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# Development and implementation of an immersive narrative for virtual reality platforms

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Final Degree Work

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## Acknowledgements

I would like to thank my colleagues JOAQUÍN SOLER and ANTONI ARLANDIS, without whom it would have been impossible to develop Vornik. I would also like to thank my supervisor at the end of my career, Marta Martín, who has helped me to correctly focus on the different aspects of this project, in addition to providing me with the necessary knowledge to focus a narrative design from the best possible perspective. I would also like to thank the rest of my professors during these four years. Finally, and most important, to my family, my parents, who have been an essential support to get to be here today.

## Abstract

This document presents the Final Report of the Video Game Design and Development project. The work consists of the development of the narrative, editing and postproduction of a video game in virtual reality, creating the bible of characters, world, game structure and walkthrough script, using the advantages and opportunities offered by the Oculus Rift platform. Unity is the game engine used, working on an immersive experience through the use of sound, post-processing profiles and lighting designs with a result optimized for VR.

## Key words

Virtual reality, Videogame, Narrative, Postproduction, Lighting.

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## Introduction

### Work motivation

Virtual reality is a booming market and provides another vision compared to the classic game. With Oculus, we can access a variety of experiences and small games, but the lack of complete video games of terror, with an elaborate narrative that allows the player to take advantage of the possibilities provided by the platform, made us decide to create a horror video game and puzzles designed from the beginning for VR.

### Objectives

- To develop an original narrative for a videogame in virtual reality.
- To achieve an immersive experience through the mechanics offered by Oculus.
- To implement the production, editing and post-production areas such as dynamic sound and post-processing.
- To use the Unity's lighting system, achieving the highest possible performance and graphic quality.

### Initial state

Vornik is a video game in which has been developed by three students: Daniel Castro Arjona, Joaquín Soler Tomás and Antoni Arlandis Daviu. We had to delimit the areas of each of the members. The entire design and development is separated in the areas of:

- Game design and narrative: Daniel Castro Arjona.
- 3D design, particles and interface: Joaquín Soler Tomás.
- Avatar and game's puzzles development area: Antoni Arlandis Daviu.

To meet the requirements of the work, each of the members had to complete a part of programming, so the code needed in each of the areas, belongs to its responsible. In order to create Vornik, a constant communication between team members has been necessary, as well as a joint plan, in addition to the individual plans.



# Planning

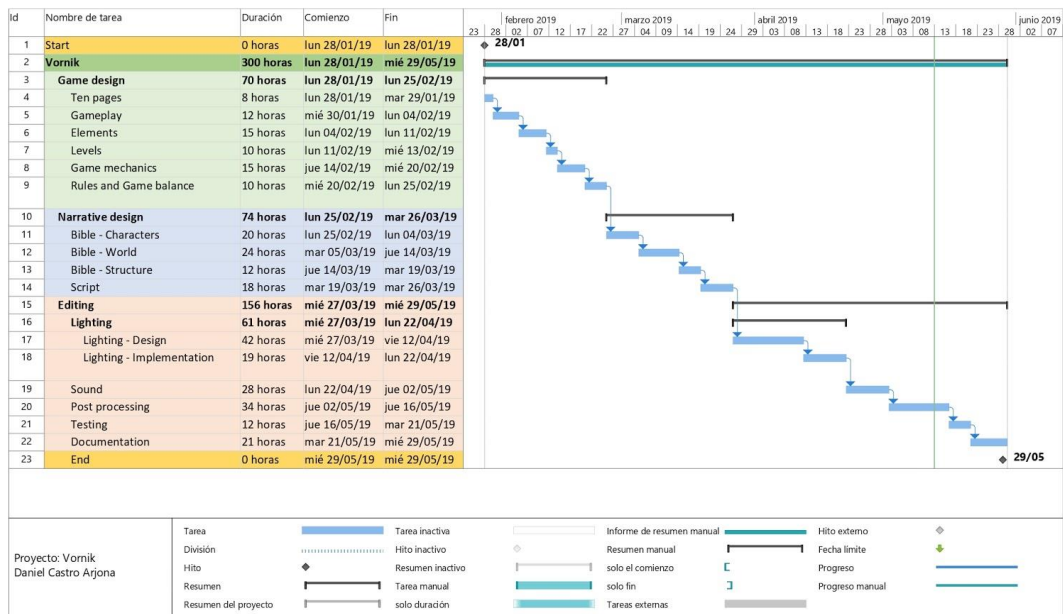


Figure 1 Gantt chart

## Related courses

VJ1207 – VISUAL CULTURE AND MASS MEDIA

VJ1218 – HYPER MEDIA NARRATIVE AND VIDEO GAMES ANALYSIS

VJ1222 – VIDEO GAME CONCEPTUAL DESIGN

VJ1227 – GAME ENGINES

VJ1230 – THEORY AND PRACTICE OF AUDIOVISUAL PRODUCTION

# Game design

## Synopsis

Vornik is a horror video game for Oculus Rift, where we control Zledic, a mysterious character with a terrible background. Throughout the game, the player will have to solve different puzzles, through the mechanics provided by virtual reality.

## Overview

### Game Concept

Vornik is a horror video game where its protagonist, Zledic, is a former sergeant in a terrible war, who has a dark past that the player must discover solving puzzles and advancing in the plot.

The action of the game is performed in first person.

Vornik's visual style is realistic 3D, using various types of textures to achieve a result as close as possible to reality. The different objects of the game are well differentiated as far as modelling and texturing, physical behavior, and interaction with the characters, are concerned.

To achieve the greatest possible immersion the player can make use of different mechanics through the use of Touch Rift, such as:

- Catching objects.
- Opening padlocks or seals.
- Joining pieces of objects.
- Breaking objects.
- Using buttons and levers.

## Genre

Horror video game.

## Target audience

Aimed at adult users of Oculus Rift, who like horror and investigative video games.

The player must be patient and curious, enjoy the stress of a hostile environment and follow experiences such as *LAYERS OF FEAR* or *PT*.

## Look and feel / game experience

The player must feel the protagonist, the controls must be intuitive allowing for smooth movements, the environment must be as realistic as possible and the interaction with objects and the interface must be user friendly.

## Gameplay and mechanics

### Gameplay overview

Many of the video games offered on the Oculus platform are experiences to promote externally or simply meet the objective of showing the specific mechanics offered by the platform. For this reason, it is important to note that Vornik is a conventional game originally designed to use the mechanics of virtual reality.

### *Interaction only with objects*

The use of objects with them is the basis of the mechanics provided in the video game. This is important because the player will have different options to use the objects of the game, on the other hand, the interaction with the secondary characters will be generated through events, controlled by the game designers.

### *Varied small environment*

Many video games offer very large worlds that sometimes remain empty and do not take full advantage. In horror video games, references like *THE DARK OCCULT* are a good example of this.



Figure 2 *The dark occult*

The goal is to find a way to bother the player, being more important the pressure than the fear, this causes closed and small environments that provide a more psychological sense of terror, to be used. This idea is used clearly in *SILENT HILL PT*.

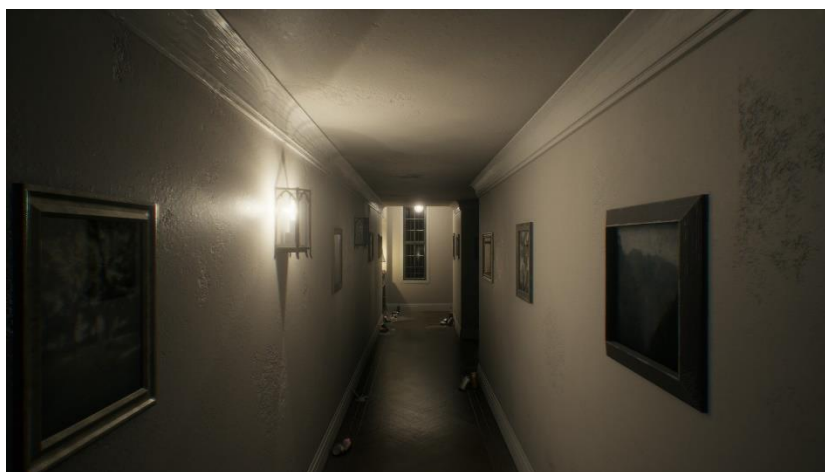


Figure 3 *Silent Hill PT*

To show the three main areas of the game, a realistic structure has been followed, both in localization, size or design, collecting data from real stories and generating corresponding plans for the subsequent 3D design.

The most controversial point has been how to represent the memories of the protagonist. To achieve this, the situation in which the memory occurred has been imitated, in a way that it is consistent. The memory area simulates the house of the protagonist, a familiar and comfortable environment for him.

#### *Images and text to get to the memory*

The amount of resources to evoke a memory are varied. In Vornik, images and documents, such as letters, diaries or paintings, have been used to give the player the necessary information to move forward and understand the story.

#### *Clear main objectives*

It is important that the player knows what his main objective is and that he has the necessary information to fulfil it. In order to achieve this, it has been a key aspect the inclusion of dialogues by the interrogators, either in the scene of interrogation or in the memory itself, that generate an objective and helps to fulfil it.

#### *Coherent puzzles*

They offer the player different ways of interacting with the objects of the world, always from the coherence of the environment and history. These have a progressive difficulty, being the second memory scene the one that offers the most complex puzzle, taking the player from one object to another until completing them all.

Three images are used in the initial room to represent the fulfillment of the puzzles and therefore the secondary objectives, which form the three memories into which Vornik's structure is divided. Each of these images is cut into as many parts as there are puzzles in the scene. To complete the image, the player must solve all of the puzzles.

#### *Game progression / mission / challenge / level structure*

The player advances by meeting the main objective, which provides a key object in each scene. These objects open a way out to the memory we seek.

#### *Use of the conscious and the subconscious*

When entering an induced dream, the pressure for the character has been represented, on the one hand, by the pressure exerted by the interrogators, forcing the character and player to comply with what they want and, on the other, by the character's own struggle not to give that information.

#### *How to represent pressure*

##### *Interrogators*

An induction session cannot last eternally, it supposes a mental and physical fatigue for the person who suffers it and this is shown in the game, one cannot be induced forever.

In the memory phase, the game has a hidden counter that offers two things, on the one hand the conversations of the interrogators, who make increasingly vehement comments but provide information that helps the player to move forward. On the other hand, it shows visually how the character is weakened thanks to post-processing profiles, explained later.

When the counter reaches 0, if the player has not completed the phase, the interrogators will intervene again and we will have to repeat the entire phase.

## Sanja

The most important character in Zledic's life, it represents the internal struggle of the character's subconscious against the interrogation he is suffering.

At first, it was designed to help the player to solve the puzzles, but the protagonist does not really want the interrogators to know everything she hides. In addition, the use of this character offers a resistance to the player.

Sanja appears in two ways:

- Mandatory appearance: at certain points, Sanja has an obligatory appearance to push the story forward and make transitions to the following phases.
- Secondary appearances: Sanja intervenes in the scene, sometimes not physically, but modifying the environment, such as painting a wall with crayons, activating her music box, making noises in certain points of the stage or others.

### *Sanja's progression*

Being a representation of Zledic's subconscious, Sanja's goal is that we do not remember what the interrogators are looking for, it is a form of Zledic self-defense, which he doesn't control. As the interrogators advance, the subconscious struggles in a more aggressive way, because the last information given in the game is the one that incriminates Zledic for good, for that reason Sanja represents that internal struggle against the search for these data.

### *How to get the key object*

At the beginning of each session, the player must read different documents, break objects, open padlocks and perform other actions that allow him to reach the location of the key object.

### *What happens when you have the key object?*

When you find the key object, the initial room will change and offer the player a way out that leads to the important memories of the story, ending the session and moving back to an interrogation scene or at the end of the game.

### *Realistic structure*

Both, the interrogation room and the house and test building, show a realistic structure, using plans with real measurements that have been the basis for the design and creation of the structures of the game world.

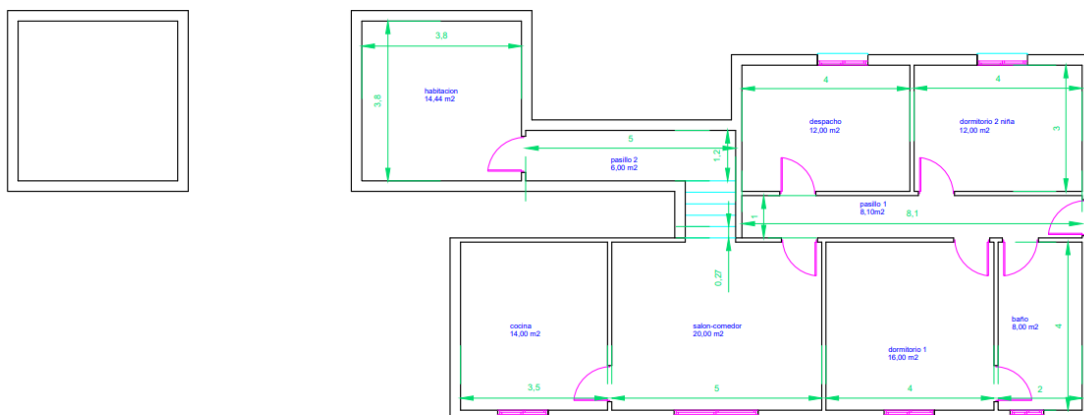


Figure 4 Plans of the building

## Movement and controls

For the movement of the protagonist a problem was given, to many people the conventional movement with Joystick in virtual reality can make them dizzy. For that reason two systems of movements have been implemented.

### *Movement with Joystick*

Using the left Touch joystick the protagonist moves in all four directions, while with the right Touch joystick the player rotates in small angles, thus trying to avoid the dizziness produced by the turns.

### *Teleport*

The implemented system offers the player the possibility of moving instantly to any walkable area of the scene, visibly, through the line renderer, which can be activated with the B button on the right Touch.

## Physics and objects

When moving between reality and the protagonist's memories, the objects must behave according to their situation. All objects found in the interrogation scenes have a realistic behaviour, with parameters in the rigidbody according to their design. In the case of memory scenes, the different objects have different behaviours, those that make up the structure behave realistically, others vary during the game (such as set, photographs...) and some important ones for the plot behave incoherently with reality but coherent with the story.

## Actions

Although Vornik is a directed video game, the player is given some freedom to investigate not only the main objectives, but also the secondary stories that provide more information about the world and its characters.

### *What freedom of movements does the player have?*

The structure of the levels mark the freedom of movement of the character. In the interrogation scenes only the player is allowed the camera movement, in addition to controlling the fingers of the hands, without being able to move them. The memory scenes allow more freedom of movement throughout the structure.

### *Simple but rewarding actions*

As it has been mentioned above, interactions with objects form the set of actions that have been implemented in Vornik, in addition to the movement itself.

The player will be able to catch, break, save objects such as the flashlight, press buttons, join pieces to make a new object, turn keys, open padlocks, throw and push.

## Screen flow

The vision has been reduced through the use of lighting and post-processing effects, so that the tension of the story is reflected in what the player sees. The use of the flashlight is essential when moving through the structure of the game, so that the investigation is resolved correctly.

### *Clear description*

The different ways of interacting are shown on screen by means of UI, for this reason the objects that need an explanation have been described so that the player knows what to do with them.

### Game flow

- First Splash screen: Unity cinematic
- Second Splash screen: Team cinematic.
- Main menu: a 3D screen appears listing the following options:
  - New game.
  - Load game.
  - Options: secondary screen.

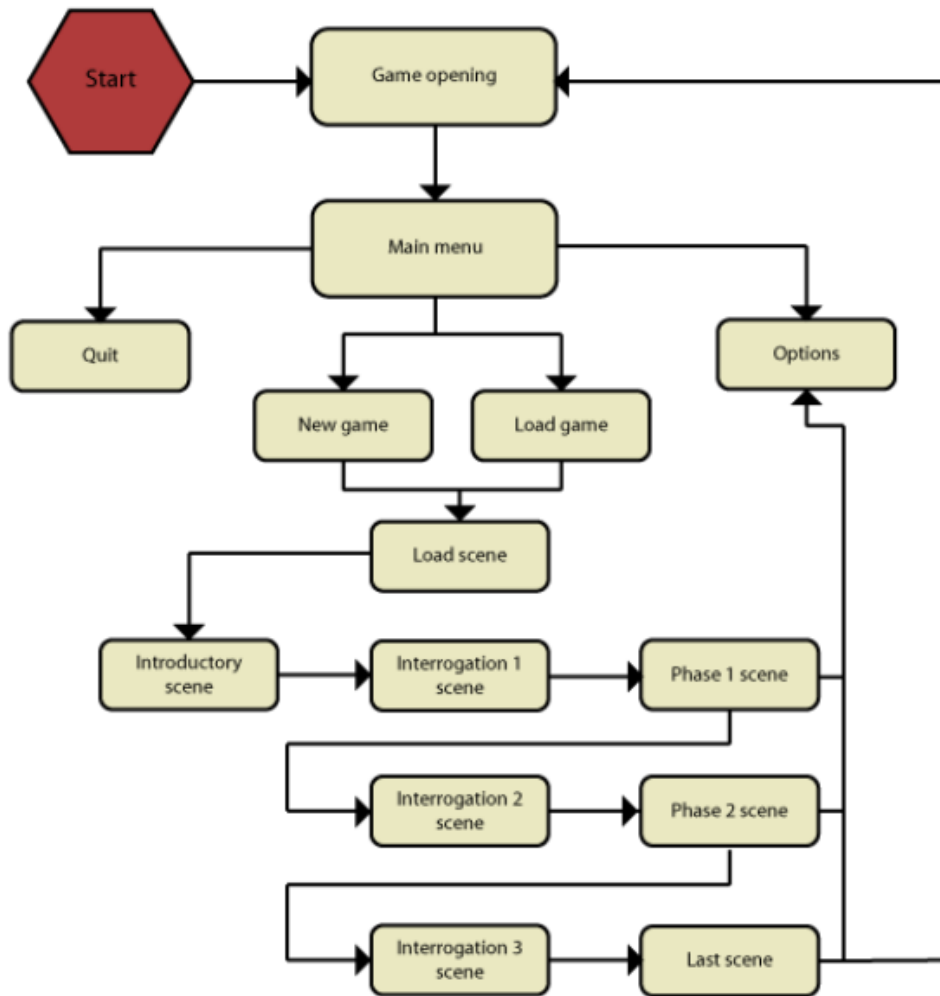


Figure 5 Flow chart

### Replaying and saving

The replaying of Vornik is limited to trying to get all the achievements, as it a video game with a linear story without ramifications.

#### *Selft-saved in each phase*

At the end of each memory phase, the video game makes a self-saved to allow the game to continue from the main menu.

#### *Back to the desired phase*

Once the story is over, the player can select the desired sessions from the main menu.



## Narrative design

### Storyline

Zledic, a former sergeant in a cruel war, has been caught and now, as a prisoner, he will have no choice but to tell everything that happened.

### Dramatic structure

#### Inciting incident

When Zledic is captured, the essential point in the plot is generated. It is when the player begins to understand in a basic way who is the protagonist and what happens in the game world. This fact forms the disturbance, which breaks the normality and generates the conflict. First knot of the plot.

#### Conflict

The interrogations start the conflict, which is separated into three parts (as many as acts and interrogations).

In the interrogations, the difficulty that the protagonist will find in the course of the game is shown. These scenes perform the function of introduction so that in the scenes of memory the player, as protagonist, performs the necessary acts to move forward.

#### Turning points

The end of the memory and the memory part are continuously joined in real time, in this stage of the scene the actions that the player does not expect are generated. That makes that the personality and attitude of the main character be reconsidered.

#### Climax

The moment when the player arrives at the office, in the research centre and verifies that it was directed by Zledic.

#### Open end

The player doesn't know if Zledic dies or he wakes up, it is up to the player's interpretation.

## Characters

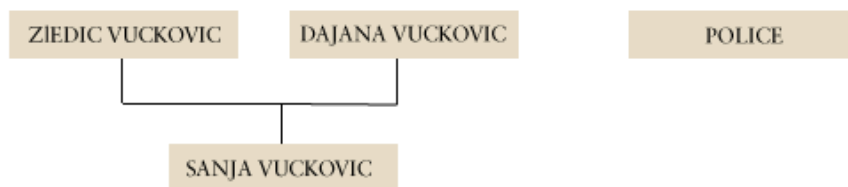


Figure 6 Characters structure



Name  
Zledic Vučković

Role  
Anti-hero

Relevance in the story  
Protagonist

### Physical description

Man of strong complexion (natural), white skin, blue eyes, gray hair, always wears military dress or gala, has a pointy nose and bushy eyebrows, has no beard, and a receding hairline.

### Biography

An army soldier, Zledic enlisted at the age of 21, a year before he met his wife (Dajana), whom he married in the Catholic Church in 1981. His parents were killed in a riot while he was on duty. In 1984 Zledic and Dajana had their only daughter (Sanja). They belonged to the upper class of society given their proximity to the high command of the army and political power where they came to have a great influence.

In May 1992 he was expelled from army and this caused great changes in his life such as the death of his wife and daughter.

### Today's character

Currently (1995), Zledic is missing and there is no record of him in the last three years. He is 52 years old.

### Motivation of the character

Convinced nationalist, he wants the "best" and the highest levels of independence for his country.

### Character progression

With nationalist convictions since his youth, he radicalized his speech over the years until reaching an extreme level that caused his expulsion from the Army.



### Name

Dajana Vučković, a name derived from Diana that has several meanings, such as "woman of light"

### Role

Anti-hero wife

### Relevance in the story

secondary

## Physical description

Thin woman, white skin, brown eyes, black long and picked up hair, wears long dresses. Has fine features, small lips and rounded nose, very thin eyebrows and wears large earrings.

## Biography

Daughter of a famous politician from the old government, she left home to marry Zledic, something her family did not approve of due to ideological differences. She accompanies her husband at all times, supporting him in difficult moments. She has received a high level of education thanks to the economic possibilities of her family. Since the birth of her daughter Sanja, her life has revolved around her, taking her away from Zledic's work. She has never known the actions of her husband in detail, he has never wanted to talk to her about it. During the war she dedicated herself to educate her daughter, trying to make her know as little as possible about what was happening abroad.

During the last months of her life, she began to understand her husband's actions, seeing the change in Zledic's increasingly aggressive and extremist behaviour. When her husband was expelled from the army, she was killed by Zledic in her home, poisoned by drinking (1992).

## Today's character

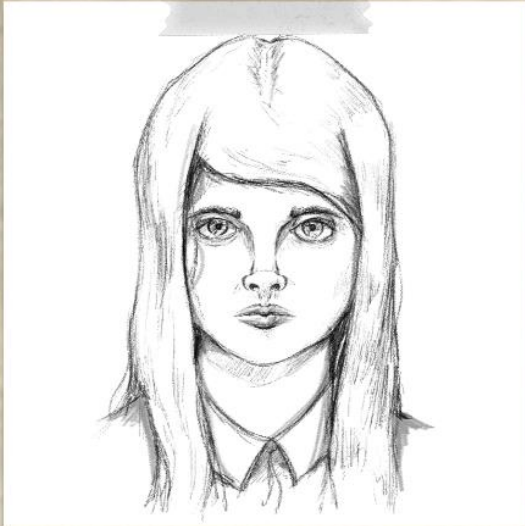
Dajana is now dead.

## Motivation of the character

Keep Sanja, her daughter, alive.

## Character progression

Starting with total confidence in Zledic's ideas, over the years she understood his radicalism and ended up distrusting the actions of her husband.



#### Name

Sanja Vučković, a name derived from the Croatian and Serbian and mens "dream"

#### Role

Opponent

#### Relevance in the story

secondary

### Physical description

1.2m high, black and long hair, large dark eyes, rounded face, small nose and mouth. She wears two small earrings, and long dresses, similar to those of her mother.

### Biography

Born in 1984, her life takes place inside the house, having the chance to go out only rarely due to the war that ravages the country. She was educated by her mother, she spends most of her time with her. She believes that his father is a hero who is saving his country from the wicked. She loves to play with her toys, which she greatly appreciates.

When her father was expelled from the army, she was killed by Zlatic in her home, by poison in her drink.

### Today's character

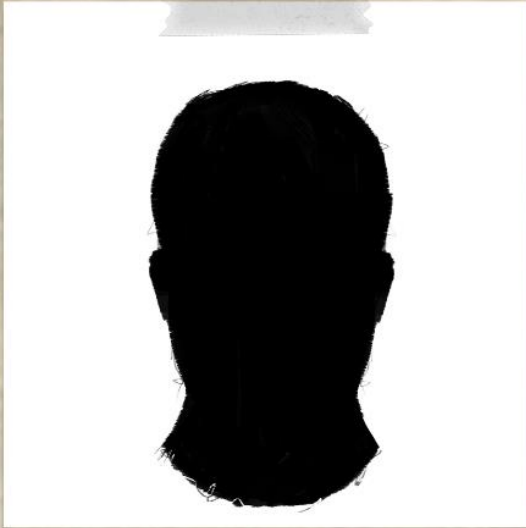
Sanja is currently dead.

### Motivation of the character

Sanja wants to be able to enjoy outside with other children.

### Character progression

Thanks to the attitude of her mother, Sanja became a very smiling girl until the end of her life, when the situation worsened at home.



Name  
Police

Role  
Antagonist

Relevance in the story  
secondary

### Physical description

Tall, wearing with police suits, strong complexion, not shown in full.

### Biography

International police who tries to capture the protagonist of the past war, they are dedicated to catch and interrogate them with any necessary method.

With a great sense of justice, they use any path necessary to achieve their goal.

### Today's character

They are currently interrogating Zledic in a small room, where they use different drugs to induce him into a controlled dream to get the necessary information from his past.

### Motivation of the character

To obtain all the information of the nationalist army and to catch its main assets.

### Character progression

They have been chasing Zledic for three years looking for him in all possible places of the country until finding him. Now, their only objective is to make him talk.

## Gameworld

### How the space structures the game?

The structure of the world in Vornik is closed, representing in the different scenes several important points of the plot, where the player is guided, to some extent, with freedom of investigation, but not of movement, beyond the structure of the level.

### *Memories*

To evoke an important memory it must be shown in a clear and concise way, therefore in the memory zones only what it is relevant is shown, taking the models and animations to an infinite space where nothing else exists.

### *Interrogation*

This is done in the present, for which a room has been created where the protagonist does not have the ability to move except the camera and fingers.

In this scene is important to listen and pay attention to the plot, so we have set the goal to focus on the importance of the characters involved and the room where we are.

### *Memory*

Main area where the player has all the abilities. To investigate and solve the puzzles he needs to advance. It is represented in two ways.

In the first and second phase, as the home of the protagonist, being the area where the character spent most of the time and where the experiences are narrated in the story. This house has a defined structure being the same as the original in the past.

On the other hand, in the third phase, the zone of memory changes to the research centre where the 80<sup>th</sup> platoon, led by Zledic, carried out experiments with captured citizens.

## Map/ sketch / images and characteristics of the area

Vornik takes its name from the city of the Republika Srpska or Serbia, Zvornik, with more than 63000 inhabitants. This city, next to the Drina river, was one of the border cities and therefore one of the first to be conquered in 1992, when it was almost completely destroyed.



Figure 7 Zvornik, source: Google maps

## Name of operation

Vornik gives name to the operation of the military police of the peace army to apprehend Zledic and all those who cooperated with him.

## The different parts of the game structure

### *Memories*

Dark environment, lighting focused on important animations, a path to go through the memories in a linear way, where they are experienced sequentially. The path is depicted in ephemeral form thanks to the use of mist particles.

### *Interrogation*

Square room, representing the rigidity of the situation and the lack of freedom, with highlighted corners, is a delimited area without escape, where the aim is to bother the player. This room is old collapsed, and shows a state of opacity to what is being done in it.

## Memory

### Home of the protagonist

- Initial room: rectangular structure, gives more security than the interrogation room. It has an exit door to the rest of the house.
- Corridor: it is narrow and leads to the whole house, leaving behind the initial room.
- Lounge: is a common area and the largest of the house. The common objects of the family are in this area.
- Office: working room of the protagonist, where he keeps all the documentation of his work, personal objects and work awards.
- Marriage/Master bedroom: shared by the protagonist and his wife, it contains memories and personal objects of both.
- Daughter room: the girl's playground, where all her toys and personal objects can be found.

### Research centre

- Initial room: structure identical to that seen in the protagonist's home.
- Corridor: a narrow space that leads to the common area of the centre.
- Patient rooms: large, full of bunk beds, square and very dark. The remaining belongings of the prisoners are in this room.
- Operating room: room where different experiments were carried out. It contains objects used for operations, such as scissors, scalpel, etc.
- Office: identical to that of the Zledic's home.

### Environmental narrative






Environmental narrative is developed through embedded narratives in items such documents, dialogues ... In the main plot the player is being interrogated by characters that he doesn't know beforehand, and takes him through a hard road to know everything that surrounded Zledic, his family and work.

The subplot tells the damages of the war and those of the 80<sup>th</sup> squadron, which devastated the city of Zvornik, narrating through documents, diaries and other objects, the thoughts of the apprehended people and Dajana. All this helps to further clarify the main plot.



## Functional and technical specifications

### Tools

	Program for writing audiovisual scripts with a WYSIWYM approach.
	Video game engine created by Unity Technologies.
	Vector graphics editor that works on a drawing board, created by Adobe.
	Computer-aided design software used for 2D drawing and 3D modelling, created by Autodesk.
	Office suite created by Microsoft

## Lighting

### Scale and units

Unity does not use real units of measurement, so you must use a coherent configuration for the whole project. In Vornik, the unit used is the meter, so:

1 unit (Unity) = 1 meter

This configuration is carried out from the modelling to the project configuration in Unity. It is used in the size of objects, draw distance in shadows and components such as rigidbody among others.

### Color space

Unity offers two color spaces, Linear and Gamma. We have decided to use the linear space according to the following points

#### *Realism*

Vornik uses a realistic visual style, so the colours must be represented with respect to the configuration made in the engine. These colours are illuminated linearly according to the intensity of the different lights that set the scene.

#### *Compatibility*

The linear color space is compatible with the Oculus Rift platform, so there has been no limit in its use when creating and developing the project.

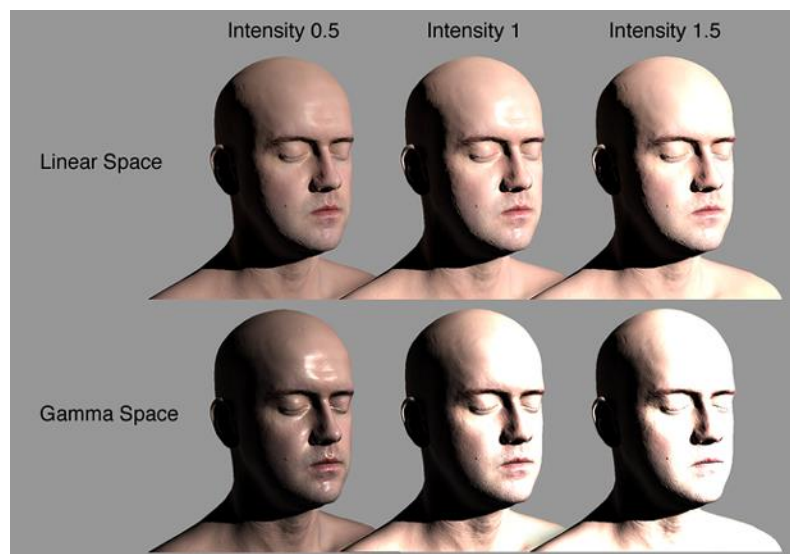


Figure 8 Using Linear and Gamma Color Space, source: Unity documentation

## Rendering path

The path used was Forward Rendering. Each object is rendered several times according to the number of lights that affect it. This can be a disadvantage if the project created was an open space, with different light sources, a large number of objects in scene and a non-optimized lighting configuration.

In the case of Vornik, the game space is reduced, the light sources are few and the use of a lighting, according to this situation, allows you to choose this path of rendering for a fast operation.

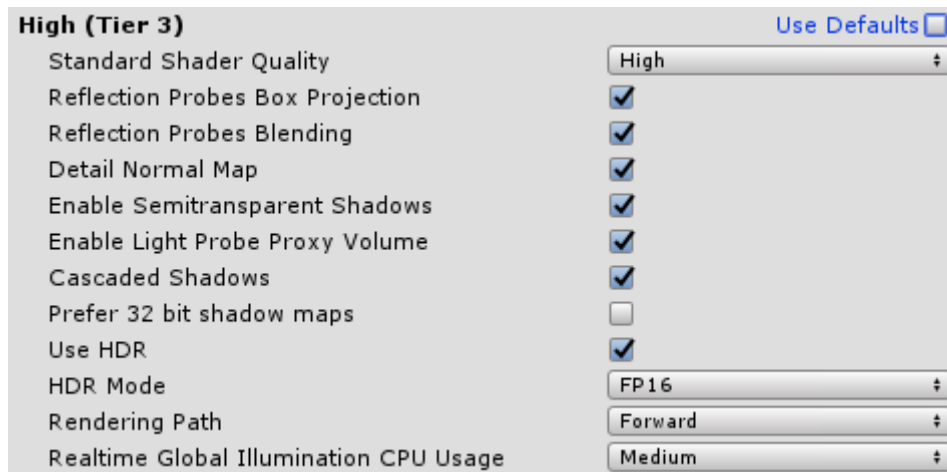


Figure 9 Rendering path configuration

## Dinamic Range

By default, Unity uses a low dynamic range (LDR), colours are stored in 8 bits per RGB channel, resulting in a reference to more than 16 million colour variants between black and white.

For Vornik, the use of LDR dynamic range may be a valid option, but the importance of reflections because of the lighting and the use of particles for the most realistic result, makes that the HDR configuration be chosen for the dynamic range configuration. Representing floating point values, the amount of visible colours are much greater, achieving an important difference in certain points of the image that with LDR remained white and, instead, now get a more realistic tonality.



Figure 10 Main Camera configuration (HDR active)

### *Tonemapping*

For the HDR to be displayed you need to enable tonemapping, in the case of Vornik, this is done from the post-processing profiles v2, in the Color Grading section.



Figure 11 Tonemapping active from post-processing profile

### *Lighting modes*

Unity has a variety of settings for scene lighting, by way of introduction, these three settings are discussed.

#### *Realtime*

Unity calculates in each frame the lights in real time during the execution time, no light is pre-calculated.

#### *Mixed*

Unity calculates some properties of mixed lights while it pre-computes other properties.

#### *Backed*

Unity pre-calculates the backed lighting before execution.

### *Lighting strategy*

Before configuring the lighting for our project, some aspects have been taken into account

#### *Closed space*

Vornik runs indoors, so there is no need to use gameobjects as terrain, besides, the number of objects on screen are reduced compared to video games in open or semi-open world.

#### *Static lighting with exceptions*

The behavior of the lights in Vornik is simplified, the level of lighting in the scene is low, with some small lights that bring warmth and most of these do not produce changes, neither in their variables nor in the effect of lighting on the different objects in the scene, because they are static gameobjects.

At certain points, where animations are produced, such as the central corridor of the scene from memory, the use of mixed lighting that can give realism to both static and dynamic gameobjects is needed.

Finally, the only cases of lights in real time are the flashlight carried by the protagonist at all times and one of the lights that use cookies.

### Mixed illumination with backed indirect + light probes

The characteristics of the project need a light performance, but not as much as a videogame with a high frame rate, for this reason the chosen configuration is a mixed illumination, with light sources in the three configurations, clearly predominating the backed lights, followed by the mixed ones and finally the light sources in real time.

The indirect mode does not use shadow masks, for that there are no distant shadows using this configuration, the maximum shadow drawing distance is specified in the Unity quality options.

Being an interior zone divided into rooms, it combines the use of short shadow drawing distances and the use of a small fog to hide any peaks.

Indirect lighting is stored in light maps and it is static. This produces a limitation if we want to move the lights, leaving the indirect lighting in a static state.

In Vornik, this is not a problem because the lights remain in the same position at all times except the light sources in real time.

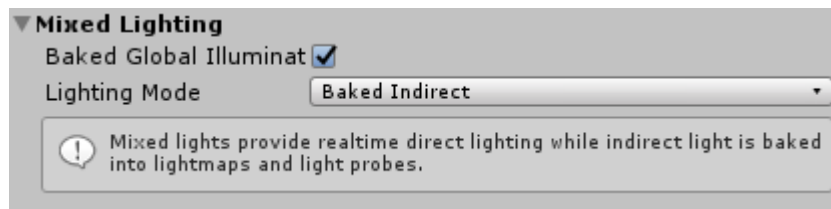


Figure 12 Lighting configuration: Baked indirect

## Light probes and reflection probes

For greater realism, both the lighting received by dynamic objects and the reflections in the scene must be modified with respect to the default values included in Unity.

### Light probes

Allow dynamic objects to receive the same lighting, regardless of whether Backed GI or Precomputed Realtime GI is used.

By default, there are no light probes in the scene, so they should be included from:

Gameobjects → Light → Light Probe Group.

The positioning of these probes is very important, the considerations that have been taken into account for the assembly are the following:

- Always above the floor object: if any probe is placed below the floor in the scene, it will produce a malfunction of all the others, so none should be below the floor. It is recommended that a space between the floor and the probe be left.
- More about changes of light: the important areas where the probes should be placed are the changes of light and colour, this causes it to be displayed smoothly towards the dynamic object.
- Reduction of probes: although the performance is more optimal using light probes than configuring all the lighting in real time, excessive use of probes can significantly affect the performance of the project, so the areas where the lighting barely changes or hidden places in the scene, should have the fewest number of probes needed.  
In Vornik, for a room about 3 meters high, two probes are used per point, one at ground level and the other at about 2 meters high.

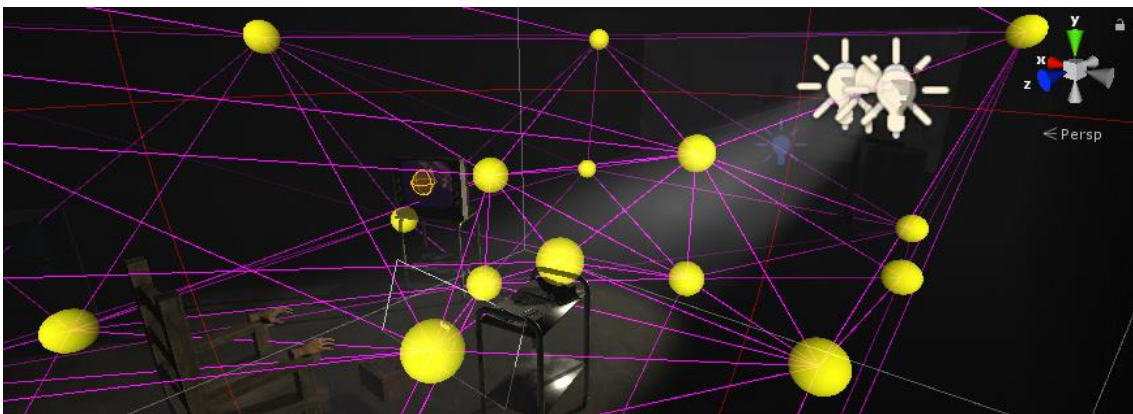


Figure 13 Light probe group, interrogation scene

### *Reflection probe*

In Unity, by default, objects with specular or metallic materials reflect the skybox, a six-sided cubemap that represents the default ambient light source in a project. There are several options to get more realistic reflections, from the design of a new cubemap for the skybox, to use of gradients or a solid colour.

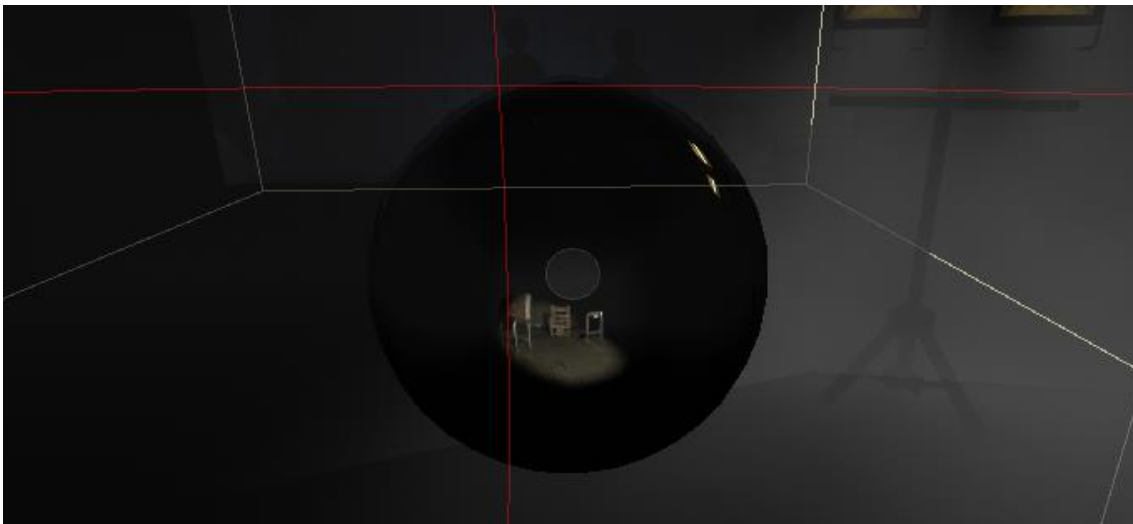
Different reflection probes have been implemented in Vornik. Their behavior is the same as that of a skybox, generating a cubemap that we can control.

To add a reflection probe:

Gameobjects → Light → Reflection Probe

The position of this objects generates a cubemap with the reflections generated by the objects of the selected layers in its performance space, which can be modified by the developer.

The reflection probes can be configured in real time or backed, the first produces very detrimental effects on performance, for the current project, a reflection probe has been placed in each room, with backed configuration, which produces a significant change in the behavior of the reflections in the scene without having a significant impact on performance.



*Figure 14 Reflection probe, interrogation scene*

## Cookies

In the second memory scene, an object is used that illuminates the room, the aim was to achieve a striking result with the lowest possible performance, at this point is where we consider the design of a light in real time using cookies.

### *Images designed specifically*

The design of the images necessary to show the illumination is made in images with a height = width, where the grayscale is used, that with the following configuration is used, the alpha channel to produce transparency and show an outline that follows the illumination.

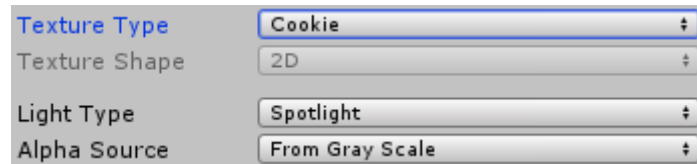


Figure 15 Cookie image

### *Creating a cubemap*

The referred object illuminates in all directions except the lower one. To introduce the cookie image in the point light that will illuminate the room, a cubemap has been created where the necessary 5 faces are filled with images with the previous configuration, thus achieving the expected result, which together with the movement of the point light, generates movement of the images in the room.



Figure 16 Cookie activated



## Post-processing

Image effects are expensive, as the camera image is shown twice, once per eye, plus an additional one if we use a complementary screen to show the game to others.

In addition, effects such as depth of field or blur are not recommended due to the possibility of producing dizziness or vertigo to the player.

## Single pass stereo rendering

In VR, this rendering uses image textures twice the width of a single camera. The representation in the two eyes is done step by step (alternates the representation of the renderers to each eye).



*Figure 17 Single pass stereo rendering VR, source: Unity documentation*

Post-processing effects are executed once for the texture shared by the two eyes, but drawing is done twice, for both the left and right eye, with half the rendering texture each time.

## Hierarchical system

After checking the cost of post-processing in VR, we have decided to limit its use in the video game, even so, the visual possibilities it provides, give a plus when deciding to use it.

Using Unity's post-processing stack v2, we configured the different post-processing profiles, volumes and layer in the camera.

## Post-process layer

In the scene camera (avatar), select the trigger of the camera in which the post-processing will act and specify the layer that will use the volumes we want to apply.

The Anti-aliasing option is not applied, because the global quality configuration is used in the project, since its cost is lower than doing it by post-processing.

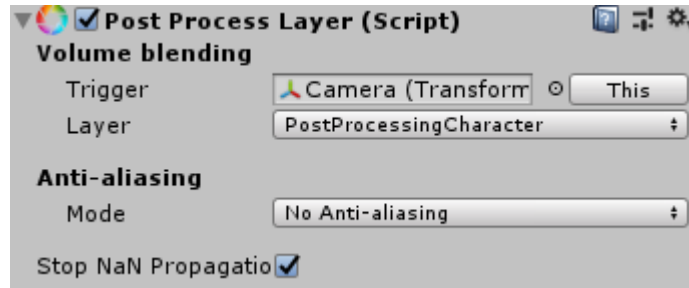


Figure 18 Post process layer configuration

## Post-process volume

Configure a gameobject with this script from Unity's post-processing stack, configure its performance distance and the priority with respect to the other profiles that can act at the same time, finally add the profile that we are going to use in this object.

To configure the base size, we add a Collider component, in this case, a box type one, with the option Is trigger activated and we select the size.

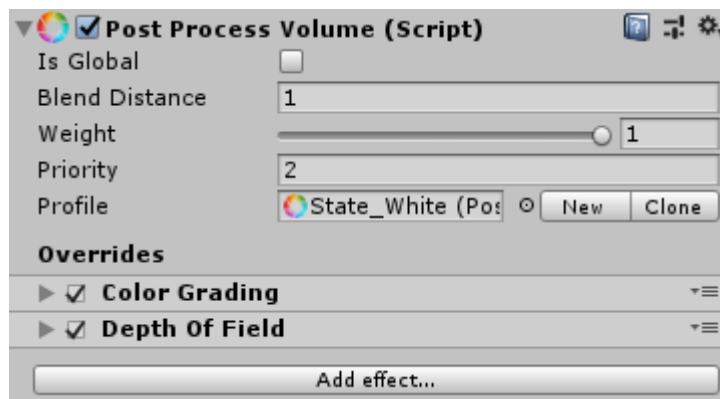


Figure 19 White transition volume

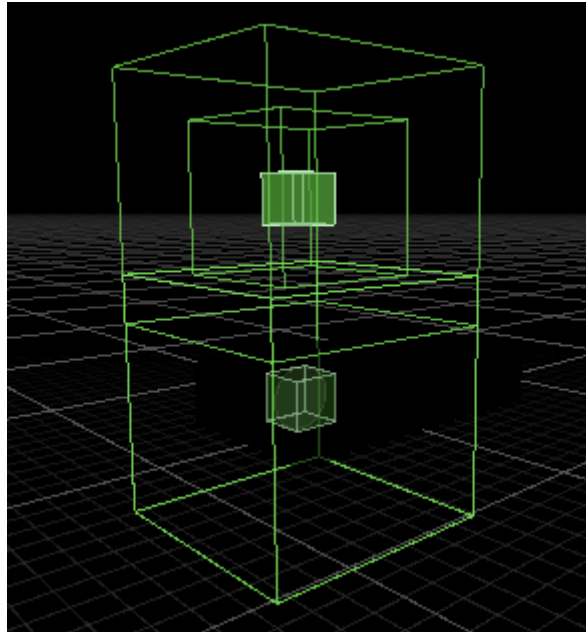
### Controlling the operation

In order to optimize to a great extent the use of post-processing profiles, a pulley system has been created by means of hierarchies, this is formed by a parent object that controls the different volumes.

### Movement for transition

One option was to change the values of the effects in each profile for the use needed at the time, instead, the physical movement is used with respect to the controller, which in turn is the avatar's son.

Once the transition is over, the volume in question is deactivated, waiting to be used and activated again, this way, we don't have to worry about its behaviour during most of the course of the game, because very rarely it is necessary to use the volumes for transitions.



*Figure 20 Post-processing pulley system*

### Continuous performance profile

The only post-processing volume used continuously is the one provided by tonemapping in the Color grading section to activate HDR.

### Lighting effect

For the interrogation scene, a post-processing effect has been included using the volume mentioned in the previous point.

### Colliding object

The light produced by the flashlight, in the interrogation scene, is the most powerful light source in the game, in its position there is an empty gameobject that has two components:

- Box collider: with the Is trigger var activated, it has measures that occupy the entire light source, both flashlights.
- Tracking code: very simple script so that it always looks towards the player's camera.

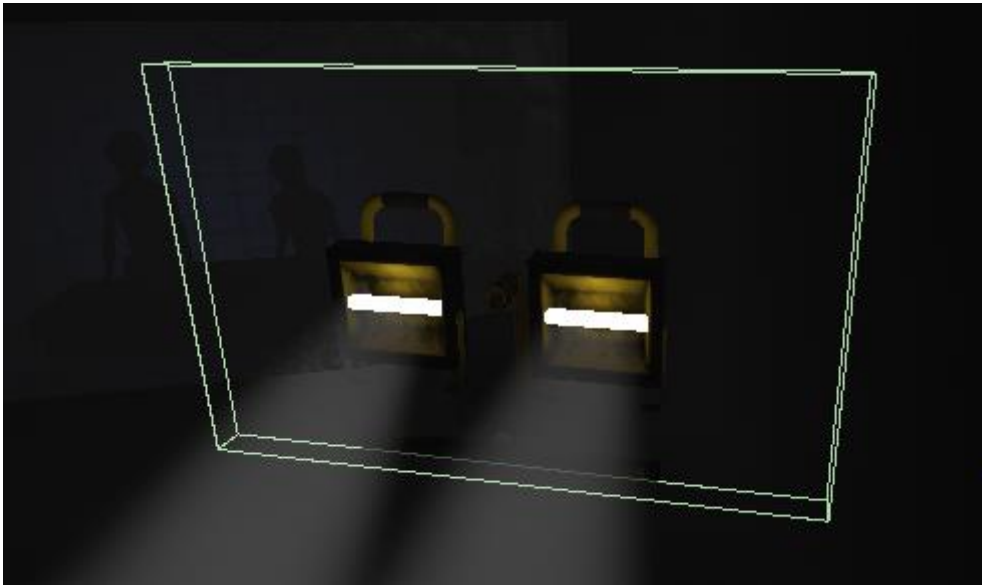


Figure 21 Colliding object

### *Ray from camera*

Creation of a Ray object that is thrown in the Forward direction of the camera itself, to check if it collides with the colliding object, using the layer Blur, if this is the case, checks the distance of the point at which the ray strikes from centre of the box collider, by percentage a value between the minimum and the maximum is returned, representing the two extreme points of the crash, the central (maximum value) and farthest (minimum value).



*Figure 22 Lighting effect: Up (ON), down (OFF)*

With this obtain an effect of blurring that depends on the movement of the camera and therefore, on where the player looks, creating the effect of dazzling if we look at the light of the flashlight.

This effect is the sample of the modifications that we can use with the post-processing stack that includes Unity, creating effects in real time very complex to do through UI or other methods.

Being a VR project, the cost is significant, so from the lighting design to the scene, allows us to use it only in the interrogation, because the movement of objects is very limited, like that of the character, in addition, the small amount of objects in scene allows us a greater exploration in the use of resources, in this case, with post-processing.

## Sound

Sound is a phenomenon produced by a mechanical vibration that is propagated by a medium, such as air.

Unity has a sound system that includes the Spatial Sound option, configuring it at the source and modifying the attenuation curve to achieve a 3D effect on the audios.

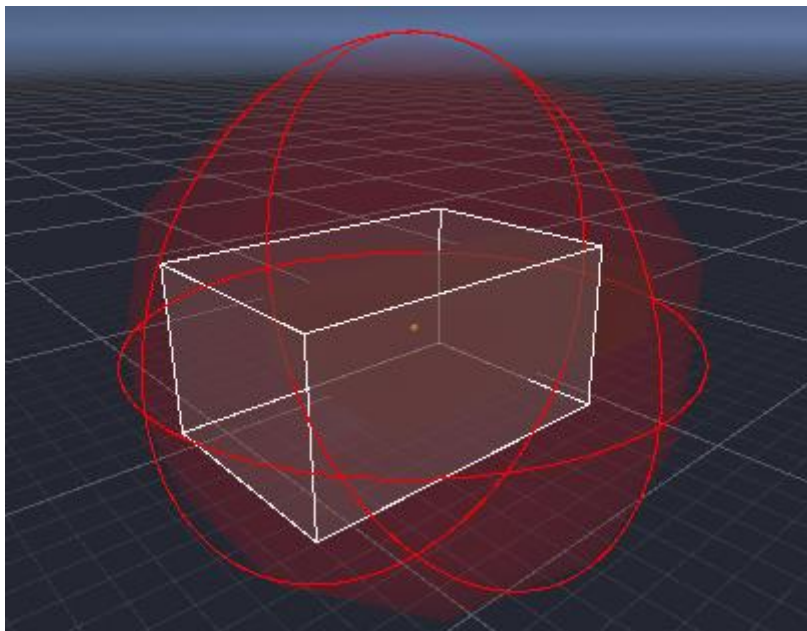
In VR, this can be expanded, taking advantage, in this case, the tools provided by the SDK of Oculus, creating a more realistic experience thanks to Rift helmets.

## Spatializer

The single-channel sounds are suitable for this configuration, as Oculus spacializer transform these audios into stereo according to the configuration of the sound source and the modelling of the room.

To apply spatialization, the Oculus script ONSPAudioSource is added to the audio source of the object in question, activating Spatialization and Reflection, configuring the range of action.

To share the spatialized sound effects in Audio Mixer, the Oculus\_Spatializer\_Reflection effect is added to the master branch and it is configured globally.



*Figure 23 Spatialization interrogation scene*

## Reverberation

In an enclosed space, the surfaces are reflective, to a greater or lesser extent, this means that two components are present when taking into account the audio received by the receiver:

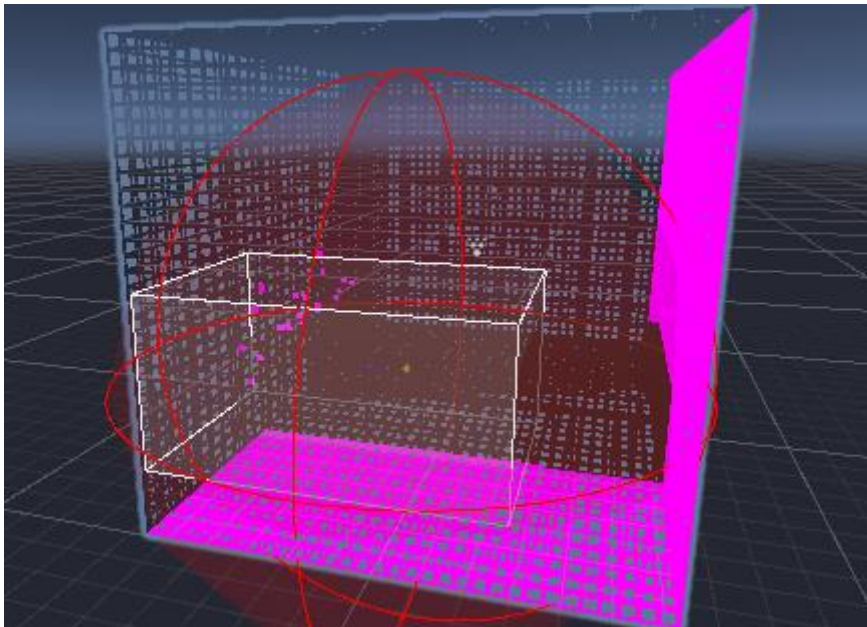
- Direct sound: that which moves directly from the source to the receiver.
- Reflected sound: it reaches the receiver after bouncing off the surfaces of the scene.

## Dynamic modelling

Due to the latest version of Oculus Spatializer, we can generate a sound box that is placed in the play space, which adapts dynamically to the structure, making itself noticed in the movement of the avatar through the space.

This script uses Unity's raycaster system in an optimized way, using a cache with the results of the previous rays.

An empty object is created to apply the dynamic modelling, which we place in the centre of the structure, we add the code `Oculus_Spatializer_Unity` and we configure the layers that we want to use for the collision of rays, the amount of rays launched per second, maximum distance and cache size.



*Figure 24 Dynamic modelling interrogation scene*

## AutoSave Multiplatform

A storage system has been designed so that several platforms supported by Unity can be reused again, thus implementing a safe and fast form of self-storage, controlled by the designer.

### StateGame class

This class contains all the data of the state of the game and configuration, it has functions to update the values of the variables.

### DataManager class

This class is the important one. We have the possibility to save in different slots besides the default one for the autosave. These functions only need to receive the StateGame data that are in the game, both to save the data and to save them in the system.

The data is saved in the address HKCU\Software\[company name]\[product name], this address is usable in different platforms, also in Windows.

Json is used for the format.

By saving it in the logs (Windows), it makes it really difficult for the casual user to modify the game data.

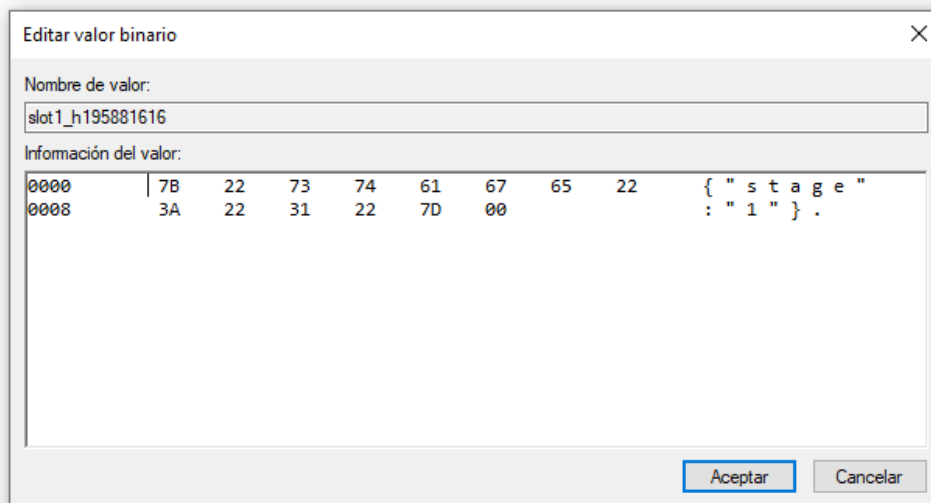


Figure 25 Data in Slot 1 (Windows)



## Results

- We have created an original story has been created, based on historical data from the Balkan war, adapted to virtual reality.
- We have designed different puzzles and mechanics for the successful use of the Oculus Rift controllers, and a remarkable graphic quality has been achieved.
- We have implemented the spatialised sound and post-processing effects that bring realism to the scenes.
- We have modified the Unity lighting system, achieving a good configuration, great visual result and optimized.

## Project Access

*Github:* <https://github.com/danicas92/Vornik>

*Executable:* <https://drive.google.com/file/d/1Zm0iAGuxle1NxKYKEG410bIuxQBCgSZalview>

*Youtube video 1:* <https://www.youtube.com/watch?v=o0g3VlgINdA>

*Youtube video 2:* <https://www.youtube.com/watch?v=FR-EVspA608>

*Trailer:* <https://www.youtube.com/watch?v=kN0BrxNzex4>

## Conclusions

Vornik has been, without a doubt, our most important project during these 4 years of study, it has been a challenge to create an original experience for virtual reality, with the little experience we have in this field, but I am very happy with the result obtained and the acquired knowledge, in addition to the good atmosphere and the way we have worked as a team, which has facilitated the development of the game.

## Future work

Vornik is a project that can be developed further because the main lines have been established, just need to continue in the same way to get to finish the experience completely, for that, we have decided to continue the project to get to a final version.

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## Appendix A – Additional documentation

### Walkthrough script (Spanish version)

#### INTERROGATORIO I/INTERIOR/NOCHE

En una sala oscura, donde las paredes están desgastadas, hay escombros y barriles viejos, en el centro se encuentra Zledic, sentado en una silla y atado, a su derecha una mesa con utensilios médicos y a su izquierda una televisión que proyecta imágenes de guerra en bucle.

Frente a Zledic, se puede ver una cristalera que ocupa casi toda la pared, detrás de esta se vislumbra dos siluetas de hombres, con una luz tenue.

Estos personajes empiezan a hablar:

#### INTERROGADOR I

Sargento Zledic, llevábamos mucho tiempo esperando esto. Sentimos tenerlo así, pero es más seguro para todos.

#### INTERROGADOR II

Si nos cuenta lo que buscamos, acabaremos pronto.

#### INTERROGADOR I

Esto no tiene por qué acabar mal, solo siente o niegue con la cabeza, nosotros haremos las preguntas.

#### INTERROGADOR I

¿Era usted el encargado de dar las órdenes al pelotón 80?

#### ZLEDIC

*I. Asiente con la cabeza.*

*II. Niega con la cabeza.*

#### INTERROGADOR I

Así nos entenderemos mejor, continuaremos poco a poco

INTERROGADOR II

Veo que quiere ponerlo difícil...

INTERROGADOR II

Vamos a suministrarle un calmante, así que relájese y no cierre los ojos.

(Transición a blanco)

#### MEMORIA I/INTERIOR/NOCHE

Zledic aparece en una habitación rectangular, donde solo hay una salida, frente a él, en el suelo, hay una linterna encendida.

Cerca de la salida, hay un mueble, con tres siluetas marcadas por el polvo, con forma rectangular.

Zledic avanza hasta la salida, es un largo pasillo, al final de este se encuentra una niña, mirando al suelo con movimientos bruscos de cuello y cabeza, lleva un papel en la mano. Al acercarse, la niña mira a Zledic y corre hacia él, lo traspasa y desaparece. El papel cae en la posición inicial de la niña.

Zledic coge el papel y ve que es un dibujo, en él aparece una familia cogiéndose de la mano, madre, padre e hija.

Las habitaciones están cerradas, solo el despacho, salón y cocina quedan abiertas.

Zledic entra en el despacho, donde hay una pequeña placa encima del escritorio sin nombre, al lado, se encuentra una caja fuerte, donde se deben introducir cuatro dígitos y un cajón con tres huecos, cada uno con una letra, "ZDS".

El protagonista busca en el salón donde encuentra un reloj de péndulo, las manillas apuntan a la hora 14:10. Zledic introduce estos números en la caja fuerte y esta se abre, dentro hay una fotografía, al cogerla, se desvanece y se escucha una puerta abrirse.

[SI TRANSCURREN TRES MINUTOS SIN INTRODUCIR LOS NÚMEROS DE LA CAJA FUERTE, INTERVIENEN LOS INTERROGADORES]

INTERROGADOR II

Tic tac Zledic, debe darse prisa.

Zledic se dirige hacia la habitación inicial, donde hay una nueva puerta, al avanzar por ella todo el espacio cambia hacia un entorno oscuro e infinito, se puede ver un pasillo gracias a una bruma que cae por sus bordes, al mirar atrás, la casa ya no está.

Continúa por el pasillo, a su izquierda aparece un hombre de forma borrosa, cogiendo un paraguas, delante de dos tumbas. Sigue caminando y a su derecha se aprecia a este mismo hombre arengando a una masa de gente. Finalmente, al frente, se vuelve a ver a este hombre disparando en lo que parece una guerra.

INTERROGADOR I

Tenemos que sacarlo ya, es suficiente información por ahora.

(Transición a negro)

**INTERROGATORIO II/INTERIOR/NOCHE**

En una sala oscura, donde las paredes están desgastadas, hay escombros y barriles viejos, en el centro se encuentra Zledic, sentado en una silla y atado, a su derecha una mesa con utensilios médicos y a su izquierda una televisión que proyecta imágenes de guerra en bucle.

Frente a Zledic, se puede ver una cristalera que ocupa casi toda la pared, detrás de esta se vislumbra dos siluetas de hombres, con una luz tenue.

Estos personajes empiezan a hablar:

INTERROGADOR I

¿Esa niña era su hija?

ZLEDIC

I.Asiente con la cabeza.

II.Niega con la cabeza.

INTERROGADOR I

No hemos encontrado a su mujer e hija,  
pero sabemos que han estado con usted  
hasta que huyó.

INTERROGADOR II

(ENFADADO)

*No nos mienta, sabemos que su familia  
estuvo con usted hasta que escapó de  
forma cobarde.*

INTERROGADOR I

Comencemos con otra sesión, relájese y no  
cierre los ojos.

(Transición a blanco)

#### MEMORIA II/INTERIOR/NOCHE

Zledic aparece en una habitación rectangular, donde  
solo hay una salida, frente a él, en el suelo, hay  
una linterna encendida.

Está un poco cansado, la vista no es totalmente  
nítida.

Cerca de la salida, hay un mueble, con tres siluetas  
marcadas por el polvo, con forma rectangular. En una  
de ellas hay un cuadro con la imagen de Zledic,  
vestido de militar.

Al salir, escucha una melodía que parece venir de  
una caja de música, avanza hasta llegar al salón,  
donde hay una mesa con tres huecos, parece que encaja  
algún objeto en ellos.

La melodía lleva a Zledic al dormitorio de Sanja, la cual está sentada en su cama, llorando.

La habitación está iluminada por un juguete, que proyecta la imagen de un cuervo.

Zledic se acerca a Sanja y todas las luces se apagan, la puerta se cierra y en un segundo, todo vuelve a iluminarse, esta vez, con un tono rojizo. Sanja ya no está en la habitación y algunos objetos están flotando. Entre ellos destacan tres que parecen formar una tetera, una vez unidos, todos los demás objetos caen y la puerta se abre, Zledic se dirige al salón, portando la tetera y la coloca en el hueco central de la mesa, se escucha una puerta abrirse.

[SI TRANSCURREN TRES MINUTOS SIN COLOCAR LA TETERA EN LA MESA, INTERVIENEN LOS INTERROGADORES]

#### INTERROGADOR I

Esa mesa tiene algo extraño.

Al llegar a la habitación inicial, se puede ver el segundo cuadro en el hueco del mueble, aunque la imagen no está completa.

En esta habitación hay una nueva puerta, al avanzar por ella todo el espacio cambia hacia un entorno oscuro e infinito, se puede ver un pasillo gracias a una bruma que cae por sus bordes, al mirar atrás, la casa ya no está.

Continúa por el pasillo, a su izquierda aparece un hombre y una mujer el día de su boda, frente a la capilla. Al avanzar, a su derecha, se observa el nacimiento de una niña, en brazos de su madre. Finalmente, al final del pasillo se ve como la mujer e hija mueren envenenadas al beber de sus tazas de té.

#### INTERROGADOR II

*(NO PUEDE CREER LO QUE ESTÁ OCURRIENDO)*

Ya basta, terminemos con esto.

(Transición a negro)

**INTERROGATORIO III/INTERIOR/NOCHE**

En una sala oscura, donde las paredes están desgastadas, hay escombros y barriles viejos, en el centro se encuentra Zledic, sentado en una silla y atado, a su derecha una mesa con utensilios médicos y a su izquierda una televisión que proyecta imágenes de guerra en bucle.

Frente a Zledic, se puede ver una cristalera que ocupa casi toda la pared, detrás de esta se vislumbra dos siluetas de hombres, con una luz tenue.

Estos personajes empiezan a hablar:

INTERROGADOR II

Sabíamos que era un cobarde, pero no imaginábamos que llegara a tal punto.

INTERROGADOR I

Esto acabará pronto, si coopera aún tiene una salida.

INTERROGADOR I

¿Realizaban experimentos en el centro de investigación?

ZLEDIC

I.Asiente con la cabeza.

II.Niega con la cabeza.

INTERROGADOR I

Lo que pensábamos...

INTERROGADOR II

...



## INTERROGADOR I

Acabará pronto, relájese y no cierre los ojos.

(Transición a blanco)

### MEMORIA III/INTERIOR/NOCHE

Zledic aparece en una habitación rectangular, donde solo hay una salida, frente a él, en el suelo, hay una linterna encendida.

Se le nota cansado, la vista no es nítida y su velocidad de movimiento es menor.

Cerca de la salida, hay un mueble, con tres siluetas marcadas por el polvo, con forma rectangular. En una de ellas hay un cuadro con la imagen de Zledic vestido de militar, en la segunda se aprecia a la familia de este.

Al salir, Zledic se encuentra frente a un pasillo con un ascensor al final, al llegar baja la palanca para que la puerta se abra y entra, pulsa el único botón iluminado y el ascensor empieza a bajar.

Zledic mira por las rejas del ascensor, se aprecia una habitación, parece el salón, pero no hay nadie. El ascensor sigue bajando y de nuevo esa habitación, se ve una sombra, como si estuviera sentada en el sillón. No para y se sigue viendo la misma sala de nuevo, esta vez Sanja está llorando en el centro, por último, Zledic vuelve a ver la misma habitación más abajo, Sanja agarra las rejas y grita de forma vehemente.

El ascensor llega finalmente a su destino y para, la puerta se abre y Zledic sale, se empiezan a escuchar sonidos de lamento y dolor.

Está en una estructura parecida a un centro médico, con una iluminación blanca y fuerte, al continuar observa que hay una habitación abierta, con una gran cristalera, dentro de ella varias literas, todo está en muy mal estado, los sonidos son cada vez más fuertes y Zledic se encuentra peor.

Al continuar por el pasillo, encuentra una puerta cerrada con un cartel en el que está escrito "Quirófano". Al final de todo se encuentra un despacho, al entrar, Zledic reconoce su nombre en la placa, es el mismo despacho que hay en su hogar.

En este momento la puerta desaparece y Zledic está en un espacio infinito y oscuro. Al fondo se ve una luz y este se dirige hacia ella, los interrogadores intervienen:

INTERROGADOR II

Al fin sabemos la verdad...

INTERROGADOR I

Ya no aguanta más, debemos sacarlo de ahí.

INTERROGADOR II

¿Quieres despertarlo? Después de lo que ha hecho...

INTERROGADOR I

Tenemos órdenes de traerlo con vida.

INTERROGADOR II

A veces ocurren accidentes, sobre todo en la guerra.

INTERROGADOR I

Zledic, ¿me escucha?

INTERROGADOR II

Esto ha terminado...

(EL SONIDO Y LA LUZ SE ATENÚAN HASTA NO ESCUCHARSE  
NI VERSE NADA)

## 5 Febrero 1991

Mañana es el día, cambiamos de hogar, estoy ilusionada con la nueva casa, espero que a Sanja le guste también, seguro que allí hay muchos más niños, al fin y al cabo, todo el escuadrón se moviliza con nosotros.

Ojala este conflicto acabe pronto y podamos vivir tranquilos, sin preocuparnos por lo que pasa fuera, me preocupa que Zledic esté en el lugar equivocado y le ocurra algo malo.

Ya hemos empaquetado todo, solo queda esperar, mañana será un día largo, seguro que acabamos agotados.

## 26 Junio 1991

Ya llevamos tres días solas, desde que se fue Zledic estamos así, espero que se encuentre bien, estoy muy preocupada.

Me doy cuenta que Sanja crece muy rápido, cada día es más responsable, hoy hemos jugado durante toda la tarde, ha recogido sus juguetes y ha caído rendida en la cama. Me gustaría que pudiéramos salir fuera cuando queremos, hace mucho que no puede jugar con sus amigos, eso no está bien en una niña de su edad.

La caja de música que trajo Zledic le encanta, no se separa de ella, hasta a mí se me ha quedado la melodía, no paro de tararearla.

Dios quiera que estemos juntos de nuevo muy pronto, como una familia.

## 15 Octubre 1991

Zledic está distinto, apenas habla con nosotras, se marcha en plena madrugada, no aparece en días...

En ocasiones noto como si no estuviera aquí, hace semanas que no me cuenta nada de su trabajo. Esta situación le está cambiando, ojalá acabe pronto y podamos volver a nuestro hogar.

Por los bombardeos han cerrado la escuela, ahora me encargo de enseñar a Sanja lo que puedo, pero no tengo muchos medios, me gustaría poder salir con ella, ver a nuestros amigos, caminar tranquilas sin escuchar esa maldita sirena...

Está siendo mucho más duro de lo que creía.

## 25 Diciembre 1991

Es insostenible, no podemos seguir así, los bombardeos no cesan y Zledic nunca está aquí, Sanja se asusta constantemente y no sé qué decirle, ella sabe que algo no va bien.

¿Qué pasará si perdemos la guerra?

Cada vez estoy menos convencida de todo, es como si aquello en lo que habíamos creído siempre, se desvaneciera, solo quiero vivir tranquila con mi hija y mi marido.

Que Dios nos ayude.

## 12 Febrero 1992

He decidido escapar con Sanja, no podemos ganar, ya apenas queda gente aquí y no vamos a morir por esta maldita guerra.

Se lo he dicho a Zledic, le ha sentado muy mal, no sé si lo aceptará pero no va a hacer que nos quedemos aquí, siendo mártires por una causa en la que ya no creemos, la decisión está tomada.

Hemos perdido esta guerra y él lo sabe.

## Classified documents (Spanish version)

---

Se Autoriza al Sgto. Zledic Vučković a definir la estrategia a seguir por los soldados del pelotón 80, otorgando poder total sobre la toma de decisiones, cumpliendo las siguientes exigencias:

- Documentación completa de las operaciones, incluyendo detalles del procedimiento.
- Límite de actuación en la ciudad de -----.
- Confidencialidad absoluta.

No cumplir alguna de estas exigencias se considerará acto de traición.

---

Soldados del pelotón n° 80:

Por decisión del Sgto. Zledic Vučković se ordena a todos los soldados de dicho pelotón que cumplan las siguientes órdenes:

- Detención de aquella persona que cumpla los requisitos impuestos en el apartado "Limpieza étnica" del documento 207, ref 456.b.
- Traslado inmediato de los varones adultos sanos al centro de detención de la ciudad de -----.
- Salvaguardar el material de dicho centro de detención.

Fuera de estas órdenes y bajo cumplimiento del resto de documentos aportados por el centro de mando, los soldados tienen total libertad de actuación.

Zledic Vučković

---

## Letters (Spanish version)

Querida Marija, los días aquí se hacen infinitos, desde que nos capturaron no hay momento en el que no recuerde sus rostros, aunque cada vez las imágenes son más difusas.

Los soldados dicen que nos van a trasladar en grupos, pero aquí no tenemos confianza en ellos, sus ojos nos miran con desprecio, con odio.

Solo espero que si no me queda mucho en este mundo, el final sea rápido y que hasta el último momento pueda tenerlos en mente.

Siempre suyo, Enis.

---

Para quien encuentre esta carta:

Estimado amigo, espero que pueda leer estas líneas y que entienda el calvario por el que estamos pasando.

Llevo aquí catorce días, sin ver el sol, sin escuchar a los pájaros, esperando que llegue la hora para decir adiós.

Dos veces al día nos dan unas pastillas grandes, me cuesta tragarlas, pasado un rato el sueño comienza a apoderarse de mí, hasta que cierro los ojos, cuando despierto estoy de nuevo en mi cama, cada vez tengo más marcas.

Ya apenas quedamos gente aquí y casi nunca vienen nuevos, nos dicen que los han liberado, pero no somos idiotas, nadie va a volver con sus familias, si aún las tienen.

Mi familia fue asesinada cruelmente, al cerrar los ojos aún veo como estos malnacidos acabaron con ellos, mi pequeña Hana...

Cada día recuerdo cuando llegaba a casa de trabajar y nos sentábamos a la mesa, mirando a mi mujer y mi hija, sus sonrisas, el amor en sus miradas, pensando que yo las podría proteger, me rompe el alma la decepción que debieron sentir cuando murieron, espero que cuando nos veamos en el otro lado me hayan perdonado.

Ya no me queda nada que dejar en este mundo, solo las líneas de esta carta y la historia que he vivido, Dios quiera que una buena persona lea y sienta mi dolor, que lo comparta y no vuelva a pasar, entonces todo esto habrá valido la pena.

Seas quien seas, espero que todo esté bien ahí fuera.

Amar

## Appendix B – Source code

### PostprocessingControl.cs

```
1. public class PostProcessingControl : MonoBehaviour
2. {
3.     static readonly float MAX = 8f;
4.     static readonly float DIF = 0.5f;
5.
6.     [Header("Entradas para la configuración de los perfiles de
postprocesado")]
7.     [Tooltip("Array de perfiles de postprocesado, el orden es: 0->
Salud, 1-> Blanco, 2-> Negro, 3-> Monocular")]
8.     public GameObject[] postProcessingProfiles;
9.     [Tooltip("Velocidad de transición entre los perfiles")]
10.    public float velocity;
11.    [Space]
12.    [Header("Activadores")]
13.    public int profileBlack, profileWhite; //1->Activado, 0->
>Desactivado, >1->otra configuracion
14.    public bool activateBlack, activateWhite;
15.
16.    //Efectos salud
17.    public bool memoryScene = false;
18.    DepthOfField depthOfField;
19.    static readonly float DEPTHMIN = 0.1f, DEPTHMAX = 1f,
TIMER = 1f;
20.    public int stateDepthOfField = 0; //0->Min, 1->Max, >1->
>Random
21.
22.
23.    private void Start ()
24.    {
25.        activateBlack = true;
26.        activateWhite = false;
27.        postProcessingProfiles[1].SetActive(activateWhite);
28.    }
29.
30.    void FixedUpdate ()
31.    {
32.
33.        //Transiciones
34.        if (activateBlack)
35.        {
36.            Vector3 vectorBlack;
37.            if (profileBlack == 1)
38.                vectorBlack = new Vector3(transform.parent.position.x,
Mathf.Lerp(postProcessingProfiles[2].transform.position.y,
transform.parent.position.y, Time.deltaTime * velocity),
transform.parent.position.z);
39.            else
40.            {
41.                vectorBlack = new Vector3(transform.parent.position.x,
Mathf.Lerp(postProcessingProfiles[2].transform.position.y,
MAX, Time.deltaTime * velocity), transform.parent.position.z);
42.                if (MAX - vectorBlack.y < 1)
43.                {
44.                    activateBlack = false;
45.                    postProcessingProfiles[2].SetActive(activate
Black);
46.                }
```

```

47.
48.         }
49.         postProcessingProfiles[2].transform.position = vecto
rBlack;
50.     }
51.
52.     if (activateWhite)
53.     {
54.         Vector3 vectorWhite;
55.         if (profileWhite == 1)
56.             vectorWhite = new Vector3(transform.parent.posit
ion.x, Mathf.Lerp(postProcessingProfiles[1].transform.position.y,
transform.parent.position.y, Time.deltaTime * velocity),
transform.parent.position.z);
57.         else
58.         {
59.             vectorWhite = new Vector3(transform.parent.posit
ion.x, Mathf.Lerp(postProcessingProfiles[1].transform.position.y,
MAX, Time.deltaTime * velocity), transform.parent.position.z);
60.             if (MAX - vectorWhite.y < 1)
61.             {
62.                 activateWhite = false;
63.                 postProcessingProfiles[1].SetActive(activate
White);
64.             }
65.
66.         }
67.         postProcessingProfiles[1].transform.position = vecto
rWhite;
68.     }
69.
70.     //Salud
71.     if (!memoryScene)
72.     {
73.         if (stateDepthOfField == 0)
74.             depthOfField.focusDistance.value = Mathf.Lerp(de
pthOfField.focusDistance.value, DEPTHMIN,
velocity * 2 * Time.deltaTime);
75.         else if (stateDepthOfField == 1)
76.             depthOfField.focusDistance.value = Mathf.Lerp(de
pthOfField.focusDistance.value, DEPTHMAX,
velocity * 2 * Time.deltaTime);
77.         else
78.             depthOfField.focusDistance.value = Mathf.Lerp(de
pthOfField.focusDistance.value, Random.Range(DEPTHMIN,
DEPTHMAX / 1.5f), velocity * Time.deltaTime);
79.     }
80.
81.
82.     }
83.
84.     public void RestartValue ()
85.     {
86.         profileBlack = 1;
87.         profileWhite = 0;
88.         postProcessingProfiles[2].transform.position = new Vecto
r3(transform.parent.position.x, transform.parent.position.y,
transform.parent.position.z);
89.         postProcessingProfiles[1].transform.position = new Vecto
r3(transform.parent.position.x, MAX, transform.parent.position.z);
90.

```



```

91.         //Salud
92.         postProcessingProfiles[0].GetComponent<PostProcessVolume
>().profile.TryGetSettings(out depthOfField);
93.         depthOfField.focusDistance.value = DEPTHMIN;
94.     }
95.
96.     public void ActivateBlack(bool state)
97.     {
98.         if (state)
99.         {
100.             profileBlack = 1;
101.             activateBlack = true;
102.         }
103.         else
104.         {
105.             profileBlack = 0;
106.         }
107.     }
108.
109.
110.     public void ActivateWhite(bool state)
111.     {
112.         if (state)
113.         {
114.             profileWhite = 0;
115.         }
116.         else
117.         {
118.             profileWhite = 1;
119.             activateWhite = true;
120.             postProcessingProfiles[1].SetActive(activateWhite);
121.         }
122.     }
123.
124.     public void FocusChange(int state)
125.     {
126.         if (state > 1)
127.             StartCoroutine(RandomFocus());
128.
129.         stateDepthOfField = state;
130.     }
131.
132.     IEnumerator RandomFocus()
133.     {
134.         yield return new WaitForSeconds(TIMER);
135.         stateDepthOfField = 1;
136.     }
137. }

```

## LightingEffect.cs

```
1. public class LightingEffect : MonoBehaviour
2. {
3.     static readonly float MAX = -2f;
4.     static readonly float MIN = 0f;
5.     static readonly float MIN_BLOOM = 2f;
6.     static readonly float MAX_BLOOM = 20f;
7.     static readonly float W_H = 1.5f;
8.
9.     /// <summary>
10.    /// Para un box collider con 2*2 el máximo es 1.5 </summary>
11.
12.
13.    [Header("Perfil de postprocesado principal para el
desenfoque y distancia del rayo")]
14.    public PostProcessVolume postProcessingProfile;
15.    public float distance, velocity;
16.    public LayerMask layermask;
17.
18.    float postExposure = MIN;
19.    bool bloomActive = false;
20.    ColorGrading colorGrading;
21.    Bloom bloom;
22.    Camera camera;
23.
24.    private void Awake ()
25.    {
26.        camera = Camera.main;
27.    }
28.
29.    void Start ()
30.    { //Reseteando el perfil de postprocesado al iniciar
31.        postProcessingProfile.profile.TryGetSettings(out bloom);
32.        postProcessingProfile.profile.TryGetSettings(out colorGr
ading);
33.        colorGrading.postExposure.value = MIN;
34.        bloom.intensity.value = MIN_BLOOM;
35.    }
36.
37.
38.    void Update ()
39.    {
40.        Debug.DrawRay(camera.transform.position,
camera.transform.forward, Color.blue);
41.        Ray ray = new Ray(camera.transform.position,
camera.transform.forward);
42.        RaycastHit raycastHit;
43.        if (Physics.Raycast(ray, out raycastHit, distance,
layermask.value))
44.        {
45.            float distanceHit = Vector3.Distance(raycastHit.poin
t, raycastHit.transform.position);
46.            float distancePosition = Vector3.Distance(this.trans
form.position, raycastHit.transform.position);
47.            postExposure = CalculeColorGrading(distanceHit,
distancePosition);
48.            bloomActive = true;
49.        }
}
```

```

50.         else
51.         {
52.             postExposure = MIN;
53.             bloomActive = false;
54.         }
55.
56.
57.         colorGrading.postExposure.value = Mathf.Lerp(colorGrading.postExposure.value, postExposure, velocity * Time.deltaTime);
58.         if(bloomActive)
59.             bloom.intensity.value = Mathf.Lerp(bloom.intensity.value, MAX_BLOOM, velocity * Time.deltaTime);
60.         else
61.             bloom.intensity.value = Mathf.Lerp(bloom.intensity.value, MIN_BLOOM, velocity * Time.deltaTime);
62.     }
63.
64.     float CalculeColorGrading(float distanceHit, float distancePosition)
65.     {
66.         if (distanceHit > W_H )
67.             return MIN;
68.         float porDistance = (distancePosition * 100f) / 20f;
69.         float porDistanceMAX = 1/(100f / (-MAX * porDistance));
70.
71.         return MAX + distanceHit + porDistanceMAX;
72.     }
73. }

```

## FocusEffect.cs

```

1. public class FocusEffect : MonoBehaviour
2. {
3.
4.     public PostProcessingControl postProcessingControl;
5.
6.     public LayerMask layermask;
7.     public float distance;
8.     Camera camera;
9.
10.
11.     private void Awake ()
12.     {
13.         camera = Camera.main;
14.         postProcessingControl = GameObject.Find("PostEffectPrefiles").GetComponent<PostProcessingControl>();
15.     }
16.
17.
18.
19.     void Update ()
20.     {
21.         Ray ray = new Ray(camera.transform.position, camera.transform.forward);
22.         RaycastHit raycastHit;

```

```

23.
24.         if (Physics.Raycast(ray, out raycastHit, distance,
layermask.value))
25.         {
26.             postProcessingControl.FocusChange(0);
27.         }
28.         else
29.             postProcessingControl.FocusChange(1);
30.
31.     }
32. }

```

## StateGame.cs

```

1. public class StateGame : MonoBehaviour
2. {
3.     public string stage;
4.     //Util para más atributos
5.     public string GetStage() { return stage; }
6.     public void SetStage(string stage) { this.stage = stage; }
7.
8. }

```

## DataManager.cs

```

1. public class DataManager : MonoBehaviour
2. {
3.     static readonly string SLOT = "slot";
4.
5.     public static void AutoSaveData(Monobehaviour component)
6.     {
7.         string jsonFormat = JsonUtility.ToJson(component);
8.         PlayerPrefs.SetString(SLOT+1, jsonFormat);
9.
10.    }
11.
12.    public static void LoadData(Monobehaviour component)
13.    {
14.        try
15.        {
16.            JsonUtility.FromJsonOverwrite(PlayerPrefs.GetString(
SLOT + 1), component);
17.        }
18.        catch
19.        {
20.            Debug.Log("No hay datos");
21.        }
22.    }
23. }
24. }

```

## ControllerManager.cs

```
1. public class ControllerManager : MonoBehaviour
2. {
3.     static readonly float TIMER = 2f;
4.
5.     SubtitleControl subtitleControl;
6.     PostProcessingControl postProcessingControl;
7.     StateGame stateGame;
8.
9.     private AsyncOperation asyncOperation;
10.
11.
12.     private void Awake ()
13.     {
14.         subtitleControl = GetComponent<SubtitleControl>();
15.         postProcessingControl = GameObject.Find("PostEffectPrefi
16. les").GetComponent<PostProcessingControl>();
17.         stateGame = GetComponent<StateGame>();
18.     }
19.
20.     void Start ()
21.     {
22.         postProcessingControl.RestartValue ();
23.         StartCoroutine (StartScene ());
24.
25.
26.         //Comprobar que esta escena no la hemos hecho y
27.         autoguardar si es el caso.
28.         DataManager.LoadData (stateGame);
29.         if (SceneManager.GetActiveScene ().buildIndex > Convert.T
30. oInt32 (stateGame.GetStage ()))
31.         {
32.             stateGame.SetStage (Convert.ToString (SceneManager.Get
33. ActiveScene ().buildIndex));
34.             DataManager.AutoSaveData (stateGame);
35.         }
36.
37.     IEnumerator StartScene ()
38.     {
39.         yield return new WaitForSeconds (TIMER);
40.         postProcessingControl.ActivateBlack (false);
41.         yield return new WaitForSeconds (TIMER/2);
42.         postProcessingControl.FocusChange (1);
43.         yield return new WaitForSeconds (TIMER);
44.         subtitleControl.ReadLine ();
45.         //Subtitulos
46.     }
47.
48.     public void ActivateTransition ()
49.     {
50.         StartCoroutine (Transition ());
51.     }
52.
53.     IEnumerator Transition ()
54.     {
55.         postProcessingControl.ActivateWhite (false);
56.         yield return new WaitForSeconds (TIMER);
```

```
55.         AsyncOperation
           operation = SceneManager.LoadSceneAsync (SceneManager.GetActiveScene
           ().buildIndex + 1);
56.     }
57. }
```