by the users will also be

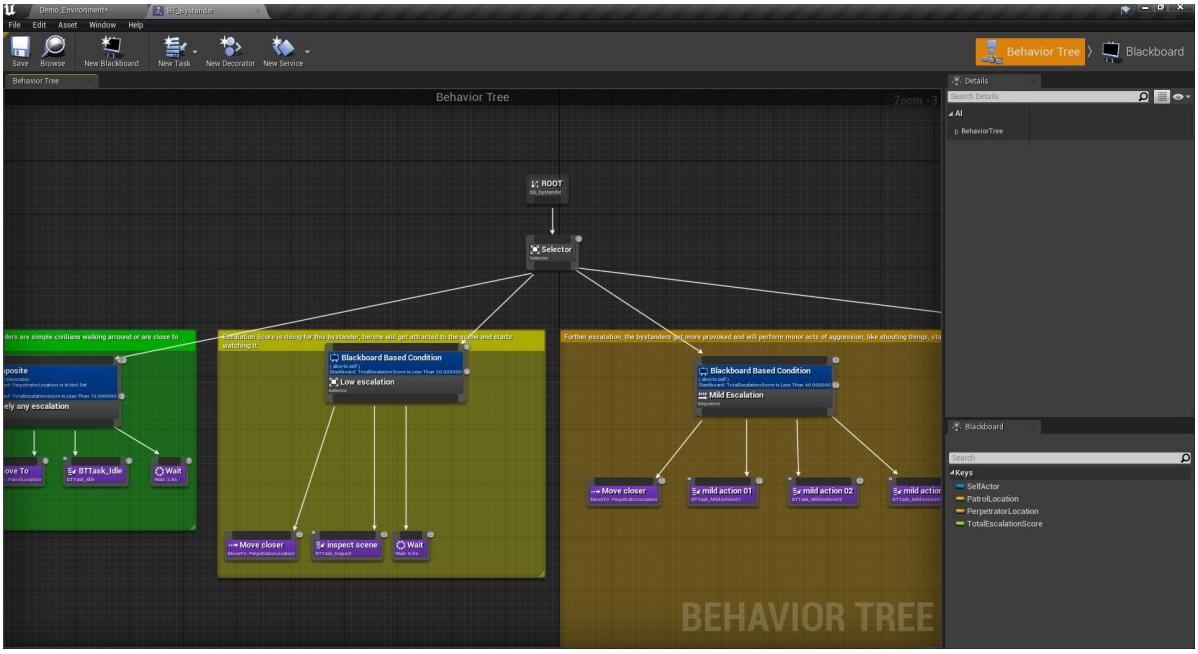

Figure 4.3: Behaviour tree example

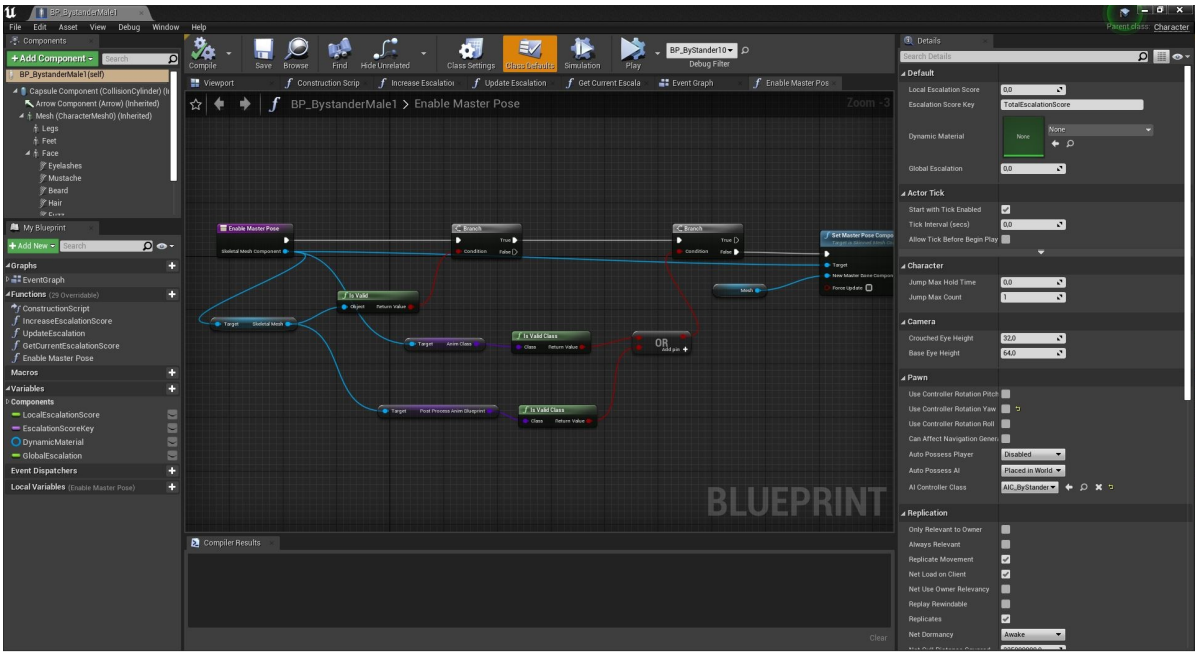

Figure 4.4: Unreal Engine editor

Figure 4.5: Quest 2 Meta [2020]

sent to this block and will be processed to trigger the appropriate action in the simulation. Thirdly, data will be collected in this block during a training session. This data will then be sent to the Data storage block. The simulation will follow a set of rules based on currently ongoing multi disciplinary research, analyzing open source footage of real events and interviews with POs.

Data Storage

The Data storage block is the place where all the data that gets collected in the artefact block gets send to. In here the data will be stored. The database was going to use a cloud storage solution. Such solutions are not only fast to set up and hook up with the artefact they also rely on a robust and secure system to store the data. Using the security system set up by the cloud provider we also ensure the privacy and safety of the collected data. This block will also contain an API which will make the data accessible for the Web Browser block.
Due to timing restrictions this cloud storage block has been moved to a solution where the data was stored locally in JSON-files Crockford [2000] on the PC which where then copied and read out to analyze the results.

VR Headset

The VR-headset block is the block that contains the interface for the user to interact with the artefact. By utilizing the VR-headset the trainee will be able to view and interact with the bystander simulations.

For this research the Oculus Quest will be used. See image 4.5 This is a headset that uses inside out tracking. This device can also be used without an external hardware device for

rendering. It is a standalone Android device that is capable of rendering stereo 3D graphics. For heavier programs it can also be linked to an external PC which then handles the rendering and game logic and then the Quest is only used as an head mounted interface.

We choose to use this device for our study for a number of reasons. Firstly, we needed a device capable of running relatively heavy simulations and that still offers the flexibility of being standalone. Using the flexibility of the standalone device we can reach and test with more POs. Other standalone devices are either a lot more expensive, like the Pico G2 and the VIVE Focus, or do not got enough CPU and GPU power to run the simulation like the Mi VR from Xiaomi.

Secondly the Quest is developed on Android which is a very accessible platform. More over most of the game engines got direct integration of the Oculus Quest in their engine which will cut development time a lot for the artifact. As this simulation will be made by a single developer this is a big concern for this project.

Web Browser

The Web Browser block is a block with two purposes. Firstly, it will visualize all the aggregated data collected by the artefact analytics and surveys. This can be used to define some of the lessons learned required by RQ4C. Secondly, the web browser can serve as an alternative front to use for the training artefact in case we are unable to distribute the headsets to the appropriate am mount of testers.

To Conclude during step 03 - Design and development RQ2 will be solved completely, all the PO actions will be described and these will then be used to create the template that described all the requirements, entities, actions and contexts. Secondly RQ3 will also be solved completely. The artefact will be created, all the different soft- and hardware-implementation blocks will be declared and implemented.

4.2.4. Step 4: Demonstration

During this step, the artefact has to show that the problem defined in step 1 is solved. In this step different POs of different background characteristics will be given the opportunity to test the Virtual Reality experience. A Police Force located in the Flemish province East-Flanders agreed on testing the artefact with a number of POs. There will be three different scenarios to test out. During each scenario, the escalation and difficulty will increase. This way one can analyze whether the PO becomes better in de-escalation over the course of the training. There will be multiple training sessions spread over a couple of weeks most fitting for the Police Forces training calendar.

Every scenario will include citizens which have a different likelihood of starting the violence. The first scenario will be a regular PO intervention on a regular day. The de-escalation lays strongly on the use of the techniques by the PO alone. The second one will be an intervention during the COVID-19 period. Citizens are more likely to protest during times of crisis Cristancho et al. [2019]. The final scene will be during a protest. In a protest, bystanders feel more connected to the cause and are often angry. Escalation during protests can lead to riots.

There will be different situations which will test different dynamics between the bystanders. For example Aytaç et al. [2018] stated that when intervening during a protest with force which seems excessive for bystanders will cause them to join the protest. Every situation will require a different approach of the PO hence training them with a broader set of techniques to utilize in real-life situations. By demonstrating three scenarios the insensibility of the artefact is also shown. If the designed template is able to create three different simulations it should also be able to generate even more.

During this part all the data needed to solve RQ4 will be collected. Also some non-functional requirements like stability and use-ability will be monitored during this step which are some of the evaluation criteria defined in RQ4a.

4.2.5. Step 5: Evaluation

The evaluation will be a mixed approach both qualitative aspects and quantitative aspects will be combined. After the demonstration, the criteria that were defined during RQ4A will be used. These will be based on some of the non-functional requirements collected during RQ1 and the non-functional ones such as stability, degree of usefulness, ease of use, etc.

Data will be collected on different points during the session. Before the POs use the artefact there will be a pre-survey. While the POs use the training artefact there will be non-intrusive analytics build into the artefact which will monitor events during the actual VR-session. This facilitates the registration of actions and choices taken by POs. By doing this, one can evaluate how well a PO improves during and between every scenario.

After every session, there will be a survey which will give us more insight into how well the PO perceived the training. By doing this, one can examine how well the PO absorbed the knowledge learned during the training by evaluating the improvement of his techniques during multiple sessions and the pre-survey. The intervention of the artefact itself will be rated by the POs. They will rate the feeling of success of the training. This can be done by providing a survey after the training to brief after their feelings about the training. All of this aggregated data than can be used to form some lessons learned and further training recommendations for the PO. All of the surveys we use during this step are reviewed and approved by the Research Ethics Committee of the Open University (cETO).

During this step RQ4b will be solved. The data is collected and by using these we will have a result of the evaluation.

4.2.6. Step 6: Communication

When the artefact is tested out and the evaluation is performed all of this data and research will be put into a report. These results will be documented in the thesis. During this step, there will also be room to suggest possible extensions for future research.

This step will solve RQ4c since the report will contain the lessons learned and will suggest possible future training recommendations.

5

Solution Implementation

5.1. Solution design

The design of this artifact was based on the Design Science Research methodology. Furthermore by using literature and interviews with experts a set of scenario's was made.These scenario's have their difficulty scale based on using the Construal-level theory of psychological distance defined by Trope and Liberman [2010]. They state that the closer a bystander is connected either social, temporal, physical or hypothetical the more likely they are to intervene during the intervention. Based on Todak [2017]; Todak and James [2018] we determined a set of tactics one can use to de-escalate a situation and how impact-full that is. In 5.1 you can see what techniques exists and how they are valued during the simulation. The higher the respective success rate the better they will reduce the current escalation score of the scenario.

5.1.1. Interviews

In table 4.1 one can see the different POs that participated in the exploratory interviews. These interviews were semi-structured and were used to help design the game scenarios. During these interviews found in most of the aspects about the research we assumed from literature were confirmed. There is indeed a great need of more education concerning bystander conflicts. The PO's were mostly interested in scenario's that are realistic and make sense to what they encounter during their day to day job. Therefore we based our scenario's not only on literature but also on the interviews and online footage that we found of PO-interventions. During the interviews the experts also indicated that enforcing covid rules was for example a situation that can easily escalated. Because of this scenario 02 is an enforcement of the COVID restrictions.

5.1.2. Game Scenario

Game Design Elements

Mechanics

Every scenario will give the PO three points of action where he/she will be presented with a situation. In every situation the PO will get to choose between 3 different reactions. Based on the selected reaction the situation will evolve into the next point of action.
There are 4 different thresholds that can be reached in the scenario in terms of escalation

Tactic	Description	Recognition	Success rate
Respect	Talking to a person in a respectful tone is key in defusing a crisis	Signs of respect	80%
Calm	Staying calm and making effort to keep one's emotions in check during stressful situations is critical	Request citizens to calm down, lower own voice.	22%
Honestly	Being forthright with the citizen about the facts of the case, about the legal system, and the officer's authority can aid in mutual understanding	The PO provides the citizen with a legal lesson, about what the officer can and cannot do.	75%
Shoes	Putting yourself in the persons shoes can help the officer to empathize for the reasons of current predicament	"If I were you I would stop doing this and avoid an arrest"	73%
Compromise	The officer makes an offer to reduce the charges	"If you make sure you son would not cause any trouble in the future, I will only give a warning"	84%
Listen	Listening to the citizen's side of the story relays that voice is being heard and helps the officer learn the root of the problem	Allow a citizen to tell their side of the story.	79%
Human	treating the interaction as if it is occurring between two equals and not between a cop and a suspect can reduce the power differential and make the citizen feel as if they are on equal terms. The human tactic can be achieved by introducing oneself by first name, shaking hands, and avoiding "cop talk."	Cops introduced themselves by their first name and avoided cop talking. POs seem to be aware of negative effect of power difference.	83%
Empower	engaging citizens in the decision-making process and encouraging them to make better decisions for themselves moving forward was defined as a useful de-escalation tool.	Provide people self-power. For example: to encourage homeless to go a homeless service by telling them the place to go.	80%

Table 5.1: Table de-escalation techniques Todak and James [2018] - used for scoring scenario-escalation

scoring. The added values are based on how many different tactics were or were not applied and if certain scenario's already started with a base higher escalation score due to to

Score	Escalation mode	Implication
0 - 10	No Escalation	Bystanders are wandering around, are not intervening.
10 - 20	Minor Escalation	Bystanders will get closer, mostly listen or watch the situation.
20 - 40	Mild Escalation	Bystanders will get a lot closer, start to gesture aggressive motions.
40+	Escalated	Bystanders will physically intervene.

Table 5.2: Escalation Thresholds

scenario setup. In table 5.2 you can see what thresh holds and what score is used.

Story

Every story will be a type of intervention that the PO is called in for. The three different scenarios will not have a story that connects them and are three separate situations.

Aesthetics

Realism for both graphics as sound effects.

Technology

The game will run using the Unreal Engine 4 (UE4) Game engine and a VR-headset. It will be written by a combination with the built in visual scripting language called Blueprints and C++.

Player Types

The game will mostly be for the Achiever player type, there is a clear goal to finish the scenario without escalation Bartle [1996].

Player Motivation Types

Both Extrinsic and Intrinsic motivation types are triggered during the simulation. A PO knows that de escalation is important and knows his/her colleagues expect this from him as well. But they will also want to improve for themselves as escalated situations are not only detrimental for their colleagues health but also for their own Legault [2020].

Player Action Types

The player can choose an option out of 4 different multiple choice options.

Rule Analysis

Operational rules

By putting on the VR headset the player starts the simulation. From this point to the end the player will have to follow the instructions that are given to him/her in the headset. By moving the controllers they hold in their hands, they will be able to select different options during the play through.

Foundational rules

Every scenario will be managed by a global manager that measures the escalation score. When this score reaches a certain threshold, the situation will escalate and the PO will lose the game. This threshold will be determined by observing different footage of escalated situations. Based on how quickly these situations escalate you can determine how many mistakes can be made in that specific scenario.

Behavioral rules

The PO will not see a counter of the escalation score, he/she will only notice the escalation rate by observing the reactions on his/her actions. Because if we would show this it would

no longer be a correct and realistic representation of real life.
Written rules
Before the game starts the PO will receive a short briefing on how he has to use the headset and how he will be able to use the different controls that are needed while playing the game. Before every scenario starts the PO will see a short briefing about the intervention he will be sent to. He/She will also be signing an informed consent with some more information about this study.

Case Scenario Input Variables
Actions and reactions of POs.
Actions' assessment of POs to understand why the escalation takes place.
Learning assessment level after each difficulty / intensity level.

5.2. Game scenario description

5.2.1. Regular intervention arrest
Inspiration/Sources
This scenario is based on the interviews with the experts.
Additional inspiration:

- Jan-Willem [2016a]: regular stopping a driver to ask for driver license etc, very well handled and explained what the person does wrong.
- Jan-Willem [2016b]: PO is called in to check for someone who is causing trouble in the neighborhood by yelling at others. After asking for an ID multiple times where the man is refusing to cooperate eventually they have to go on and arrest the man. Even then they ask the perpetrator to cooperate and if not they will have to use violence. Eventually they make an arrest.
- Jan-Willem [2022]:arrest of someone with stolen scooter, apparently someone of the bystanders keeps cursing on all the POs that are on scene. The POs react by arresting that specific person and taking him to office.

Scenario Aim Let the PO get used to the VR setting, to the different choices he will get, seeing how he reacts in a very modest environment so he can learn from a low challenging environment and take this experience in the next few scenarios.
Learning Objectives The PO will learn how to use some basic de escalation techniques in a safe environment. **Learning Activities (actions)**

- Observing the scene to use all the information available to him.
- Choosing the right set of actions based on these observations.
- Applying the right de-escalation methods based on the situation.

Context Description/Background
Story line: The PO is called for an intervention in broad daylight in a peaceful neighborhood. There is no obvious reason for escalation. The bystander involved in this conflict will be a female as Loef et al. [2010] showed that 84% of perpetrators of public violence is male.

Having a female as bystander makes it so that there is less chance of an escalated conflict.
Environment
Regular neighborhood Distrust towards POs in these kind of neighborhoods is relatively low. Rodriguez et al. [2018] showed us that when bystanders distrust the state or POs the chance of escalation rises.
Time of day
As this is a beginner situation it will be situated in the middle of the day as van den Brink et al. [2015] stated that during the daytime there is less chance of an escalation.

ACTOR PROFILE

Regular intervention			
Variable	**PO**	**Perpetrator**	**Bystander**
Age	..	25	28
Gender	..	male	female
Race	..	Caucasian	mixed
Region	..	Belgian	Belgian
Experience	..	/	/
Shift	..	/	/
Social status	/	middle or lower class	middle or lower class
Social distance	/	family	family or friends
Negative Expectation	..	no	no

DIALOGUES

Option A	**Option B**	**Option C**	**Option D**
Step 01			
Hallo, mijn naam is agent .. . Ik heb enkele vragen voor je. Zou je identiteitspapieren kunnen pakken en ze tonen aan mij?	Hallo meneer, kan u even je papieren tonen?	Papieren alstublieft!	Hey jij, papieren nu!
Mag ik vragen waarom juist? Ik heb toch niets misdaan?	Mag ik vragen waarom juist? Ik heb toch niets misdaan?	Waarom, ik doe toch niets verkeerd?	Waarom, ik doe toch niets verkeerd?
+ 0	+ 0	+ 5	+10
Respect, Calm, Human	Respect, Calm	Show of force, Respect	show of force

Step 02			
Neen hoor dit is gewoon een routine controle, als ik zie dat er niets mis is na de check met de centrale dan kan je terug beschikken.	Ik neem deze even mee om na te kijken in de auto.	Als je je papieren nu niet geeft dan neem ik je mee naar het bureau!	Ik moet niet verklaren waarom ik je papieren nakijkt, jij moet je papieren afgeven!
Oh oke, geen probleem ik ben zeker dat er dan geen problemen zijn.	Waarom wat moet je nakijken dan?	Zo ver moet het niet komen hier zijn mijn papieren.	Oh.. uhm excuses hier zijn ze.
- 5	+ 0	+ 5	+10
Respect, Calm, Human, Honesty	Respect, Calm	Show of force	show of force
Step 03			
Hey hier zijn je papieren terug, hartelijk dank voor je medewerking en nog een prettige dag verder.	Geen zorgen dit is een gewone routine controle, wanneer we je papieren hebben nagekeken bij de centrale mag je gaan.	Hier wachten terwijl ik alles nakijk in de auto!	Dat dacht ik al, niet vergeten naar wie je moet luisteren he!
Oke bedankt en tot ziens.	h oke, prima dan zal het wel geen probleem zijn, ik wacht hier even tot je de controle hebt nagezien.	Ik vind toch dat dit een beetje buitensporige is voor een gewone identiteitscontrole, ik eis een verklaring wat ik heb misdaan!	Excuses mijnheer ik wacht hier wel.
- 5	- 5	+ 5	+5
Respect, Calm, Human	Respect, Calm, Human, Honesty	Show of force	show of force

5.2.2. COVID-19 RULE ENFORCEMENT.

Inspiration/Sources

Trope and Liberman [2010] states that all dimensions of psychological distances are correlated. Both physical and emotional bounds are thus of importance during a bystander conflict. To simulate this there will be a bystander next to the perpetrator. According Phillips and Cooney [2005] the connection between the perpetrator and the bystander is stronger the more similarities are between them. The more social connection the higher the likelihood of disturbance by the bystanders. For this reason both of them are from the same neighborhood and know each other well and have the same racial features. Furthermore Loef et al. [2010] states that 84% of the perpetrators of public violence is male, hence the bystander will be a male.

- RTBF [2021]: Force full arrest in the outskirts of Brussels.

- VSOA [2020]: Escalated corona intervention.

Scenario Aim
Aim: Applying earlier learned basic de escalation techniques in a more complex environment. We will follow the de escalation techniques observed by Todak and James [2018] who observed 131 interventions and graded different types of de escalation. Respect, Honesty, Shoes, Compromise, Listen, Human and Empower are some of the most successful de-escalation techniques while lying and dominant force are more likely to end up in an escalated situation.
Learning Objectives
Correct usage of de escalation methods in a more stressful and challenging environment.
Learning Activities

- Observing the scene to use all the information available to him.
- Choosing the right set of actions based on these observations.
- Applying the right de-escalation methods based on the situation.

Context Description/Background

- Story line: The COVID restrictions are still all imposed, people have to follow certain rules and if they do not adhere like wearing a face mask the PO has to enforce these rules. The PO is called in to enforce the rules to a group of young people that are walking in the street.
- Cristancho et al. [2019] found that citizens are more willing to protest in situations of crisis. To combat the Coronavirus there were a lot of governmental regulations and restrictions for citizens. Because of this the number of conflict situations between POs and citizens increased Voskuil [2020].
- Environment: neighborhood where both persons gew up since Phillips and Cooney [2005] proved that location matters for the behavior of bystanders.
- Time of day: Day time because van den Brink et al. [2015] proved that most violence happens during weekends and nights. Because of this POs are more likely to become victims of a bystander conflict during a night shift. As we do not want to make the second scenario already too difficult we decided to have it happen during the day.

ACTOR PROFILE

Covid-19 enforcement			
Variable	**PO**	**Perpetrator**	**Bystander**
Age	..	18	18-24
Gender	..	male	male
Race	..	mixed	mixed
Region	..	Belgian	Belgian
Experience	..	/	/
Shift	..	/	/
Social status	/	middle or lower class	middle or lower class
Social distance	/	friends	friends
Negative Expectation	..	yes	yes

Option A	Option B	Option C	Option D
Step 01			
Hallo mijn naam is x , ik zie dat je mondmasker niet op staat, het is momenteel verplicht om hier je mondmasker altijd correct te dragen.	Hallo meneer, het is momenteel volgens de lockdown maatregelen nog steeds verplicht om een mondmasker op te zetten, kan je je mondmasker zo snel mogelijk op zetten?	Beste kan je je mondmasker zo snel mogelijk opzetten.	Hey jij, het niet dragen van een mondmasker levert je een boete op!
Excuseert u mij ik ben mijn mondmasker thuis vergeten.	Excuseert u mij ik ben mijn mondmasker thuis vergeten.	Hoezo waarom, ik mag toch doen wat ik wil?	Hoezo ik doe toch niets mis? Niemand ondervindt last van mij!
+ 0	+ 5	+ 10	+15
Respect, Calm, Human	Respect, Calm	Respect	show of force
Step 02			
Ik begrijp dat het soms lastig is om de maatregelen te volgen, maar we doen dit niet alleen voor ons zelf maar ook om de zwakkere van de maatschappij te beschermen. U zal toch even over huis moeten om een nieuw masker te gaan halen.	Een mondmasker is verplicht zodat u zelf en de mensen rondom u veiliger zijn. U zal toch even over huis moeten om een nieuw masker te gaan halen.	De regels zijn gemaakt om te volgen, u zal terug naar huis moeten om een mondmasker op te halen.	De maatregelen zijn al meermaals duidelijk gemaakt, buiten komen zonder masker wordt beboet!
Dat begrijp ik maar ik moet maar even langs de winkel passeren, het zal niet lang duren.	Dat begrijp ik maar ik moet maar even langs de winkel passeren, het zal niet lang duren.	Ik kan toch moeilijk helemaal over huis gaan voor zo iets klein!	Ik weiger, probeer me maar eens te verplichten een mondmasker te dragen.
- 5	+ 0	+ 5	+10
Shoes, Respect, Calm, Human	Respect, Calm, Empower	not using any techniques	No de-escalation and show of force

Step 03			
Ik heb nog een extra mondmasker bij de hand meneer, ik zal u voor 1 keer een masker geven maar zorgt u dat het volgende keer niet meer gebeurt!	Wanneer u weigert om naar huis te gaan voor een mondmasker te gaan halen moet ik u er toch op wijzen dat het niet dragen van een mondmasker u een GAS-boete kan opleveren tot wel 250 euro.	Het is een simpele keuze meneer, ofwel gaat u naar huis ofwel krijgt u een GAS boete van 250 euro.	Dan zal ik u moeten meenemen naar het politiecommissariaat!
Hartelijk dank, ik zal er zeker op letten vanaf nu.	Dat begrijp ik meneer, dan zal ik wel beter even naar huis gaan voor een mondmasker op te halen.	Mijn excuses meneer, ik ga naar huis.	Ik ben onschuldig! Ik heb ook mijn rechten!
- 5	0	+ 5	+20
Shoes, Respect, Calm, Human, Compromise	Respect, Calm	Compromise, minor usage of force	Dominating force

5.2.3. INTERVENTION DURING A PROTEST

Inspiration/Sources

For the last case we will have an intervention during a protest targeted against the government. As Thomas [2020] showed us how people that have bad feelings for their current government are more likely to use violence against public workers also including the POs. When a PO uses any form of violence during a protest like this its a big reason for the bystander to interfere and even start using violence as state by Aytaç et al. [2018]. Since a protest is used to change things a protester is more invested in both all the other protesters and the cause. When they would feel like a PO disrespects one of the other people or the reason for the protest they will resort more quickly to violence Stott and Reicher [1998].

Scenario Aim

Applying all previously learned de-escalation techniques in a very stressful and prone to escalate situation.

Learning Objectives

Correct usage of de-escalation methods in a very stressful and prone to escalate situation.

Learning Activities

- Observing the scene to use all the information available to him.
- Choosing the right set of actions based on these observations.
- Applying the right de-escalation methods based on the situation.

Context Description/Background
Story line: There is a protest going on about a politician who imposed some rules that the people do not agree with. You are asked to intervene at a situation where protesters are trying to escalate the protest and start riots.
Environment
City
Time of day
Falling of the evening, still light.

ACTOR PROFILE

Intervention during a protest			
Variable	**PO**	**Perpetrator**	**Bystander**
Age	..	28	18-30
Gender	..	male	male and female
Race	..	mixed	mixed
Region	..	Belgian	Belgian
Experience	..	/	/
Shift	..	/	/
Social status	/	middle or lower class	middle or lower class
Social distance	/	fellow protester	fellow protester
Negative Expectation	..	yes	yes

DIALOGUES

Option A	**Option B**	**Option C**	**Option D**
Step 01			
Beste wij hebben gezien op beelden dat u een steen hebt gesmeten tijdens de betoging. We hadden dit graag verder besproken op het bureau. Zou u even mee willen komen met ons.	Wij hebben beelden van u dat je een steen hebt gesmeten tijdens de betoging. Je kan nu rustig mee komen met ons of we zullen je arresteren en handboeien.	Beste, gelieve nu mee te komen naar het bureau, u staat onder arrest.	Spreid u armen, op u knieen! Je staat onder arrest.
MIk heb niets gedaan. Echt waar, het was iemand anders!	MIk heb niets gedaan. Echt waar!	Waarom, het is mijn recht om te betogen, ik heb niets verkeerd gedaan!	Probeer het mij maar eens te verplichten!
- 5	+ 0	+ 5	+15
Respect, Calm, Human, Honesty	Respect, Calm, Honesty	Respect, Calm	use of force

Step 02			
Geen probleem, als u rustig mee komt naar het bureau kunnen we rustig de beelden bekijken en kan je jouw deel van de feiten uitleggen. Wanneer het blijkt dat je onschuldig bent kan je daarna terug beschikken.	We hebben u kunnen identificeren op het beeldmateriaal en geven je nu de kans om rustig mee te komen naar de bureau. Daar kan je de verdere uitleg geven.	U kan nu rustig mee komen of we boeien u en nemen je zo mee.	Oke dan boeien we je nu, armen achter je rug!
Hoe weet ik dat dit geen trukje is om mij weg te lokken van deze betoging?	WHoe weet ik dat dit geen trukje is om mij weg te lokken van deze betoging?	Probeer mij maar eens te verplichten!	... Escalated
- 5	+ 0	+ 10	+20
Respect, Calm, Human, Honesty	Respect, Calm, Honesty	Use of force	dominating force

Step 03			
We begrijpen dat je momenteel wantrouwen hebt ten opzichte van de politiekers, maar ik kan je verzekeren dat dit niets met de betoging te maken heeft. Wanneer we dit rustig kunnen uitklaren op het bureau zal het allemaal duidelijk worden.	Je zal ons moeten vertrouwen, wij hebben geen tijd voor spelletjes. Je kan nu rustig mee komen of we boeien je en nemen je mee naar het bureau.	Oke dan boeien we je nu, armen achter je rug!	Situation already escalated
Oke, ik begrijp het goed dan kom ik mee.	oke oke rustig, ik kom wel mee.	Ik vind toch dat dit escalated	
- 5	+ 0	+ 20	+ 0
Respect, Calm, Human, Honesty	Respect, Calm	use of dominating force	

5.3. SOLUTION DEVELOPMENT

This section will explain how the logic is built up in Unreal Engine itself. The first subsection 'Code' will explain the code and logic used for running the simulation. In this section there will be a general architecture overview and then a more detailed explanation about the most important classes and actors that built up the entire experience. The Second subsection 'Art' will discuss how we went with the selection of the ART and how proper usage of technique is equally important in this step then as with regular code.

5.3.1. CODE

The most common game architecture used is a component based structure. This allows for great flexibility but still the ability to built very specialized classes. An example would be the usage of a component that encapsulate all the escalation modifiers and affects. This way the other AI's can easily access the current escalation score but they do not have to access the logic behind it. Another great advantage of this is balancing and adjusting systems like these affect all actors from a single source.

UNREAL ENGINE

For further and better understanding of the architecture of this artifact a short introduction to the Unreal game flow is explained out next. Unreal Engine starts and initializes every session in the same flow. You can see this flow in 5.1. Every part of the engine holds their own information for better data management and to assure data persistent where you want it and to clear data and or actors when you want to end a level or a scene. The game

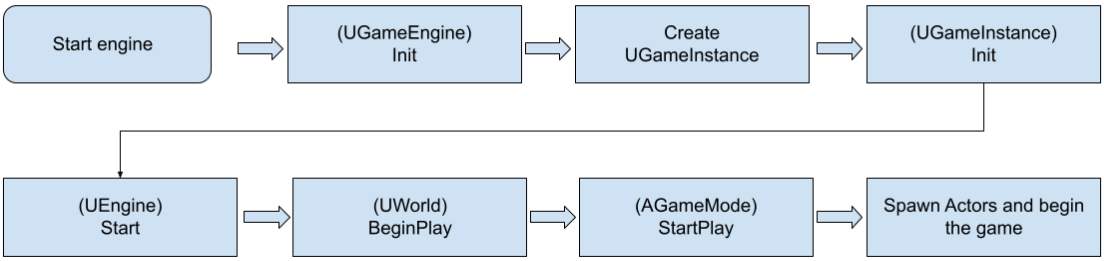

Figure 5.1: Startup flow Unreal engine

starts with initializing the engine itself. This means all the low level threads are started, the memory gets initialized and the game can start. After this base process creation the game instance is created. This is where all the per game specific data can be stored. If you want that any data is persistent throughout all your different levels you have to keep it in the UGameInstance class. After creating and initializing the game instance the engine it self can call the Engine start event. This triggers the final initialization and eventual start of the world and game mode. A game is split up in different worlds which got a set of rules defined in the game mode. After both of this classes are also correctly set up all the different actors will start spawning in the world and the game is ready to launch.

Architecture

How the overall architecture fits in this flow can be seen in 5.2. In the the game instance the current state of the simulation is stored and the different answers of the PO. By storing this data in the game instance we ensure while the program is running all this data is persistent even though we change through the different scenes. In the game instance we created a specific game mode and a world. The game mode is where we put all the rules of the simulation. In our case here we store on what specific values a scenario escalates for example. There is only data in here that defines rules and in general does not change during runtime. Then our world is created which consists of level data which is the static scenery and art, a Level Blueprint, a VR-pawn a Perpetrator-class and multiple Bystander classes.

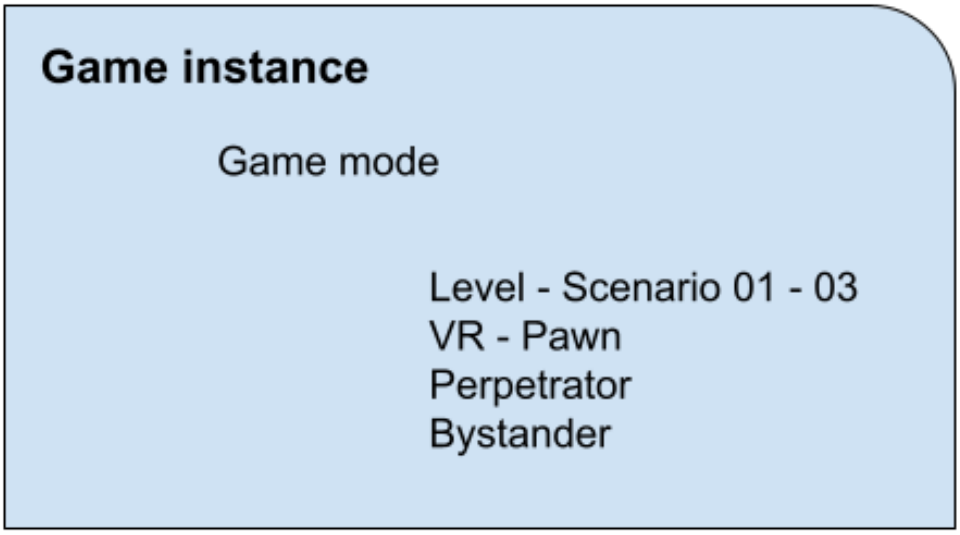

Figure 5.2: Game architecture

Level Blueprint

The level blueprint is the logic that is built up per specific scenario. This is based on the base scenario template and on top of that additional logic is added to add all the unique events and modifiers that are present per scene. The descriptions of this logic can be found in the previous section - Scenarios.

VR-Pawn

A pawn is a controllable character in a game world. The VR-pawn is basically character controlled by the player. The VR-pawn class view can be seen in 5.3 In the left top corner the hierarchy of different objects is shown which also illustrates the component based architecture of the game engine quite well. Every class is built up out of several other classes each who add specific additional functionality to the class. The camera is the class which is the in game render the player will see when actually playing the game. It defines the point of view of the simulation, in this case as our game is in VR the camera is in first person view

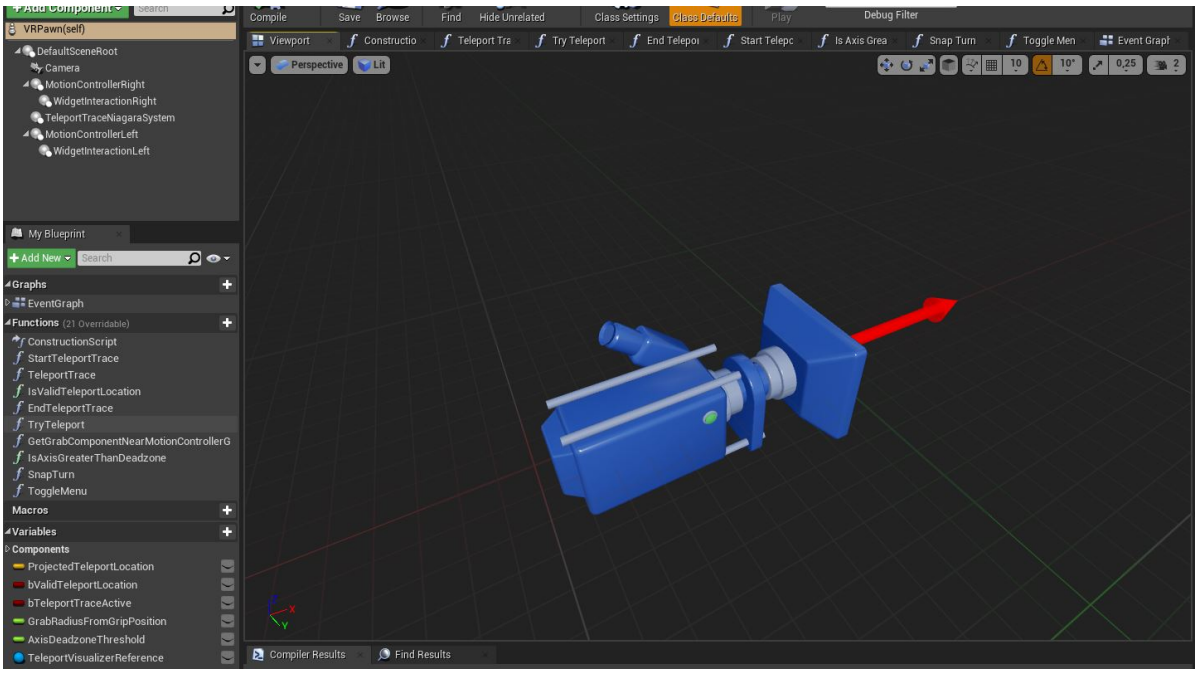

Figure 5.3: In unreal engine view of the VR-pawn

which can be seen as the camera being in the middle of the pawn and aligning with the red arrow which reflects the forward direction of this class.

Underneath the camera there are two components who handle the motion controllers of the VR-player. These objects are attached to the actual players controller location and follow these in real time. Every Motion Controller holds a WidgetInteraction component which is used to show a menu which follows the players hands while they are moving for easier interaction. Lastly the player pawn also has a TeleportTraceNiagaraSystem component. This component is a visual effect which will show a red arc starting from the players controller position towards a specific point in the level. When pressing your movement buttons on the VR-controllers the player then will move from the current location towards the point at the end of this arc.

BYSTANDER AI

The bystander AI is the agent that is used to drive the bystanders. Based on this decision tree the agent will think and move around in the scene. The agents are capable of using what they see, hear or even feel to act on. They will react on what the other agents around them say, on what action the POs do or what actions the bystander-agent executes. Based on these different observations the agent will asses the current escalation modifier. Based on this modifier the agent will execute different steps in its behaviour tree, you can find an example of the behaviour tree in 5.5. From left to right one can see how based on a higher escalation score the AI will start performing different actions, from regular walking around and minding its own towards getting engaged into the conflict and eventually also interfere when the escalation modifier reaches the red zone.

The first substep the agent processes is the low escalation score seen in 5.6. The agent will here simulate regular behaviour a regular civilian might perform as well that is nearby.

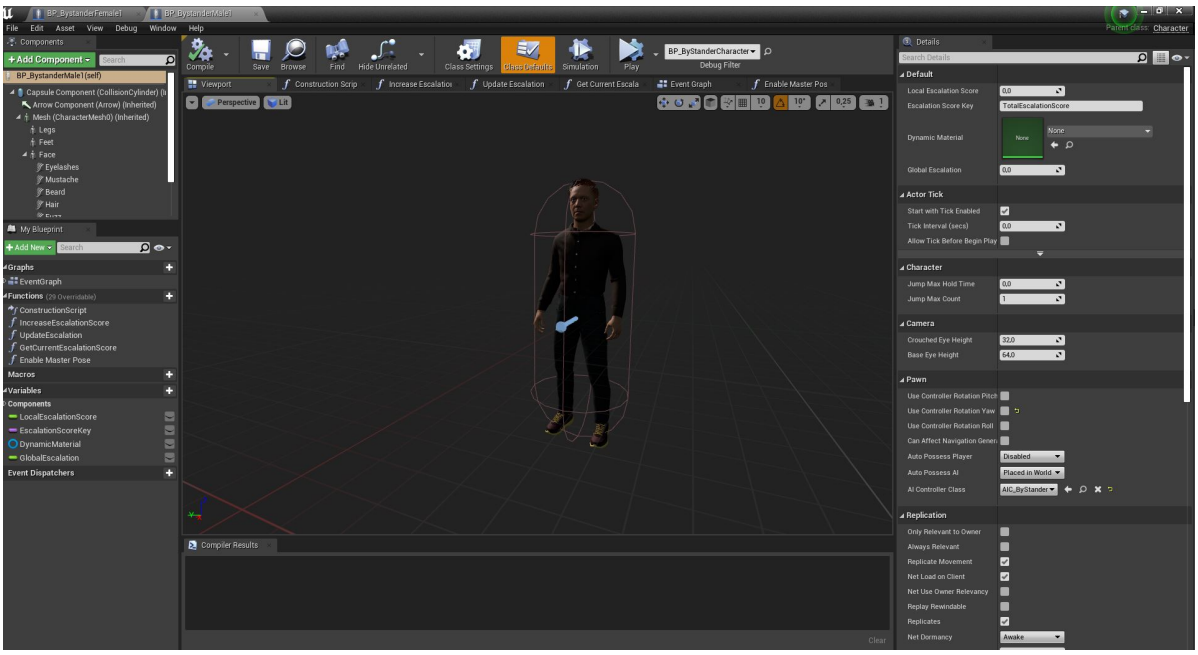

Figure 5.4: Bystander Blueprint example

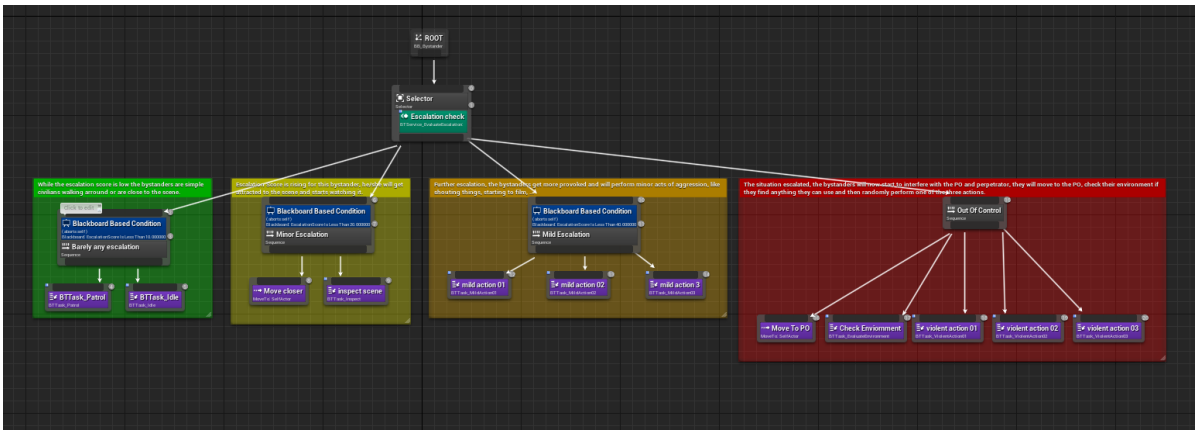

Figure 5.5: Bystander AI agent overview

Walk around, perform a minor task, stand still, look around, basically the agent is not actively engaged at all in the current PO-perpetrator conflict.

The Second step in 5.7 is the step were some sort of escalation is already there. The score is affected by all special relations that might be present between the bystander and the perpetrator as well. For example when the perpetrator is a family member or a good friend the score will already by in this step. The bystander will now walk towards the PO and the perpetrator and start observing the scene.

The third step in the tree is the mild escalation phase seen in 5.8. In this step the bystander will stop from being passive to a more active role and will perform one of the prescripted actions that are considered mild. One of these actions could be starting to film the intervention, verbally opposing the POs or even getting closer and slightly obstructing the

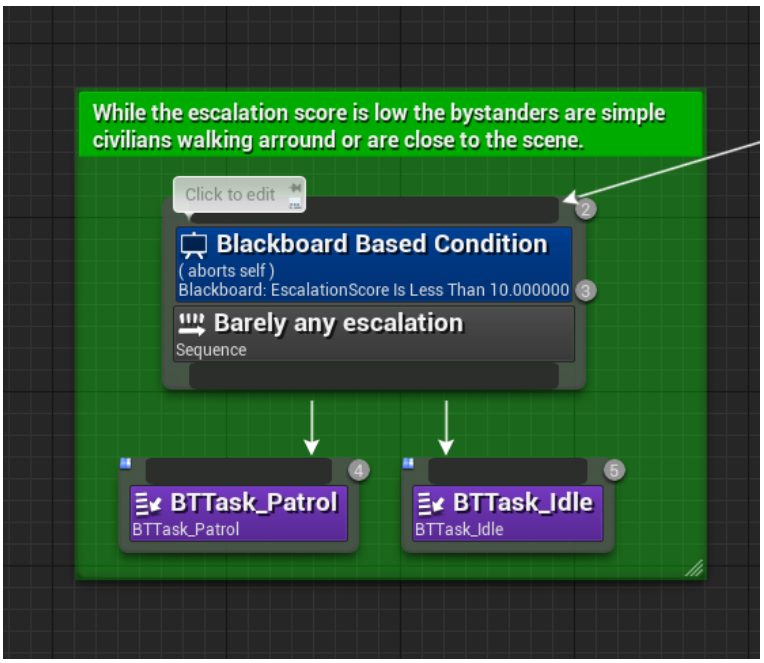

Figure 5.6: Low Escalation step detail

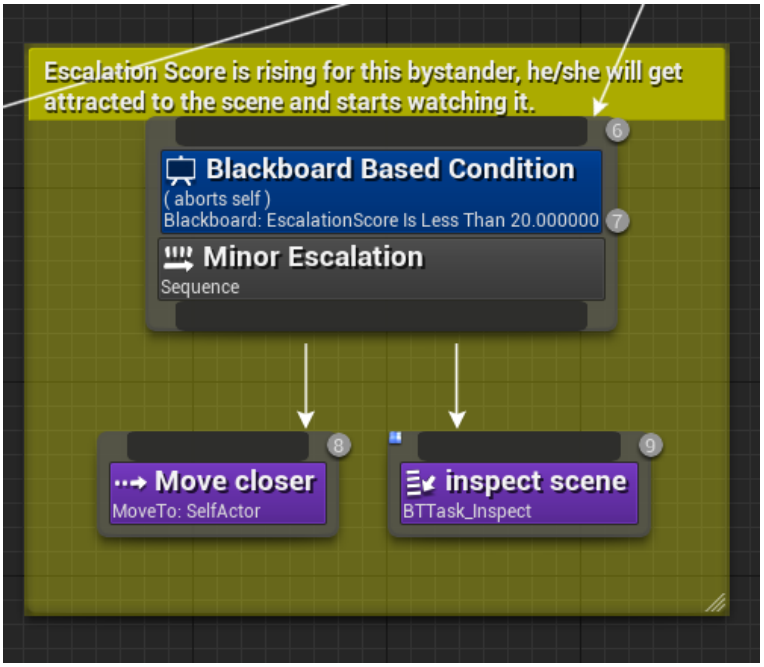

Figure 5.7: Minor Escalation step detail

ongoing intervention.

The final step in the tree is the escalation phase 5.9. Here the upper threshold is reached for this particular bystander and he will start to actively participate in the bystander conflict. This can be throwing of objects or obstructing the intervention more aggressively. The PO will now actively have to deal with the bystanders and attempt to lower the escalation score again or abort the intervention all together.

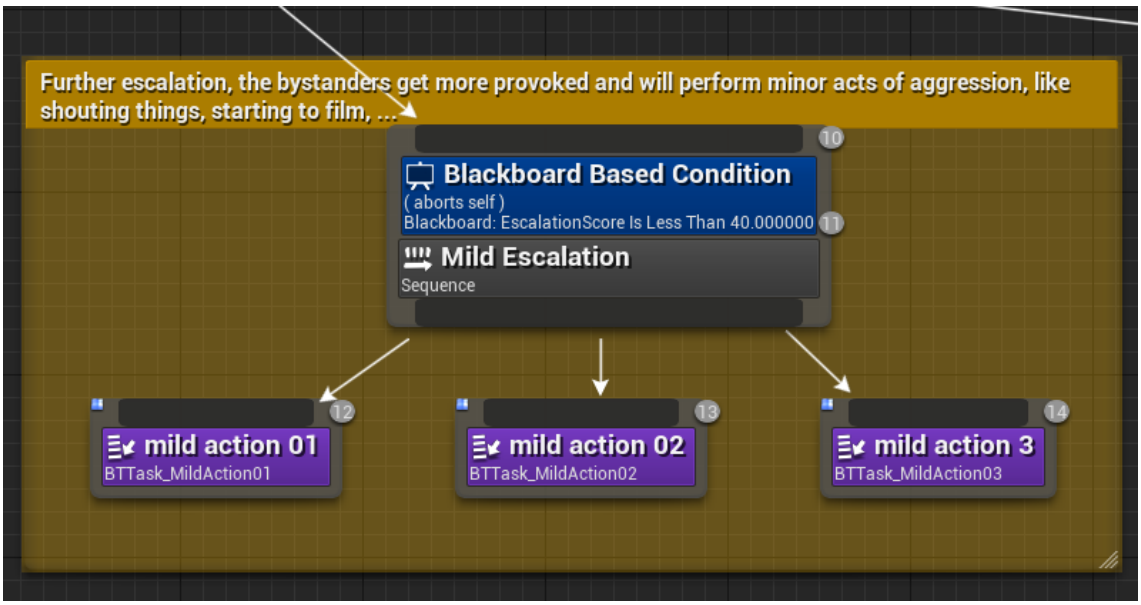

Figure 5.8: Mild Escalation step detail

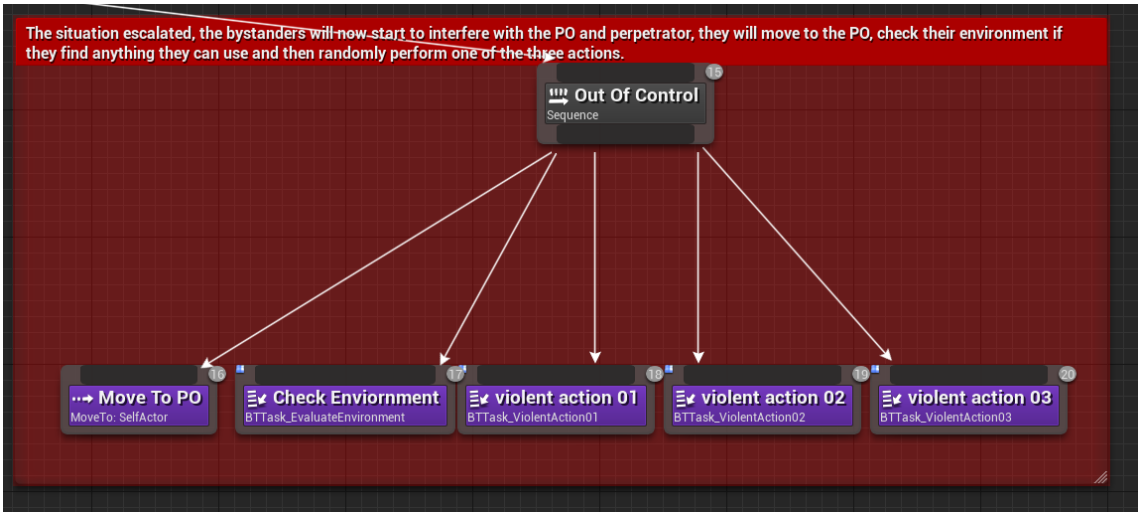

Figure 5.9: Escalated step detail

PERPETRATOR AI AGENT

The perpetrator AI agent is less complex as the bystander AI agent. This AI agent mostly converts the chosen reaction of the PO into a specific answer. This answer is then coupled with a specific 'noise' which is triggered by the AI agent and can be sensed by nearby bystanders. This noise reflects the amount of escalation that was linked to the action the PO chose to select. This function can be seen in 5.11. The event perpetrator shout is called by a delegate that is listening to the scenario manager. This event gets called every time the PO answers one of the scenario steps. Then the pawn will call a function called MakeNoise. This will then make a noise based on the current escalation of the scene, as when the tension will heat up people will shout louder and thus the higher the escalation the higher the noise will be sensable by other bystanders.

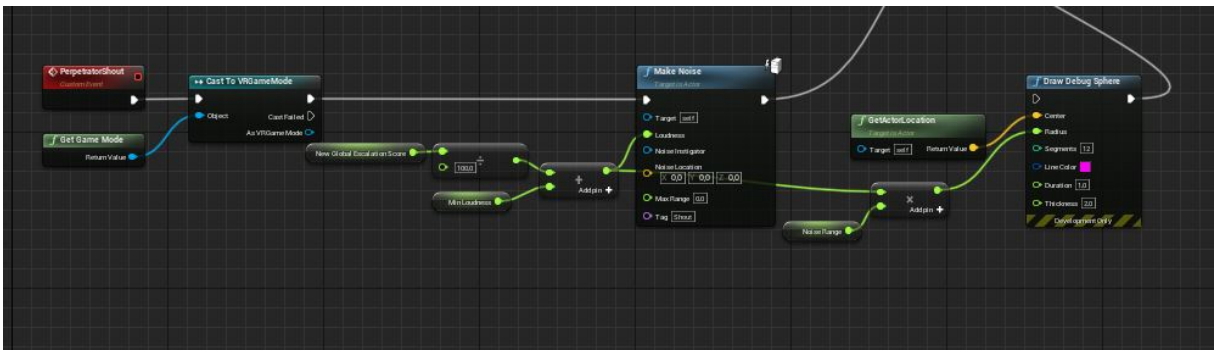

Figure 5.10: Make noise function

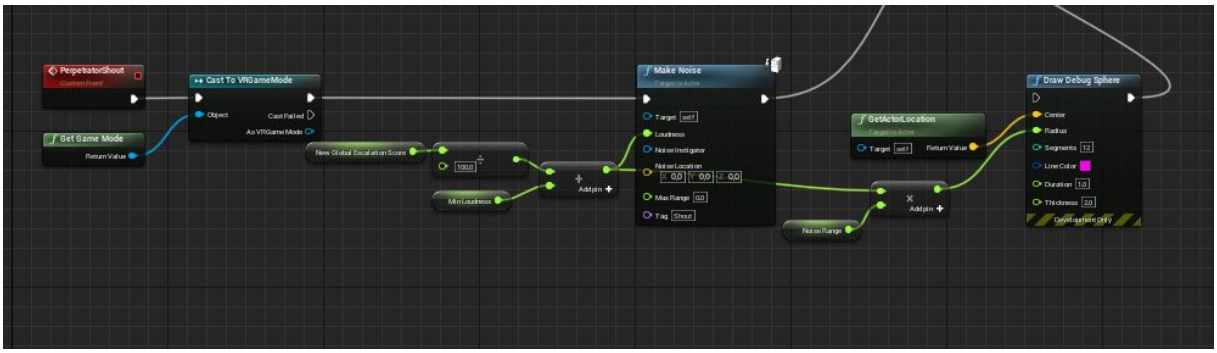

Figure 5.11: Make noise function

5.3.2. Art

Graphical Optimization

For the experience to be able to run in VR we have to keep a close eye on how detailed our 3D models are and what different rendering methods we utilize.

Scenery

There are two scenes created for this project, one friendly sub urban area where you can find an example from in 5.12 for the first and second scenario and then a bigger slightly darker city for the third scenario as seen in. 5.13.

Character model

For the creation of our character model we used the Meta human creator from Unreal Engine EpicGames [2020]. It is a tool that can be used to create high realistic digital humans which can then be used to animate so the models can become interactive.

5.3.3. Animation

Body Animation

In figure 5.14 you can see how the animation works of the bystanders. There are basically different character states where there is a specific animation defined to be played in that state. When the bystander is in the WalkToRun state it will play an walking animation. This animation is scaled with the direction and speed of the character making the output animation more realistic. Then based on the escalation score of the scenario there are multiple animation states that the character can be in. As you can see there is a flow going

Figure 5.12: Scene 01: urban

Figure 5.13: Scene 02: City

from WalkToRun to MildEscalation. When in this state the character will play an animation showing mild escalation. The same happens when going to HighEscalation. An in-between state Idle2Fists is added here for a nicer blend from going to the regular idle state to the raised Fist state which indicates a higher escalation point.

Facial Animation

Applying facial animation onto our characters was out of scope of the current simulation. This is because adding believable facial human emotions to a digital character is very hard to achieve. If this would be included one could use facial capturing software like Faceware [2012]. This software is able to capture facial expressions. By using a Machine learning algorithm it can match a digital avatar to the recorded footage and then play these animations in a digital world. An example of Faceware can be seen at 5.15.

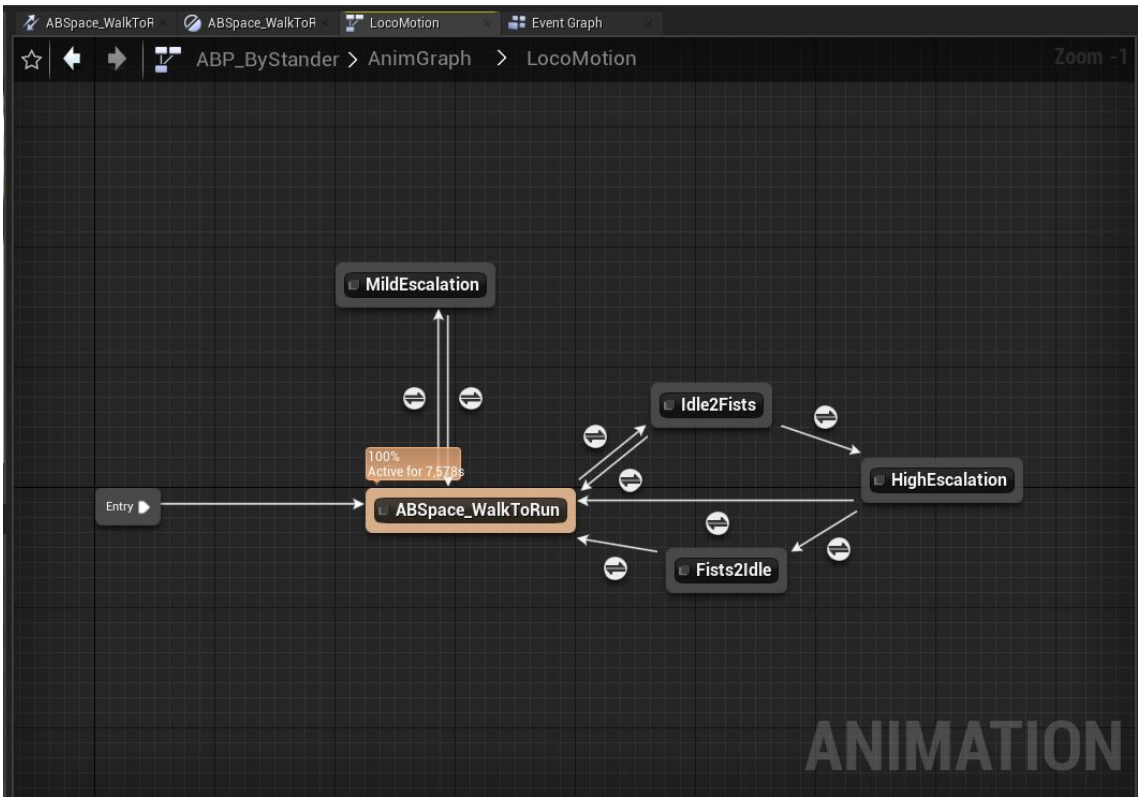

Figure 5.14: Animation blueprint

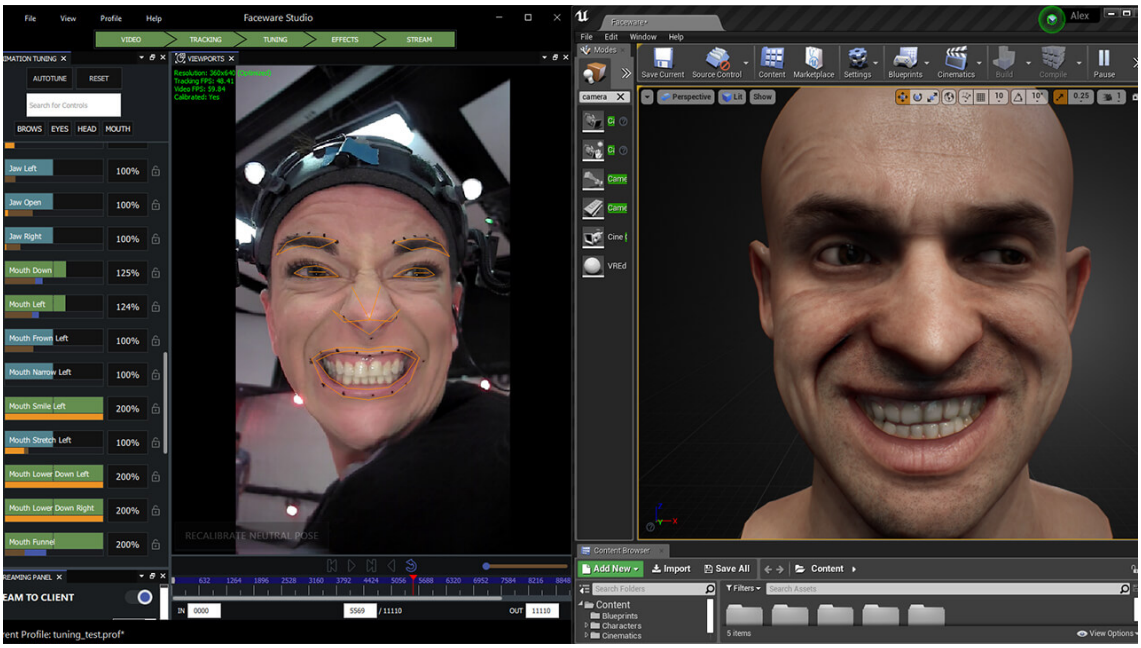

Figure 5.15: Faceware Example

6

SOLUTION EVALUATION

In this chapter we will talk about the 4th and 5th, step of the Design Science Research methodology, the demonstration and evaluation, as described in section 4.2 - Research Method. For the 4th step, demonstration of the artefact, we organised a testing event with 5 POs. A picture of the test setup can be seen in 6.1. Before the simulation started the POs were requested to fill in a pre survey (see .2), then they were asked to complete the simulation which consisted of three different scenarios 6.2,6.3,6.4, then a post survey was conducted which consisted of a set of questions rating all the different scenario's (see appendix .3.1,.3.2) and the general impression of the PO of the entire simulation (see appendix .3.4). To conclude a workshop was held with a discussion about the simulation in group. The POs were able to share their experience and state what they thought would be needed in future research (see appendix .4.2). After the demonstration and collecting all of the data step 5: Evaluation can start.

6.1. EVALUATION METHOD

Gyeonggi-Do and Gu [2018] proposes an evaluation procedure for VR-simulations in three steps. First, the quality requirements are defined. Second, a matrix is created to measure the quality requirements. Last, the evaluation moment is held. For this research there were multiple moments were POs were interviewed as you can see in 6.1. During that exploratory interview multiple requirements were deducted. Based on the ISO/IEC 9126 standard Botella et al. [2004]; Kanellopoulos et al. [2010] these were then put into different evaluation metrics and are further described in the next section 6.2 Evaluation Criteria.

6.2. EVALUATION CRITERIA

CASE SCENARIO EVALUATION METRICS

Technical metrics

These metrics were largely collected from the analytics that are collected during the simulation and by observations of the researcher who follows up the testing of the PO. There was also a post survey which checks for stability and completeness (See Appendix: .3.1, .3.2, .3.3,.3.4) and lastly the scenarios and overall simulation was further discussed in a workshop (See Appendix: .4.2.)

Figure 6.1: Evaluation setup

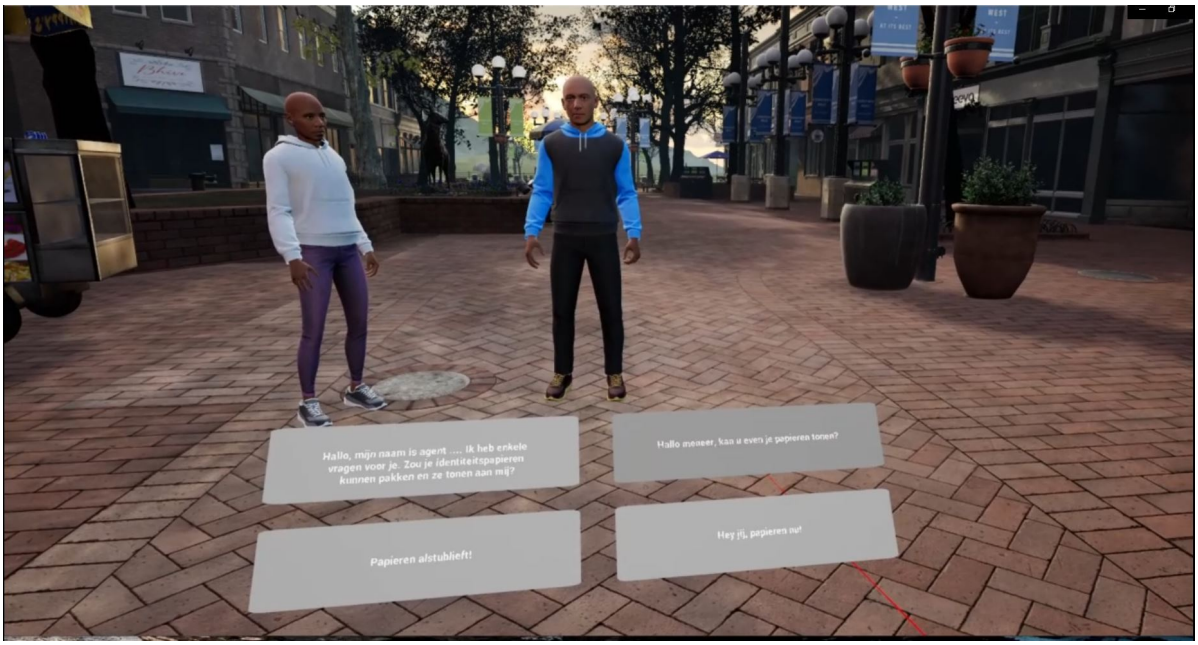

Figure 6.2: Simulation footage of Scenario 01 - Regular intervention arrest

- Stability: We aim to have a crash free experience with no game loop breaking bugs.

Figure 6.3: Simulation footage of scenario 02 - Covid-19 rule enforcement

Figure 6.4: Simulation footage of scenario 03- Intervention during a protest

Ideally the game is also running at 90fps during the entire scenario. Germani et al. [2009] states that for achieving a higher presence during the simulation the player should have a stable experience, as little as possible crashes or game freezing bugs.

- Completeness: Are all the proposed requirements properly implemented. The requirement list is defined during this research. We are loosely basing this metric on Matthews [1985] definition of a complete function. Does the program or function does what was stated that it should do. So should our simulation do what was stated that it should do.

	Years of experience	Participated in	Date
PO 1	28	exploratory interview, simulation, pre/post interview, workshop	25/10/2021, 20/05/2022
PO 2	12	exploratory interview	04/10/2021
PO 3	1	exploratory interview, simulation, pre/post interview, workshop	25/10/2021, 20/05/2022
PO 4	18	exploratory interview	25/10/2021
PO 5	10	simulation, pre/post interview, workshop	20/05/2022
PO 6	10	simulation, pre/post interview, workshop	20/05/2022
PO 7	0 - intern	simulation, pre/post interview, workshop	20/05/2022

Table 6.1: interview and survey moments

Educational metrics These metrics are mostly collected by conducting post simulation questionnaires for the POs.

- Feasibility: We can find out the feasibility of the training solution by doing a post interview after the simulation. By seeing if the target thinks this a feasible solution to help their current training. Schröder et al. [2019] also used feasibility as a metric to find out if their training could be useful in the future.

- Degree of usefulness: During the simulation we can see if the PO learns about using the right de-escalation methods from scenario to scenario. In the post interview there will also be questions about what they learned and whether or not they will be utilizing these techniques during their future interventions. These results can also be used to determine how many POs were able to succeed in their scenarios. Germani et al. [2009] state that the greater the presence of the trainee the greater the usefulness.

- Ease-of-use: How long does it take before the PO is ready from not having tested the game at all up to successfully completing the simulation without getting stuck because the PO does not know what to do. Described by Karre et al. [2019]; Virvou and Katsionis [2008] as usability. It is an important factor because the easier it is to use the software the more the trainee will be able to focus on the simulation and therefore learn more.

- Acceptability: Can the PO that performed the simulation see the VR-training as a useful extension for future training sessions. This metric is a combination of multiple other points earlier touched like Germani et al. [2009]; Gyeonggi-Do and Gu [2018]; Samini and Palmerius [2017] as they all state that it is important for the trainee to be open and interested in the subject.

6.3. RESULT ANALYSIS

The pre-surveys mostly showed that all of the POs already encountered bystander conflicts and also showed that there was little to no training dedicated in this field during training. Thus further confirming the actual social impact and necessity of this research. Furthermore the experts all stated that they believe there is a future in VR-training and think that this way of training is a lot more convenient then other alternatives like scenario based training.

When comparing the pre-survey with the post survey one can see that the POs still see value in the future of a simulation tool as this one. Even though their perception about bystander conflicts did not change compared to pre- and post- simulation.
Based on the post surveys, observations during the simulation by the researcher and workshop interviews the evaluation matrix was filled in with a scoring from 1 to 5 which you can see in table 6.2. The scoring is given based on the related multiple choice answers which is then translated to a number according to the answer.
Based on this table we can conclude that although the software was stable with an average

Survey Evaluation Metrics						
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**average**
Stability	2	5	3	5	5	4
Completeness	2	3	3	3	2	2.6
Feasibility	3	5	2	5	3	3.6
Degree Of Usefulness	3	1	2	3	3	2.4
Ease of Use	5	4	4	5	4	4.4
Acceptability	3	5	5	4	4	4.2

Table 6.2: Evaluation Metrics

of 4 out of 5 and easy to use with an average of 4.4 out of 5 it was lacking on completeness 2.6 out of 5 and 2.4 out of 5 on degree of usefulness. Which means that the software in itself was working as expected but the content was found lacking by the POs. Although they state that in its current form it was not that useful for the experts the acceptability still averages quite high on a 4.2. This is because they do believe there is room for VR-simulation training and see how this way of training has a future. We will further discuss every separate evaluation point further down in this chapter.

6.3.1. STABILITY

In table 6.3 You can see detailed observations of problems that occurred during the simulations. In 3 out the 5 simulations there were no technical issues. PO 3 had a failure in the VR-headset which is out of hand of this simulation. This was eventually solved after rebooting the system completely after which the PO was able to start the simulation. Then there was a fatal crash during the simulation of PO1 that occurred due to a rendering bug. This was caused due to usage of an experimental rendering feature for the Meta Humans. We had to restart the simulation and invalidate the result of the first two scenarios he had to go through after the crash.

Stability Metrics					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**
Rendering thread crash	yes	no	no	no	no
VR-hardware issue	no	no	yes	no	no
Game play loop	no	no	no	no	no
Game interaction	yes	no	no	no	no

Table 6.3: Stability Metrics

6.3.2. Completeness

The goal was to create a simulation that provided meaningful insight in bystander conflicts and to teach the POs to use proper de-escalation techniques in the right situation. The simulation worked correctly as proposed in the research questions.

6.3.3. Feasibility

Although that the POs sees how this simulation is use full for training they stated that it is more suited for police schools to learn the basics about bystanders and interventions rather then the more complex cases they get confronted with during their real life interventions.

6.3.4. Degree Of Usefulness

All of the POs were able to use the right de-escalation techniques and none of the officers had an escalated situation. In table 6.4 you can find all the answers the POs gave during the simulations. Every situation had 4 choices where a number from 1 to 4 reflects the answer chosen. The higher the answer the more the escalation also would raise between the different scenarios. There was no noticeable improvement between the different scenarios as the POs always answered option 1 or 2.

The cause for this can be explained by multiple reasons. Firstly, the experts stated that

Survey Evaluation Metrics					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**
scenario 1 q 1	1	1	2	1	1
scenario 1 q 2	1	1	1	1	1
scenario 1 q 3	2	2	1	1	1
scenario 2 q 1	1	1	1	2	1
scenario 2 q 2	2	2	2	2	1
scenario 2 q 3	2	2	2	2	1
scenario 3 q 1	1	1	2	1	1
scenario 3 q 2	2	1	1	1	1
scenario 3 q 3	2	2	2	2	2

Table 6.4: Scenario answer

by having a multiple choice answer system you basically already give the most optimal an-

swer for them which make answering in certain situations to obvious. Secondly, the testing audience in average already consisted out of mostly experienced officers, who encountered similar situations already and can easily see what the least escalating option would be when faced by a scenario as proposed. Thirdly the experts also answered in the survey that in general the situations were a bit to basic, in real life a bystander conflict has multiple layers and is a lot less straight forward then currently presented in our simulation.

6.3.5. Ease of Use

The POs were able to start the simulation with a minimal introduction to base VR-controls. Even though most had none or very little experience in VR they were all able to use the application without asking new help during the simulations.

6.3.6. Acceptability

The general consensus of the experts was that they do see a future for training and simulations similar like this in training. They do however find it more suited in this form as a training tool as an introduction to the problem for police training school rather then for more experienced POs.

6.4. Evaluation conclusion

To conclude this chapter we can note that although there were no major technical issues during the simulation, the effectiveness of the simulation is hard to prove with this limited amount of testers. In the workshop we received the feedback that although the scenarios were relatively basic it would be more useful if tested in a police school for POs still in training as the scenarios do show important basic interactions which are important to properly understand. A positive note however was that the testers do believe in importance of additional training in bystander conflicts and do think that VR could be a useful tool for this. We will discuss this more in depth in the next chapter and will also state what should be added or further researched to make this a reality.

7

CONCLUSION

This chapter provides concluding remarks and future research ideas. What did we learn and how did we solve our research questions. What could we have done better and what is still possible in future research?

7.1. RESEARCH CONCLUSION

Our main research question 'How to design a VR-game for simulating Police bystander conflicts?' was split in multiple smaller sub-questions. The first question we had to solve was how to find the design requirements necessary to build the simulation.

RQ 1 - WHAT ARE THE DESIGN REQUIREMENTS NECESSARY TO BUILD THE VR-GAME?

For this we conducted exploratory interviews with field experts and literature research focused on other VR-training methods like: Andaluz et al. [2018]; Haskins et al. [2020]; Yigitbas et al. [2020].

RQ 2 - WHAT ARE THE ACTIONS DESCRIBING VR-GAME SIMULATION SCENARIOS?

Once the requirements were defined we focused on a way to describe what actions the POs would be able to perform. These were then described in our scenario's in chapter 5 - Solution Implementation. The description consisted of the scenario setting, a set of dialogues and response options. These are also used to create rules and conditions to further evaluate the simulation in RQ 4.

RQ 3 - HOW TO IMPLEMENT THE VR-GAME?

This then formed the basis to start solving our third research question, How to implement the VR-game? This question was split up in two smaller blocks. First we had to define our different soft- and hard-ware blocks. On one hand there was decided to use an Oculus Quest as hardware and to use Unreal Engine for our software framework. By using Unreal Engine we were able to use a their OpenXR implementation Khronos [2017] that handled most communication to and from the headset. This made it possible for us to focus more on the implementation of the software side.

RQ 4- How to evaluate the VR-game using the simulation scenarios considered?
After creating the simulation we used a method proposed by Gyeonggi-Do and Gu [2018] for evaluating the simulation. We did this in three different steps starting with deciding what requirements were important for our simulation. This was already answered by our first research question and then we further added some more requirements based on qualitative software development based on the ISO/IEC 9126 standard.

RQ 5 - What are the evaluation criteria that should be considered to evaluate the VR- game?
Once that the game was developed, evaluation mechanisms have been considered. The evaluation metrics were gathered from both the literature as well as expert based evaluation in the form of pre-, post-surveys and a workshop together with 3 simulation scenarios. First, these evaluation metrics were used to set up multiple tables. Then, these were completed with all the data of the surveys and analytics collected during the demonstration event. Last, these results were discussed in depth in chapter 6 Solution Evaluation.

So we can conclude that by completing all of these steps we were able to design and create a VR-simulation of a police-bystander conflict.

7.2. Discussion

Although the creation of the artefact was successful we can conclude out of the data that our simulation did not succeed in learning something new about bystander conflicts and de-escalation methods. While discussing this during the workshop the POs mentioned a few reason which could have caused this. The most important one probably is because the scenarios currently had limited amount of means to interact with the scenes and bystanders. The experts state that de-escalation is not solely about verbal communication but about so much more like hand gestures or facial emotions. The reason we chose for this research to only focus on verbal comunication was because this research was done by a one man team. Because of that we were limited in means of time and abilities to further build out this simulation.

A second reason might have been that most of the POs we interviewed and tested with already had a considerable amount of experiences 10+. Most of these POs were already well aware of the fact how you should or should not handle a situation to avoid escalation.

A third reason was that the scenarios were using multiple choice answers to respond to the perpetrator. This made the most de-escalating solution very obvious per scenario.
Even though there were some reasons why our current setup did not yield us the expected results we did however collected valuable feedback and insight in the stated problem. The POs already confirmed in during the exploratory interviews that they are very interested to learn more about bystander conflicts. They also believe that VR-simulations are something very valuable for future training. We were able to identify the reasons why the current setup is not yielding the expected results and we discuss in the next section on what we could do to solve these. This represents the basis for future VR-research and applications in this domain.

Given the previous limitations listed this research is not enough to prove if the Construal Level Theory was a good choice to build these scenario upon or not. We could not show a correlation in the data collected by playing the scenarios whether or not the theory has an impact on faster escalation. However during the interviews the POs were aware of the fact that certain factors like social and psychologically distance are something they have to be aware of when on an intervention and how this could impact escalation.

7.3. FUTURE WORK

As this was a first research into how VR-simulations could be used for training POs in bystander conflicts there is still a lot of room for future research and work. We will see what different points could be further improved for providing a better simulation.

It is equally important to have means of verbal and non verbal communication in a simulation like this, thus spending more time on intuitive ways to recognize input during the simulation would be very interesting for the future. A first thing to consider could be to recognize gestures made by the controllers to a meaningful emotional actions. For example if the PO would calmly gesture with his hands in and up and downward motion in order to calm the perpetrator down. The artefact could recognize this as a calming action and so de-escalates the situation. A further extension here could be by using headsets that are able to track the eyes and face of the wearer. By doing this one could analyze this footage and actually recognize the expression of the testers face and further enhance the non verbal communication during the simulation.

Another interesting way to accept input during a simulation as this would be to implement some form of speech synthesis which would the be able to understand and to handle based on what the PO says. This way we avoid the multiple choice input and as an added benefit one can also recognize emotions through intensity of the voice.

Another next step in this research should be focusing more on the artistic side and not only on the software engineering side. As having realistic graphics and animations make for a more believable scenario. How further the reality can be copied in the virtual environment the more effective and thus better results will be achieved. One could consider 3D scanning known places in the specific trainee's zone for even deeper and better understanding of some scenarios.

Further enhancing these types of non verbal communication could also be enhanced by adding more believable animations both facial as body on the perpetrator and bystanders. Damjanovic et al. [2014] Shows that it is important for the PO to recognise facial expression, due to the complexity of believable human facial expression and animations this was not the focus of the current study.

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APPENDIX A - INTERVIEW QUESTIONS

.1. EXPLORATORY INTERVIEW

- How many years experience do you currently got?
  - How many of those years were on the field?
- Did you ever become the victim of a bystander conflict?
  - What was the reason for the intervention before you got involved in this conflict.
  - What was the briefing before you arrived on scene.
    - Is there an adjusted briefing depending on an intervention in an unsafe area or neighbourhood?
    - After a briefing like that what are your expectations before arriving on the scene.
  - What was the situation when you arrived on the scene
    - How was the atmosphere when you arrived.
    - Was there a relation between the different involved parties and bystanders.
  - What was your first reaction on scene.
    - How did the perpetrator react?
    - How did the bystanders react?
    - When the bystanders started to interfere in the situation did you change your approach?
  - How did the situation eventually end?
- What do you think is important to know about a bystander conflict?
  - Are there sometimes situations where you know before even arriving that they will escalate?
    - Why do you think that?
    - Will you try to approach a situation like this with extra care to avoid escalation?
  - What are important hints you should be able to recognize that could point on escalation?
  - Do you think age, culture or surroundings are important aspects that could influence a bystander conflict?
  - How do you try to handle a tense conflict?
  - Are there any techniques you use during escalating conflicts?

  - Are these techniques you learn and try to adapt based on prior experiences?

- Did you have any training or during your education got specific information about bystander conflicts and how to handle them?
  - How many times did this subject get mentioned?
  - Did this training go specifically about bystanders?
  - What are some pointers that are told to pay special attention on?
  - When is it advised to have heightened senses for possible bystander conflicts?
  - Were you able to use any of these techniques learned during training in the field already?
  - Do you think that having more training concerning bystander conflicts would be beneficial?

- When a training tool about this subject would be made what are any important aspects that especially should be brought to attention?
  - Do you think it is more important to have more realistic graphics then realistic situations during the simulation?
  - What would a good scene setup be to be trained in with this tool?
    - What type of intervention?
    - What setting? (Time, Location, Background,...)
  - How many interaction choices do you expect to have per situation step.
  - what would be a good way of receiving feedback about this training?

- Are you willing to participate with the simulations themselves?

.2. Pre Simulation Survey

- Hoeveel jaar heeft u al dienst?

- Bent u al eens slachtoffer geworden van omstander conflicten? Zoja kan u de omstandigheden kort beschrijven.

- Heeft u dan gebruik gemaakt van de escalerende technieken? En zoja wat hield dit juist in?

- In welke mate had de gebruikte de-escalatie techniek een positief effect op het gedrag van de omstanders?
  - Niet van toepassing
  - Geen effect
  - Matig effect
  - Positief effect
  - Zeer positief effect

- In welke mate heeft u tijdens uw opleiding specifiek training gehad omtrent omstanderconflicten.
  - Geen
  - Beperkt
  - Gemiddeld
  - Uitgebreid
- In welke mate baseert u deze technieken uit ervaring van vorige conflicten?
  - Niet
  - Soms
  - Vaak
  - Meestal
  - Altijd
- In welke mate heeft u al Virtual Reality-ervaring opgedaan?
  - Niets
  - Een malig
  - Gemiddeld
  - Uitgebreid
- In welke mate ziet u potentieel in VR als een aanvullende aspect op de bestaande training?
  - Geen
  - Matig
  - Neutraal
  - Overtuigd
- Is er nog iets dat u hieraan wilt toevoegen?

.3. Post Simulation Survey

.3.1. Scenario 01

- Wat vond u van het scenario?
  - Makkelijk
  - Neutraal
  - Moeilijk
- Vond u dit een realistische situatie?
  - Niet realistisch

  - Tamelijk realistisch
  - Erg realistisch

- Wat vond u van de grafiek?
  - Niet realistisch
  - Tamelijk realistisch
  - Erg realistisch

- Herkende u bepaalde de escalatie technieken? Zo ja de welke?
  - Respect - een respectvol dialoog voeren
  - Kalm - een kalme dialoog voeren
  - Eerlijk - zo eerlijk en direct mogelijk antwoorden op mogelijke vragen
  - Schoenen - nadenken over hoe een bepaalde situatie ook jezelf kan overkomen waardoor er meer empathie is voor de overtreder
  - Compromis - soms kan het helpen om een compromis te zoeken
  - Luisteren - goed luisteren kan niet alleen de overtreder gehoord laten voelen het helpt ook om de situatie beter in te schatten
  - Humaan - een gesprek voeren alsof zowel de overtreder als de agent op hetzelfde niveau staan
  - Empower - soms moet je iemand zijn eigen keuzes laten opnieuw overwegen met de gevolgen van dien indien hij hier mee verder gaat

- Welk van de geziene de escalatie technieken zou u toepassen of gebruikt u momenteel al in een gelijkaardige situatie?

.3.2. SCENARIO 02

- Wat vond u van het scenario?
  - Makkelijk
  - Neutraal
  - Moeilijk

- Vond u dit een realistische situatie?
  - Niet realistisch
  - Tamelijk realistisch
  - Erg realistisch

- Wat vond u van de grafiek?
  - Niet realistisch
  - Tamelijk realistisch

- Erg realistisch

- Herkende u bepaalde de escalatie technieken? Zo ja de welke?
  - Respect - een respectvol dialoog voeren
  - Kalm - een kalme dialoog voeren
  - Eerlijk - zo eerlijk en direct mogelijk antwoorden op mogelijke vragen
  - Schoenen - nadenken over hoe een bepaalde situatie ook jezelf kan overkomen waardoor er meer empathie is voor de overtreder
  - Compromis - soms kan het helpen om een compromis te zoeken
  - Luisteren - goed luisteren kan niet alleen de overtreder gehoord laten voelen het helpt ook om de situatie beter in te schatten
  - Humaan - een gesprek voeren alsof zowel de overtreder als de agent op hetzelfde niveau staan
  - Empower - soms moet je iemand zijn eigen keuzes laten opnieuw overwegen met de gevolgen van dien indien hij hier mee verder gaat

- Welk van de geziene de escalatie technieken zou u toepassen of gebruikt u momenteel al in een gelijkaardige situatie?

.3.3. Scenario 03

- Wat vond u van het scenario?
  - Makkelijk
  - Neutraal
  - Moeilijk

- Vond u dit een realistische situatie?
  - Niet realistisch
  - Tamelijk realistisch
  - Erg realistisch

- Wat vond u van de grafiek?
  - Niet realistisch
  - Tamelijk realistisch
  - Erg realistisch

- Herkende u bepaalde de escalatie technieken? Zo ja de welke?
  - Respect - een respectvol dialoog voeren
  - Kalm - een kalme dialoog voeren
  - Eerlijk - zo eerlijk en direct mogelijk antwoorden op mogelijke vragen

  - Schoenen - nadenken over hoe een bepaalde situatie ook jezelf kan overkomen waardoor er meer empathie is voor de overtreder
  - Compromis - soms kan het helpen om een compromis te zoeken
  - Luisteren - goed luisteren kan niet alleen de overtreder gehoord laten voelen het helpt ook om de situatie beter in te schatten
  - Humaan - een gesprek voeren alsof zowel de overtreder als de agent op hetzelfde niveau staan
  - Empower - soms moet je iemand zijn eigen keuzes laten opnieuw overwegen met de gevolgen van dien indien hij hier mee verder gaat
- Welk van de geziene de escalatie technieken zou u toepassen of gebruikt u momenteel al in een gelijkaardige situatie?

.3.4. General Post Survey

- Wat vond u van deze simulatie?
- Zal u bepaalde situaties ander bekijken als voorheen?
- Wat heeft u bijgeleerd omtrent omstander conflicten?
- Wat heeft u bijgeleerd omtrent de escalatie technieken?
- In welke mate denkt u dat deze simulatie potentieel heeft om gebruikt te worden als aanvullende training methode?
  - Geen
  - Neutraal
  - Matig
  - Veel
- In welke mate vond u de app gebruiksvriendelijk?
  - Niet gebruiksvriendelijk
  - Vaak onvriendelijk
  - Neutraal
  - Eerder gebruiksvriendelijke
  - Zeer gebruiksvriendelijk
- In welke mate vond u de simulaties al omvattend genoeg?
  - Niet
  - Soms
  - Meestal
  - Vaak
  - Altijd

- Heeft u technische problemen ondervonden tijdens de simulatie? Zo ja, welke?
- Wat zijn volgens u momenteel de grootste limiterende factoren van deze simulatie om bruikbaar te zijn als training tool?
- Wat zijn momenteel de elementen die het meeste potentieel tonen om deze simulatie als bruikbare training tool te gebruiken?
- Heeft uzelf nog opmerkingen/suggesties?

.4. WORKSHOP POST DISCUSSION

.4.1. QUESTIONS ABOUT THE SIMULATION

- Zijn er gelijkaardige situaties al mee gevallen tijdens een interventie? Zoja de welke?
- Hoe heeft u deze afgehandeldt?
- Wat waren elementen die u het onrealistische vond tijdens de scenarios?
  - Kwam dit vooral door de grafiek?
  - Door de animaties?
  - Door de scenario's?
  - Door de interactie?
- Wat waren elementen die u het meest realistische vond tijdens de scenarios?
  - Kwam dit vooral door de grafiek?
  - Door de animaties?
  - Door de scenario's?
  - Door de interactie?
- Heeft u nieuwe inzichten gekregen omtrent omstander conflicten en zoja de welke?
- Waren er bepaalde de-escalatie technieken die getoond werden tijdens de simulatie die je al zelf gebruikt?
  - De welke?
  - Welke kwamen momenteel niet aan bod in de simulatie?
- Denkt u dat deze simulatie nuttig kan zijn als aanvulling bij bestaande trainingen?
- Wat denkt u dat eventuele limitatie's zijn tov live scenario training?
- Wat vonden jullie wel en wat vonden jullie niet gebruiksvriendelijk aan de simulatie?
- Denken jullie dat het mogelijk is om een app als dit te gebruiken als aanvulling op jullie bestaande trainingen?

.4.2. THOUGHTS ABOUT FUTURE IMPLEMENTATION AND FUTURE WORK

- Zijn er bepaalde zaken waarvan u denkt dat nodig zijn om deze situaties verder te verbeteren?
  - Is er iets specifieks omtrent grafiek?
  - Is er iets specifieks omtrent scenarios?
  - Iets omtrent acting/animatie?
- Zijn er bepaalde de escalatie technieken die niet aan bod kwamen maar die ook zeer belangrijk/impactvol kunnen zijn?
- In welke mate ziet u Virtual Reality scenario training als een aanvulling voor bestaande trainingen?
- Wat zou volgens u noodzakelijk zijn om op in te zetten om dit dan waar te maken?
- Heeft u zelf nog opmerkingen/suggesties?