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JAUME·I

FINAL REPORT DOCUMENT

Design and development of a historical  
game level about lifestyle and architecture  
in Ancient Rome

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## Abstract

This Degree's Final Project 'Design and development of a historical game level about lifestyle and architecture in Ancient Rome', which consists in a playable game level whose objective is learning through the construction of a roman city and its free exploration. The player will have different buildings at his disposal to freely create the city, with a few restrictions. Once built or during construction, the player can visit and interact with the buildings and the automatically generated characters that inhabit the city. These characters have their routes and tasks in the public buildings of the city.

This project has two different gameplay modes with different learning objectives. First, there is the build mode, where the player must build the city from an isometric view choosing from 10 different types of buildings on an empty terrain, placing every building freely as the player wishes. In this game mode the player will learn about the key buildings that were an integral part of the cities of the Ancient Rome Empire, and which type they belong to (housing, public building, basic infrastructure or defensive structure), in addition to their distribution in the city.

On the other hand, the first person mode places the player in a first person mode inside the city. The player can walk around the city and visit the buildings and their characters. The objective of this mode is the immersion of the player in the setting, and teaching about the architecture, the usage of the buildings and the social class hierarchy of the Empire.

This project has been developed with the game engine Unity3D [1], the building 3D models and the characters have been modeled with 3DS Max [2] and the animations have been created with Adobe Mixamo [3] lately edited with 3DS Max.

**Keywords:** History, Setting, Visual, Animations, Interaction

# Chapter 1

## Technical Proposal

### 1.1 Introduction

What do we know about Ancient Rome? Do we know about its history? Nowadays many people does not have much interest about history, be it because most books seem boring (despite the existence of historic novels) or because having to dive in the reading makes it less appealing to the public. With the recent technological advances and the rise of videogames, there are many ways to make history more appealing and accessible to kids as well as grown-ups, and to make learning it more fun.

Taking advantage of videogames world to learn history is a good way to interest people in it, and to make it more appealing than consulting books. This is possible introducing the lifestyle of the Roman Empire in a visual way in a playable part. For example, an actual saga that puts this in practice is Assassin's Creed [4] from Ubisoft[5]. In this games, when a historical place is visited, such as a building, square, etc; a database entry is unlocked, and the player can access it anytime and read about the historical location.

For this reason, this project is a playable level where, instead of being focused in war like most of historical games, will be focused in the building of a roman city and the lifestyle of its citizens. The player, be an aerial view, has to build it from scratch, placing the buildings where he wishes and placing he city defenses that he considers necessary. This aerial view and its controls have been inspired by the videogame Imperium Civitas [6][7]. Furthermore, to boost immersion in the city and setting, the player can visit and walk through his city and interact with the people and the buildings to learn in visual and interactive way about the functions of the buildings and how people lived in that era.

### 1.2 Related Subjects

- 3D Design (VJ1216).
- Character Design and Animation (VJ1226).
- Game Engines (VJ1227).
- Foundations for Didactic Videogames Design (VJ1238).

## 1.3 Objectives

- To represent lifestyle in a roman city through a videogame.
- To teach about the functions and the distribution of every key building in a roman city(Temple, baths, forum, etc).
- To immerse the player in the setting via first person view.

## 1.4 Tasks

- Redacting the technical proposal (6h).
- Modeling and texturing the buildings (36h).
- Modeling and texturing the three character types (Legionary, Patrician, Citizen).
- Animating the three character types (Legionary, Patrician, Citizen)(12h).
- Implementing the isometric camera and the building interface (24h).
- Implementing the building placing system (40h).
- Implementing the first person camera and HUD (48h).
- Implementing the character routes (28h).
- Redacting the historical text (16h).
- Testing and bug correction (12h).
- Redacting the final project document and project presentation (40h).

## 1.5 Tools

### 1.5.1 Programming

- Unity 3D. The game engine where the project will be developed.

### 1.5.2 3D modeling and texturing

- Autodesk 3DS max. It will be used for modeling the buildings and the characters.
- Gimp [8]. It will be used for editing the textures.
- Adobe Photoshop [9]. For editing the textures too.

### 1.5.3 Animation

- Adobe Mixamo. Web tool for add and edit the skeletal mesh to a character and animate it. It will be used for the character animations.

#### 1.5.4 Documents

- Overleaf[10]. Used for writing the technical proposal and the final project document.

#### 1.5.5 Version control system

- Github[11].Used to upload the different project versions.

### 1.6 Expected Results

Of this project a playable level is expected, in which starting from an empty terrain the player will be able to select buildings from the interface and place them on the terrain. Characters will automatically spawn from those buildings, which will do their routines. Furthermore, an immersive first person mode is expected too, where the player will be able to walk and interact with the city and the characters.

This project will show the lifestyle in a city of the Roman Empire, where the player himself will found the city. It is intended that the player, while playing and building the city, understands the distribution of buildings and what utility they had through placed texts in them, as well as learn in a visual way the routines of every citizen according to its social class(Patrician, citizen or soldier). Each class had a different job and different tasks.

## Chapter 2

# Related Work

This project is born from the fusion of two passions: History and videogames. Nowadays not many people is interested in history, on the other hand videogames are on the rise and wining fans every year. For that reason, the need of learning history through videogames is born, since it is proven that telling a real story through a novel (like Santiago Posteguillo's historical novels about Roman Empire, the principal subject of this project [12]) or by a audiovisual medium is more appealing to most people that reading boring history books. In videogames like 'Assassin's Creed' learning history and playing videogames can go together. In this case, the game includes real events while the game plot happens or the player explores locations, buildings or real monuments where there is the possibility of reading a text where the origin of the building as well as trivia about it is told. On that way, the videogame 'Assassin's Creed' justifies and proves that the objective of this project is possible.

About the gameplay foundations of this project, it has two game modes with different gameplay and objectives, and each of them are influenced by the next games:

- **Imperium civitas 3**

As said before, there is the building mode, where from an aerial view the buildings will be selected to be placed on the terrain and, once placed, depending on the building type, different types of characters will spawn on them and they will start to live on the built city. The gameplay of this mode is based on the videogame 'Imperium Civitas 3', because its excellent interface to select the buildings and its excellent building placement system, and the automatically character spawn idea and how they live in the city. As shown in the [following video](#) a demonstration of the game's building system is shown.

- **Metal Gear Solid V**

About the second gameplay mode, the first person mode, it immerses the player in the city, improving learning through visuals. This mode is based on a part of the game 'Metal Gear Solid V', where the player can visit his own base, where the player manages resources and the staff, and he also can interact with its elements, including staff. In [this video](#) a five minutes demonstration on this part in the game is shown.

In addition to the reasons and gameplay foundations previously cited, another reason why this project is based on 'Imperium Civitas 3' is because it its based in the ancient Roman Empire, and its missions tell real battles and events of that era and, also, shows a roman city in all its splendor, with all its key buildings and a brief explanation of its usage. Also, this project

goes further, not only focusing on the city on an aerial view like 'Imperium Civitas 3', but also the player immersion is intended with the first person mode with the previously cited characteristics of 'Metal Gear Solid V', boosting the player's immersion by the interaction with the city elements.

In conclusion, this project bets on a technique of learning history, centered in the cities of the ancient Roman Empire, through videogames by the city construction and watching and investigating its elements, and by that way prove that telling history through this arising audiovisual medium is a great idea to awake the people's interest about learning the events of the past.

# Chapter 3

## Design

In this chapter the game design document is presented, where the technical details of this project are detailed.

### 3.1 Game Analysis

This project is a playable level which objective is learning about lifestyle of an ancient Rome city. The player will be able to build the city as he wishes and, once built, the characters will be spawned and they will do their routines through the city, depending of their social class and job. In addition, a first person mode is included that allows the player to have an immersive experience in the city, and he will be able to watch and interact with the city elements.

### 3.2 Genre

The genre of this project could be a 'Historical game' because of its setting on the Roman Empire and could also be a 'Visual game' because its objective of learning through watching and interacting with the city elements.

### 3.3 Platform

This project is made with Unity game engine, and it is aimed at the PC platform.

### 3.4 Target Audience

This project is aimed to any kind of audience and of any age that interested about learning about ancient cultures of the past, in particular this game focuses on the culture of ancient Rome and its cities.

## 3.5 Gameplay Overview

The gameplay of this game is an hybrid of two genres, since the game has two game modes with different gameplays and different objectives. In one hand, the first game mode is the building mode, based on videogames like Imperium Civitas[6][7], that consists in an aerial view, where the player, from an interface, will select the building that wants to place on the terrain and build the city as he wishes, with all the elements that considers necessary. That interface consists in a pop up menu where the buildings are separated by type.

On the other hand, in the first person mode the player is placed at the same height as the characters and he will be able to visit the buildings and interact with the characters automatically spawned. In this game mode, the gameplay and the controls change from the building mode, using a first person camera where the player will be able to walk through the city, watch and investigate its elements to learn about lifestyle on the city. This game mode is based on a game mode of 'Metal Gear Solid V'[13], where the player can visit the base built by himself, despite this game mode is played with a third person camera.

The two modes offer a different game experience and have two different objectives. The building mode is focused on teaching the player about building distribution and functions, by letting the player place those buildings freely so he learns about their role in the city.

Lastly, the first person mode lets the player dive into the city that he is building, where he can learn, through observation and exploration, the social class hierarchy of the citizens and the usage of the previously placed buildings.

## 3.6 Player Experience

The game starts at the main menu, where the player has the following options:

- **New City**

In this mode, the player starts a game with an empty terrain and has to build a city from scratch.

- **Load prebuilt city**

This option loads a city with all the elements already placed. The player can directly enter the first person mode and explore it.

- **Exit game**

Closes the application.

## 3.7 Game Objectives and Rewards

The main objective of this project is learning about the lifestyle in a city of the Roman Empire through free interaction and observation, and concerning rewards, the only reward of this project is the knowledge acquired and the entertainment provided. The learning objective varies in the two modes, but the previously cited reward remains the same. Such objectives are the following:



In the building mode, the player will learn about the most common buildings from that era and which type they belong to, while in the first person mode bets on learning based on immersing the player in the city, where he can freely walk its streets and buildings to understand their functions, as well as observe the routines of the citizens to learn about the social class hierarchy and tasks.

## 3.8 Gameplay Mechanics

The game mechanics have been previously mentioned, but they are fully explained here:

- **Building view:** The main mechanic for building the city. This view uses the mouse, and the player can do the following actions:
  - **Select and place buildings:** Using the left mouse button (LMB from now on) the player selects the buildings in the pop up menu. Once it is loaded, the building follows the cursor around the terrain. It can be placed by clicking LMB again.
  - **Delete selected building:** When a building is selected, it can be deleted by pressing the right mouse button.
  - **Rotate selected building:** Again, the selected building can be rotated 90 degrees by moving the scroll wheel up and down.
- **First Person View:** The main mechanic for immersing the player in the city. In this mode, the player controls the avatar with the keyboard and mouse. The controls are the following:
  - **Movement:** The 'WASD' keys of the keyboard are used to control the movement of the character. The 'W' key is pressed to move forward, 'S' to move backwards, 'A' to strafe left and 'D' to strafe right.
  - **Camera aiming:** The camera is controlled by moving the mouse around.
  - **Interact:** To interact with the environment, the player has to press the 'E' when the prompt appears on screen. when the prompt appears on screen.

## 3.9 Game World

The game world is set in the rise of the Roman Empire, where thousand of cities were built around Europe. This project is not set in any specific location, the terrain and the city are fictional but set in a real world and era.

## 3.10 Art

The art is the most important part of this project, since most of the learning is through visual observation. That is why the 3D models, the textures and the animations are very realistic, to favor immersion and offer the player the closest imitation to reality.

## Chapter 4

# Art and Development

This chapter explains all the tasks done during the project development. In every task there are images if it belongs to the art part, or, in the programming tasks, the algorithm will be shown, a description of how it was implemented and the hours required to complete that task.

### 4.1 Art

The 3D models in this project are divided in two groups:

#### 4.1.1 Buildings

Ten different buildings have been modeled, which belong to one of four different types: housing, public buildings, basic infrastructure and defenses. The following describes how it was done as well as images of the textures used and the final result. The modeling process has been very similar for all the buildings. To model them, a few primitives have been used: boxes, cylinders and planes. Adding the 'Edit Poly' to this primitives, they can be shaped and fit together in order to obtain the final shape of the building.

Once the building is modeled, it's time to start texturing it. A texture is a 'png' of 'jpg' file created in Photoshop with a size of 1024x1024 that contains all the textures used in the building (in the explanation of every building, its texture map is included). A material is assigned to the mesh, and the texture is imported to it. Then, the 'Unwrap UVW' modifier is added to the material in order to unwrap the texture and fit it in the mesh. Lastly, to add realism to the models, the same texture in black and white is added as a Bump Map to give relief to the textures. In figure 4.1 an screenshot of the tools used in 3DS Max can be appreciated.

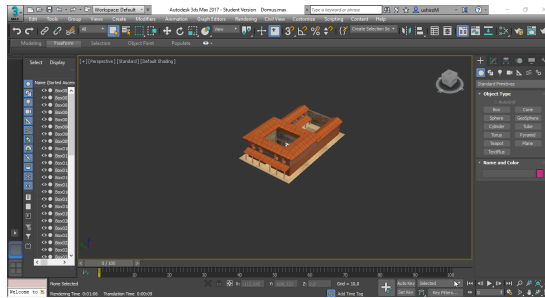


Figure 4.1: Screenshot of the Domus in the 3DS Max editor.

## Domus

The domus where the dwellings of the upper families of the city, called 'patricias'. The head of the family (paterfamilias) received the title of dominus. They were 120 meters long and 30 wide, and usually, only had one floor. They had two parts: the vestibulum and the atrium, separated by the tablinium. The atrium was open in the centre, and a impluvium, situated in the floor, collected rain water, and was the center of the domestic life of the house. The tablinium, located between the vestibulum and the atrium, was the place where the pater familias had his office, next to the library. This Domus is based in the plane shown in figure 4.2. In figures 4.3, 4.4, 4.5 and 4.6 renders of the domus can be appreciated [14].

**Time invested in modeling and texturing the Domus: 8 hours**



Figure 4.2: Map of a typical domus on which the domus of this project has been based.



Figure 4.3: Render of the Domus from outside.

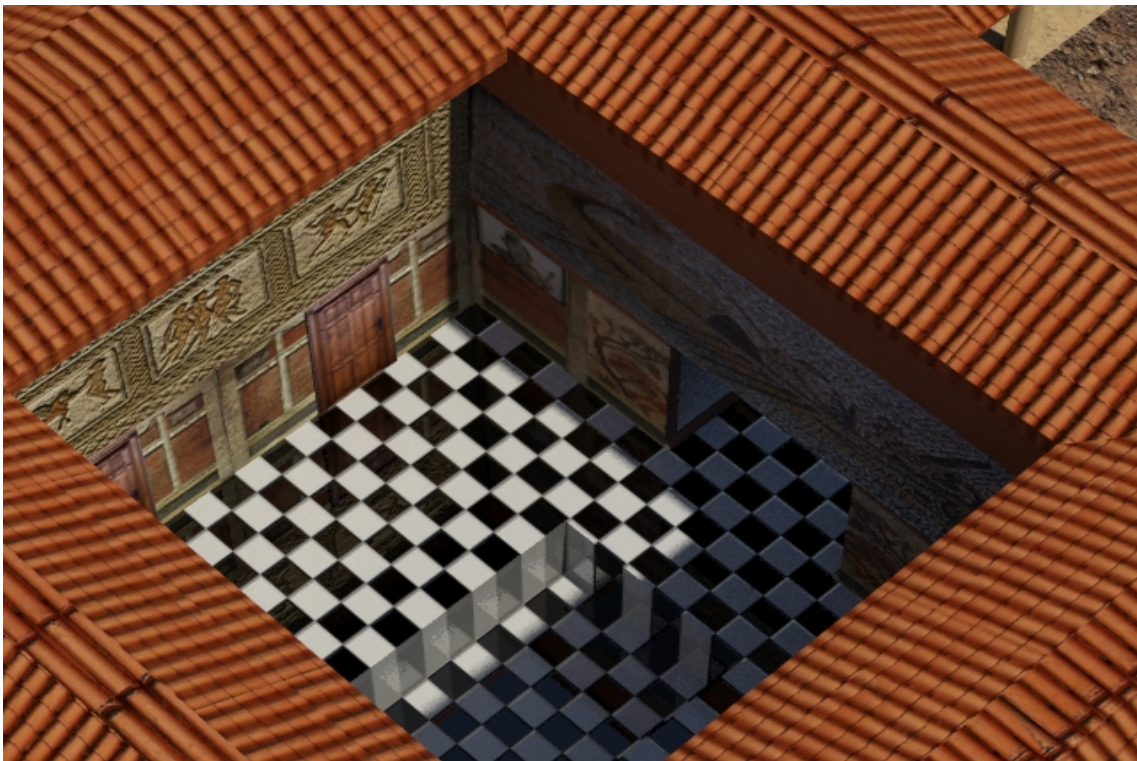


Figure 4.4: Render of the Domus from above.





Figure 4.5: Render of the Domus from inside.

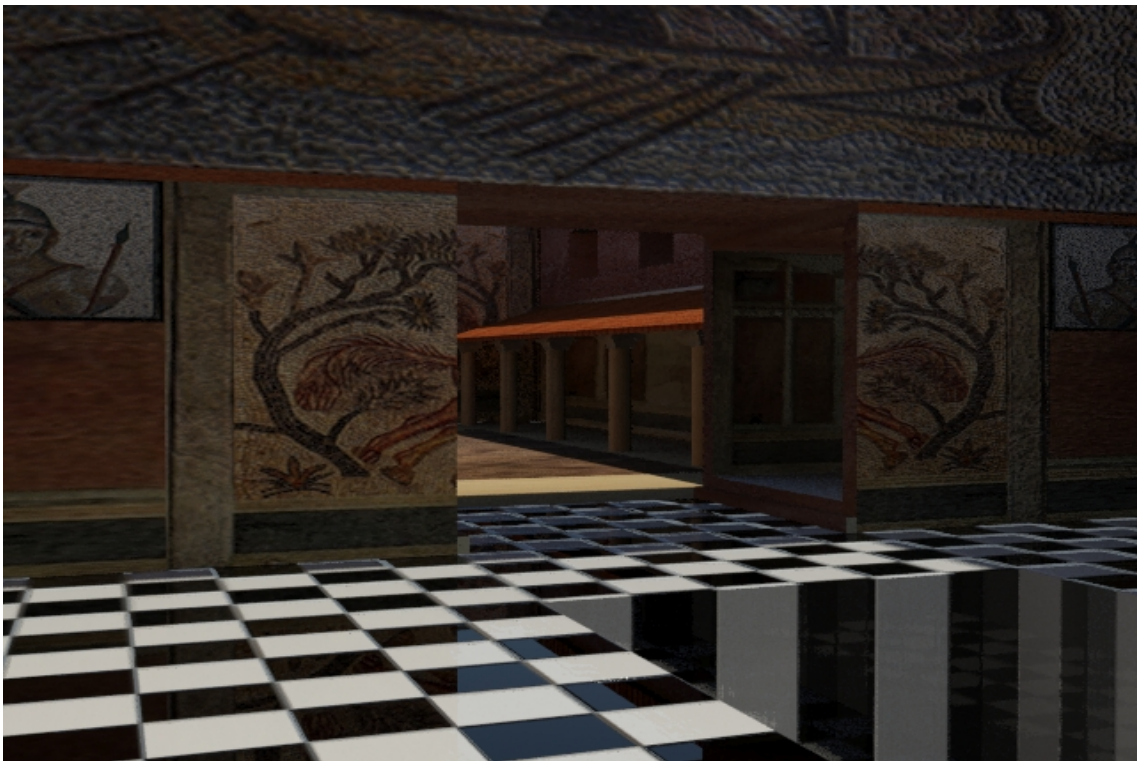


Figure 4.6: Render of the Domus from inside.





Figure 4.7: Textures used in the Domus.

## Villa

The villas were the most luxurious homes of the time. They belonged to patrician families, since building and maintaining them was extremely expensive. They were characterized by luxury, and had mosaics that depicted the feats of the owner, called 'villicus'. The villas were surrounded by walls to defend them against thieves and robbers. The villa of this project is based on the villa form figure 4.8 combined with the roof and walls shape of that era.

In figures 4.9, 4.4, 4.5 and 4.6 renders from the resulting villa can be appreciated [15].

**Time invested in modeling and texturing the Villa: 6 hours**



Figure 4.8: Remains of a villa in Tarragona.

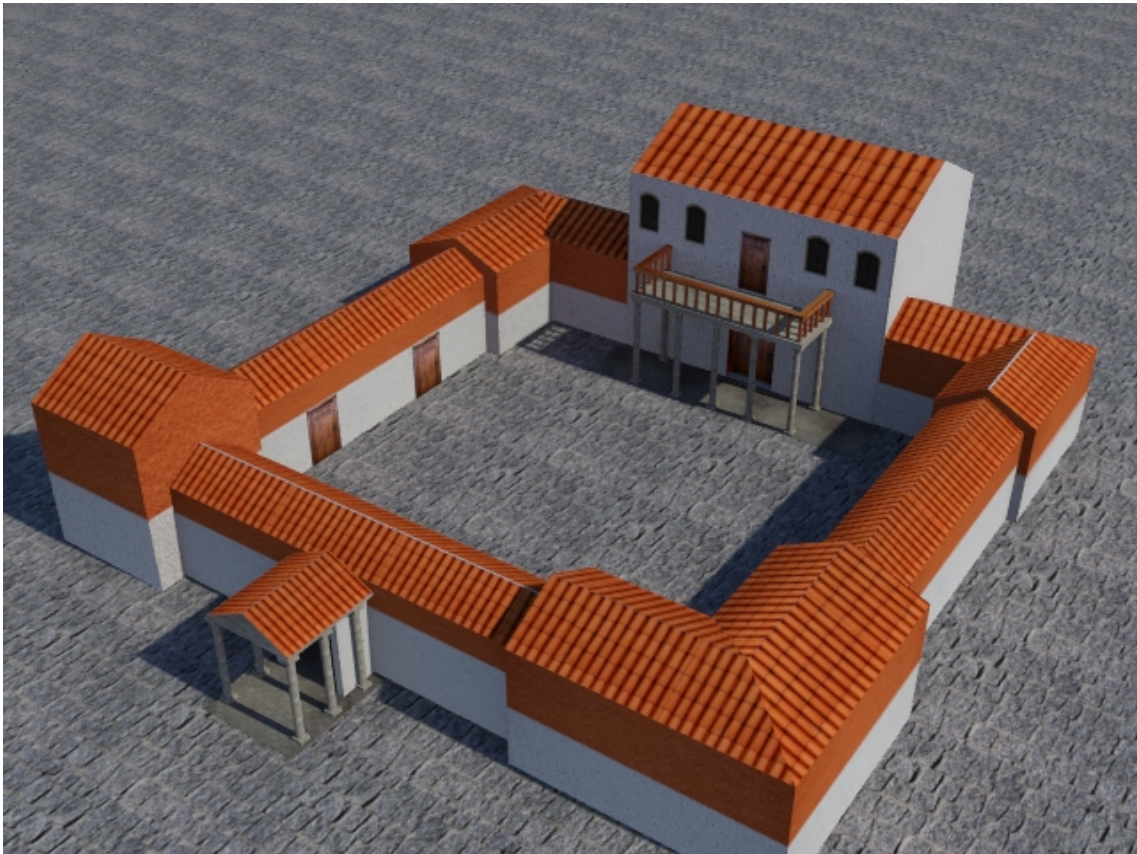


Figure 4.9: Render of the villa from above.





Figure 4.10: Render of the villa from inside.



Figure 4.11: Render of the villa from the front.





Figure 4.12: Render of the villa from the back.



Figure 4.13: Textures used in the villa.



Figure 4.14: Textures used in the villa.

## Insulae

The insulae were the homes of the most humble class. They used to be a block of flats 20 meters high with a courtyard in the center, open to take advantage of the sunlight. This Insula is based on the illustration in figure 4.15. In figures 4.16, 4.17 and 4.18 renders from the final Insula can be appreciated [16].

**Time invested in modeling and texturing the Insula: 6 hours**



Figure 4.15: Screenshot from an insula in Imperium Civitas 3.





Figure 4.16: Render of the insula from above.



Figure 4.17: Render of the Insula from the gate.





Figure 4.18: Render of the courtyard.



Figure 4.19: Textures used in the Insula.



## Triumphal Arch

The Triumphal Arch is a monument built to commemorate the victorious general in honor of some military victory. In its simplest form, it consists of two massive pilasters connected by an arch, finished by an attic where it could contain a statue or commemorative inscriptions. The Triumphal Arch modeled in this project is based on the Arch of Constantine located in Rome, illustrated in the figure 4.20 [17]. In figures 4.21, 4.22 and 4.23 renders of the result can be appreciated.

**Time invested in modeling and texturing the Triumphal Arch: 8 hours**



Figure 4.20: Image of the Arch of the Emperor Constantine in Rome.



Figure 4.21: Aerial view of the Triumphal Arch.



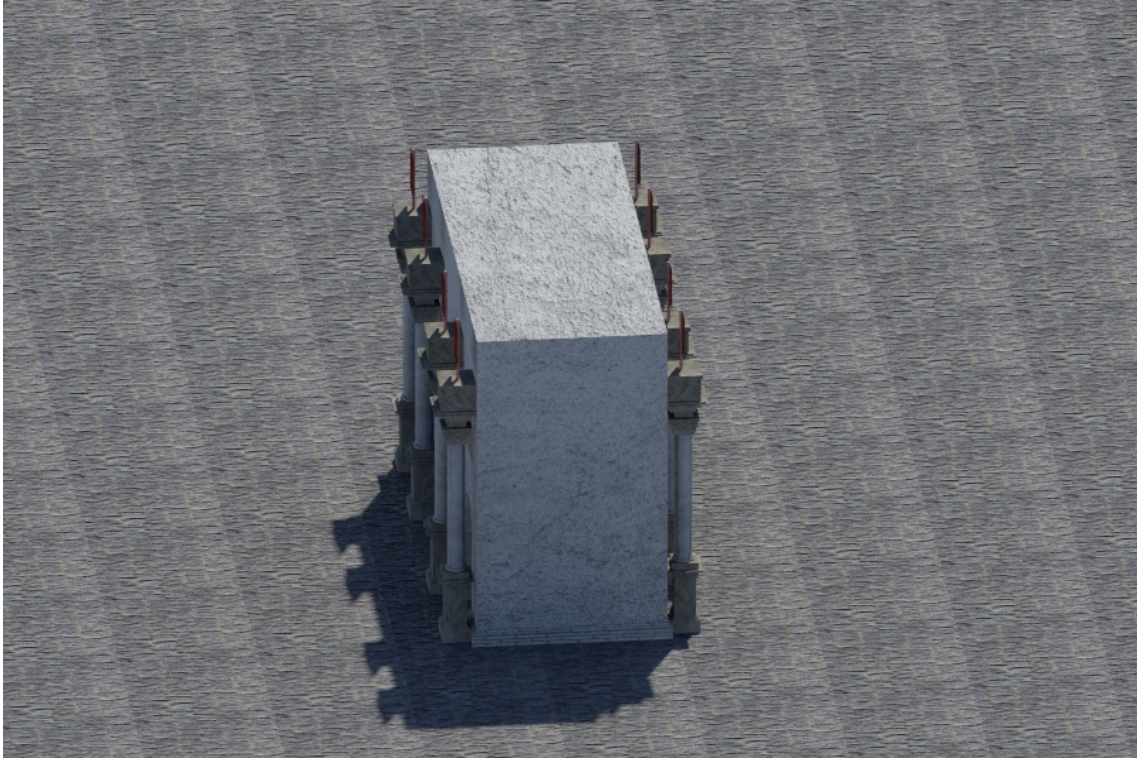


Figure 4.22: Aerial view of the Triumphal Arch from the side.

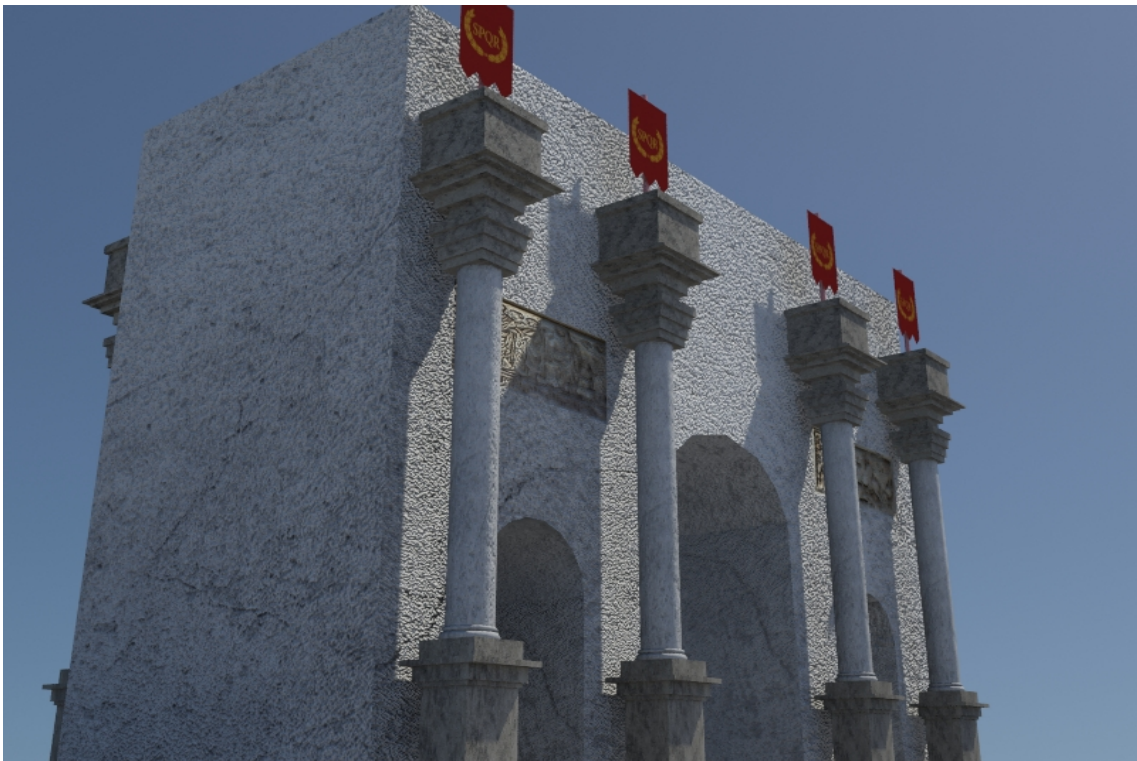


Figure 4.23: Front image of the Triumphal Arch.



## Amphitheatre

The amphitheatres were where the main entertainment of the time was developed. In this building took place public executions and fights between gladiators. Usually, they tried to recreate a real battle as commemoration. Amphitheatres used to have an oval shape, although some could have a circular shape. The stands (called 'cávea' in Latin) were divided into four zones, the lower one for senators and high officials, the middle zone for the plebs and the upper one for women. They were built of carved stone in large blocks, although later concrete was used, and at the top of the amphitheater awnings were deployed to protect the spectators from sunlight. The amphitheater of this project is based on the famous coliseum of Rome as it is illustrated in the figure 4.24 [18]. In figures 4.25, 4.26, 4.27, 4.28, 4.29 and 4.30 renders of the amphitheatre can be appreciated.

**Time invested in modeling and texturing the amphitheatre: 12 hours**



Figure 4.24: Image of the Roman Coliseum.

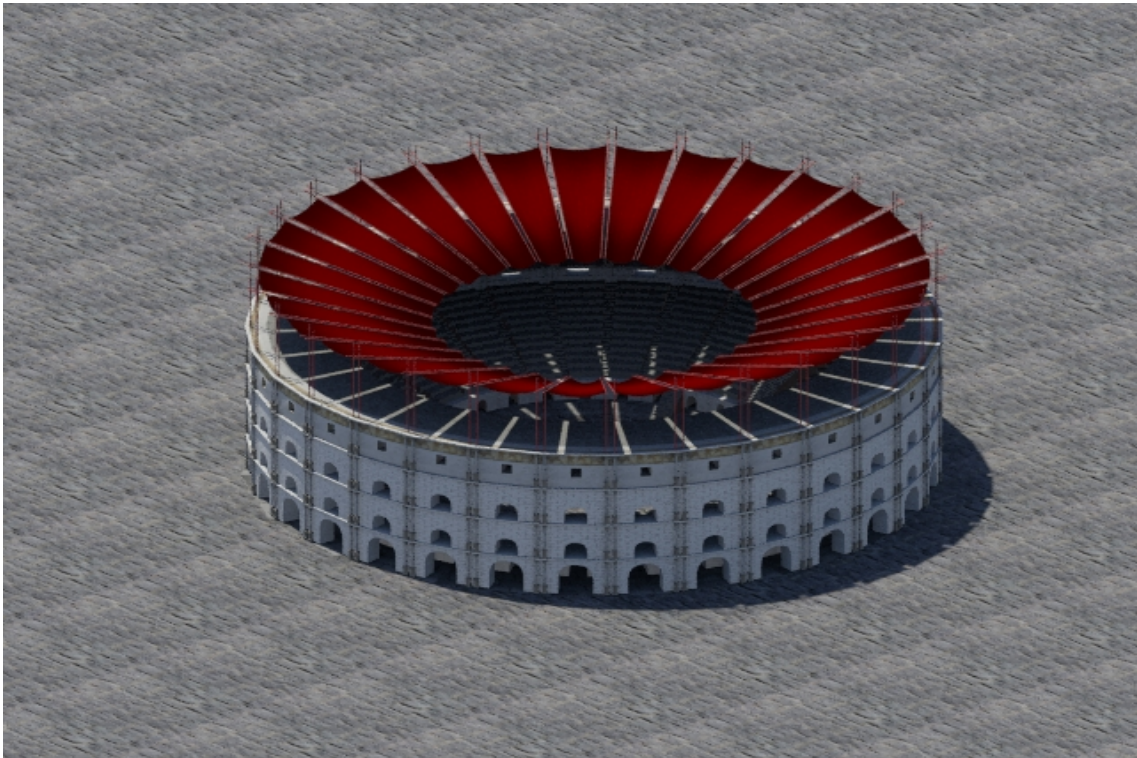


Figure 4.25: Aerial view of the amphitheatre.



Figure 4.26: Front view of the amphitheatre.

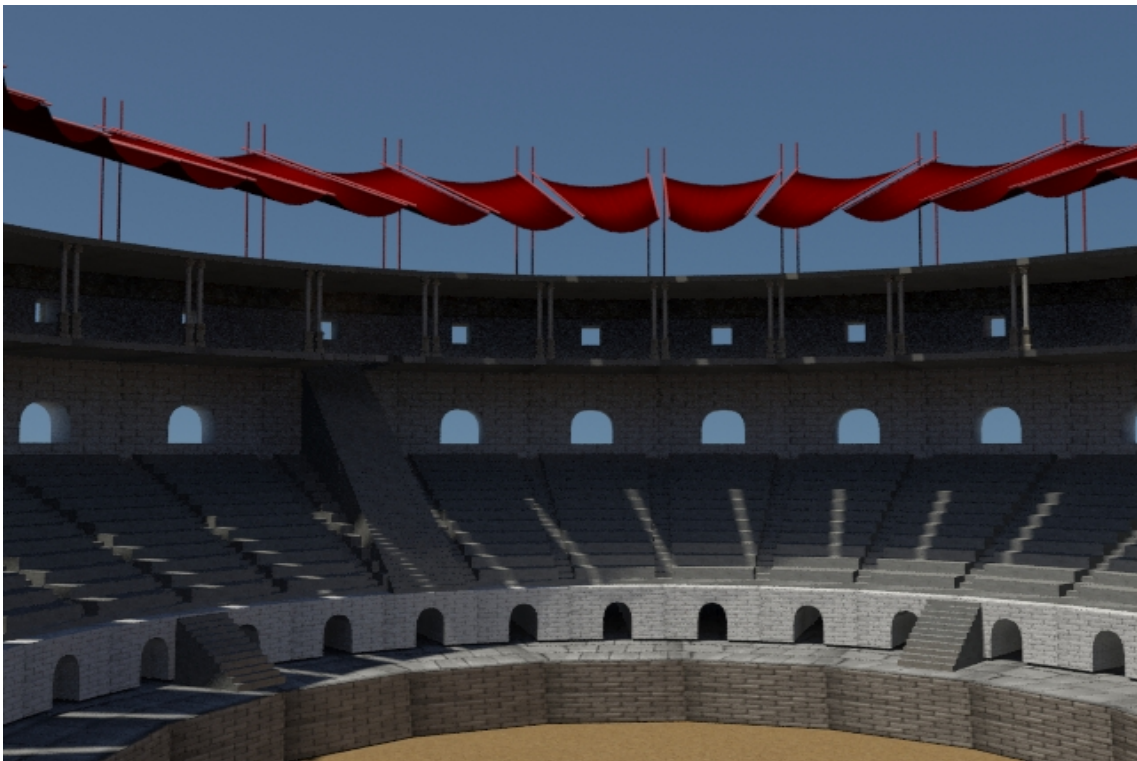


Figure 4.27: Render of the amphitheatre from within.



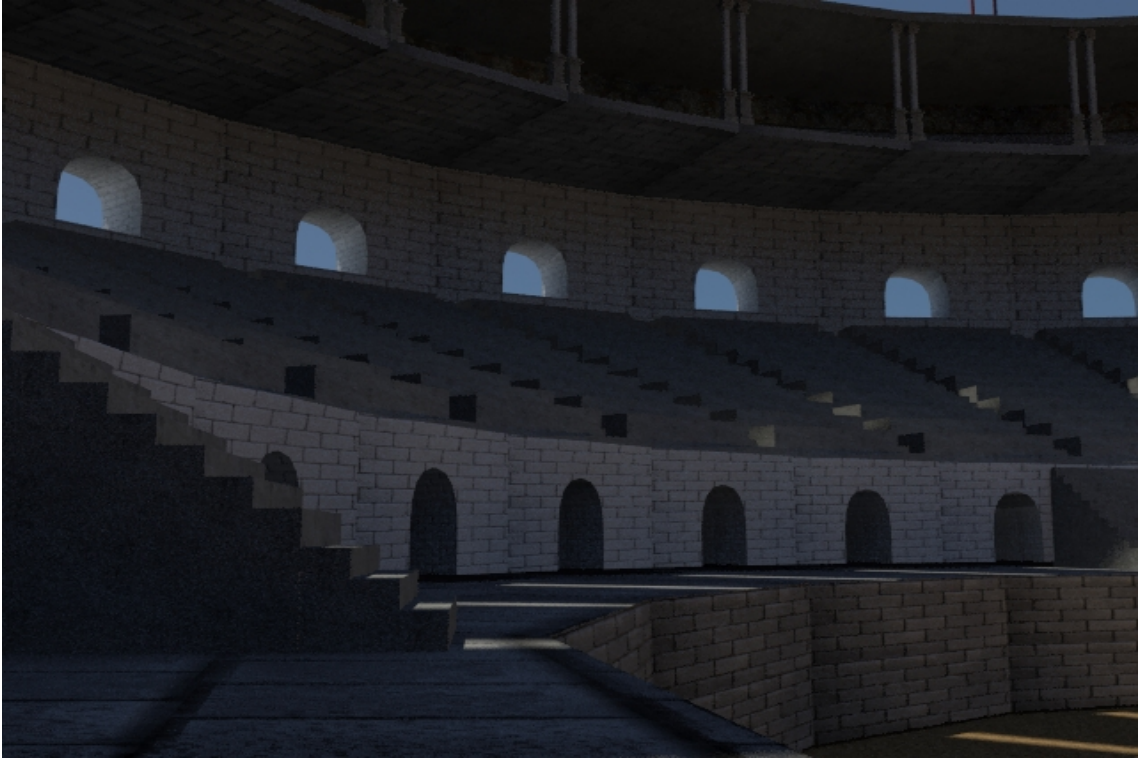


Figure 4.28: Render of the stands.

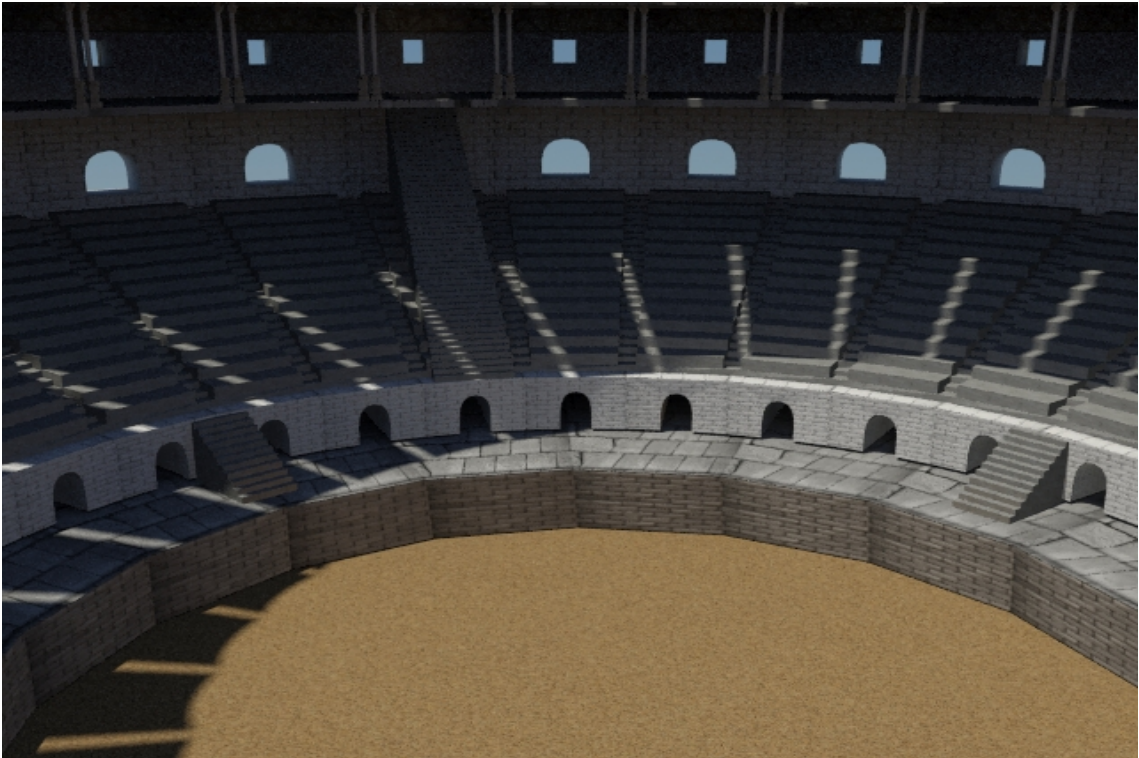


Figure 4.29: Render of the arena.

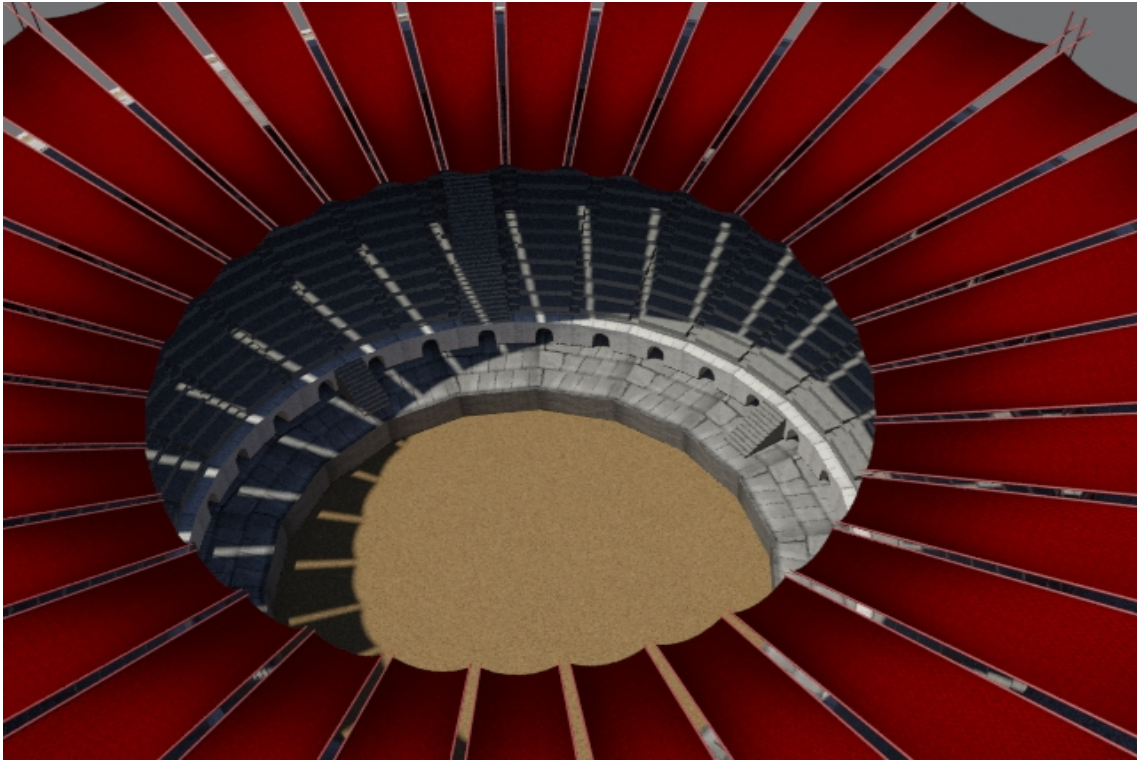


Figure 4.30: Render from the top.

## Circus

The circuses were also buildings where entertaining events took place, in particular there were celebrated chariot races, horse races or even naval battles, flooding the circus with water. The circuses had a rectangular shape that ended with a semicircular section. The circus modeled for this project is not based on any existing circus but has been modeled based on the typical shape of the circus, with all its elements shown in the figure 4.31 [19]. In figures 4.32, 4.33, 4.34, 4.35, 4.36 and 4.37 the circus is shown.

**Time invested in modeling and texturing the circus: 16 hours**

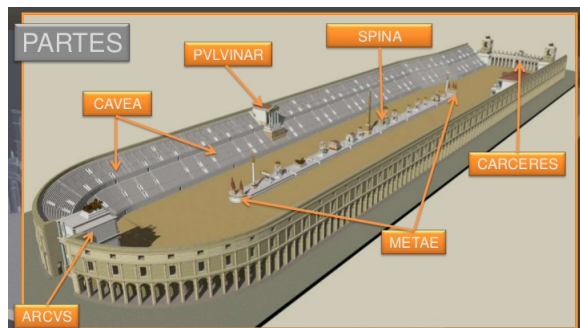


Figure 4.31: Map of a common circus.



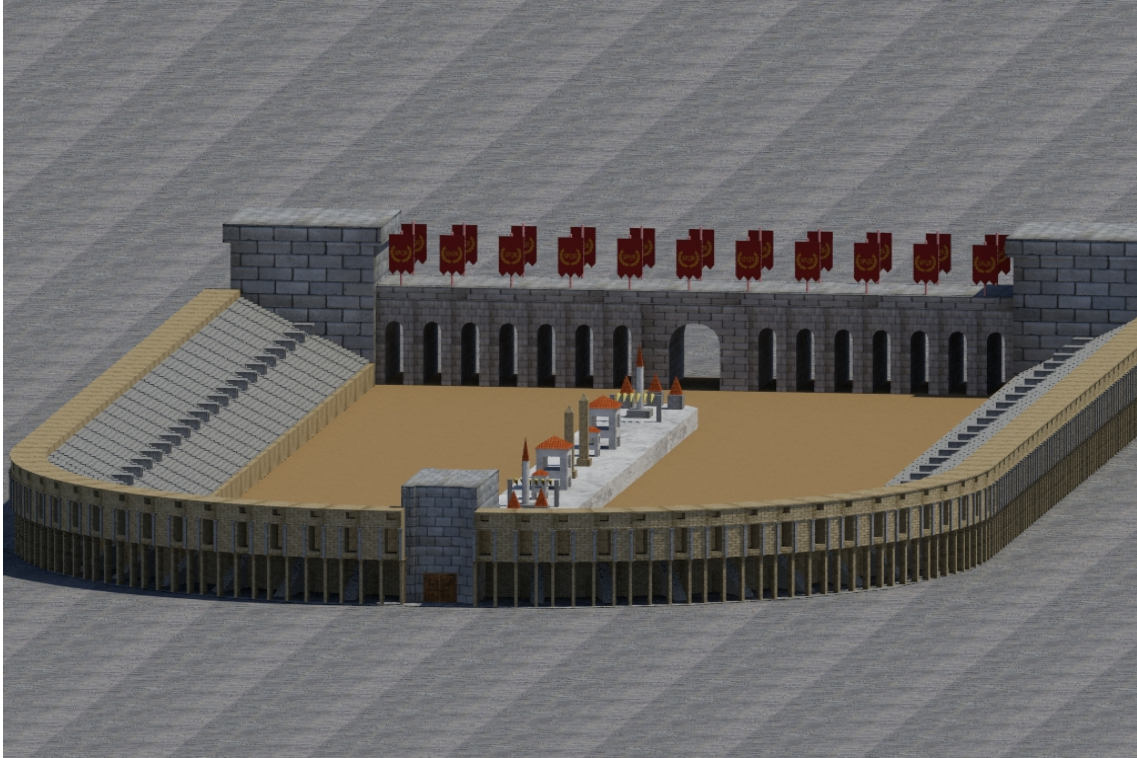


Figure 4.32: Render of the aerial view of the circus.



Figure 4.33: Side view of the circus.

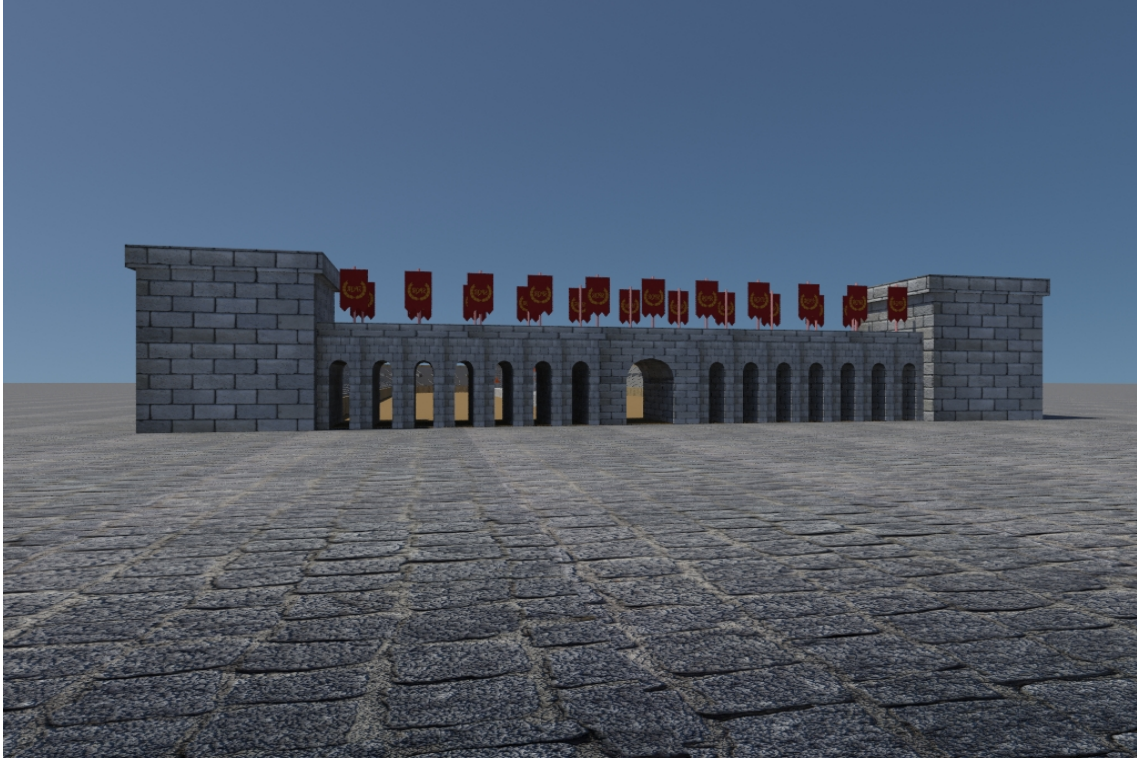


Figure 4.34: Front view of the circus.

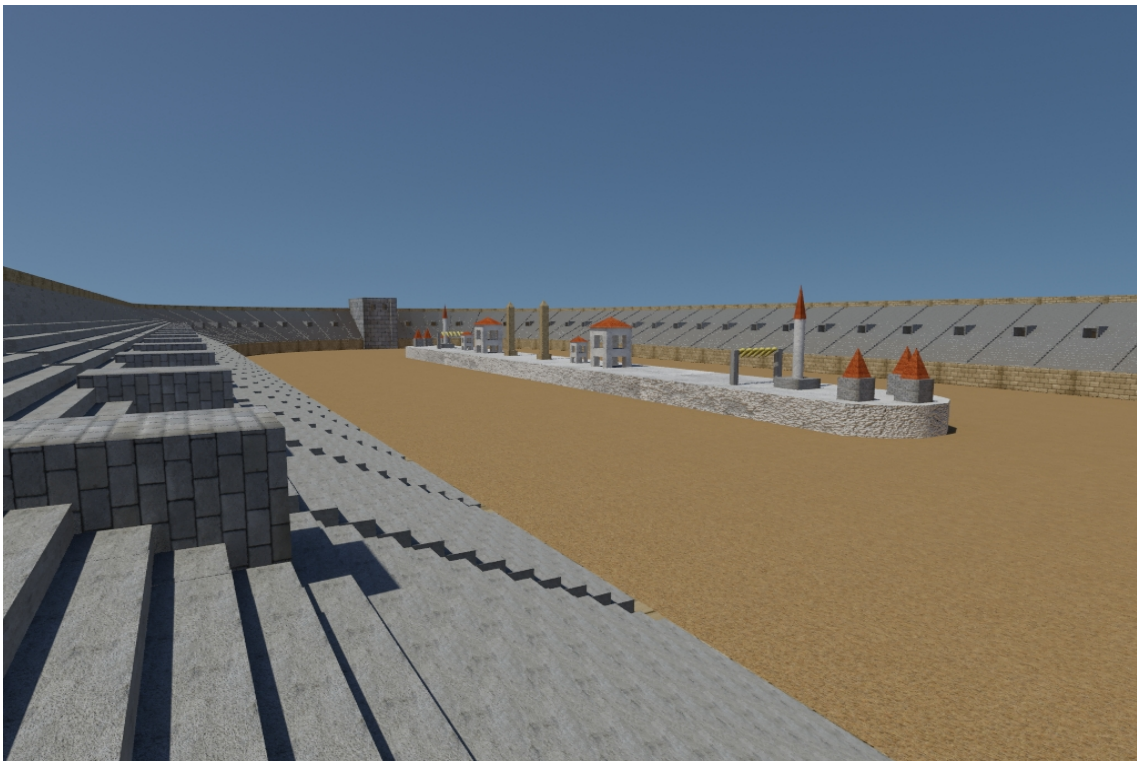


Figure 4.35: Render from the stands.





Figure 4.36: Render of the arena.

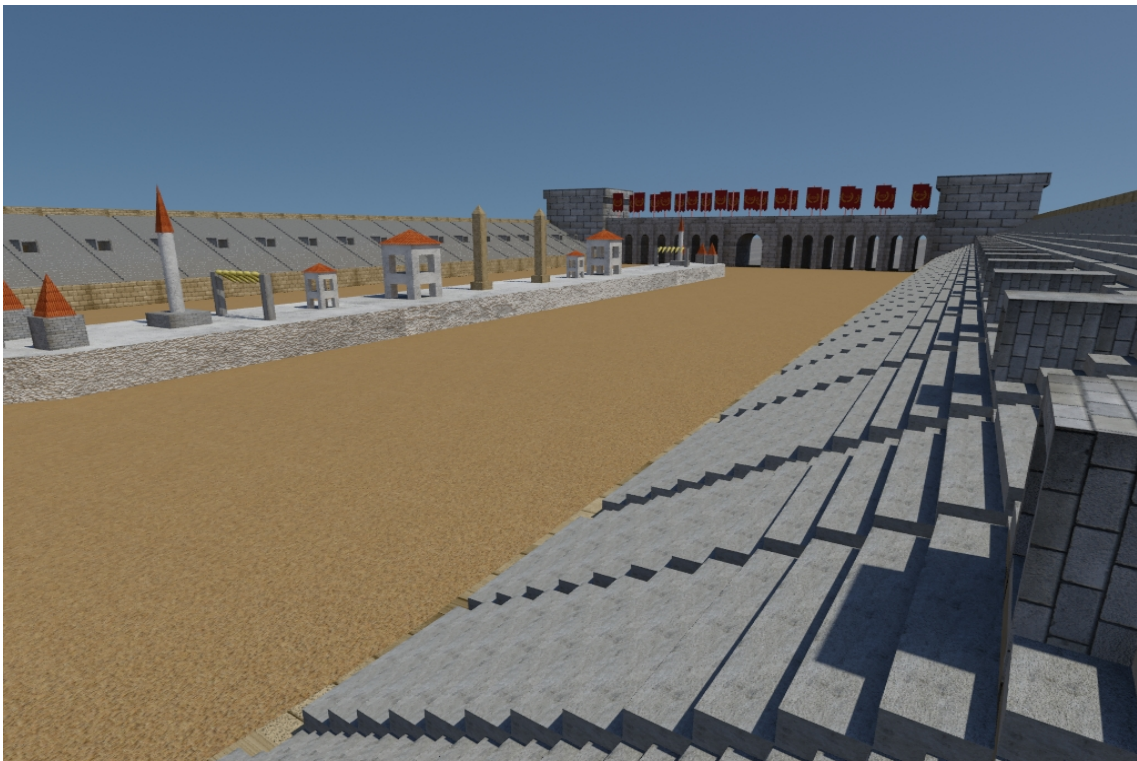


Figure 4.37: Another render from the stands.

## Theatre

Another entertainment building was the theaters. Here theater plays of all kinds took place, a form of entertainment very popular in ancient Rome. Roman theaters derive from Greek theaters, as many features of Roman architecture come directly from Greek architecture. The first theater was built of wood and adobe, since there was a law that prevented the construction of permanent theaters. Later, with the construction of the first stone theater, the Theater of Pompey, theaters began to were built with carved stone, just as they were built in Greece. The theater modeled in this project derives from the theater of Mérida illustrated in figure 4.38[20]. The theater of this projects is shown in figures 4.39, 4.40, 4.41, 4.42 and 4.43.

**Time invested in modeling and texturing the theater: 8 hours**



Figure 4.38: Image of the Roman Theater of Mérida.

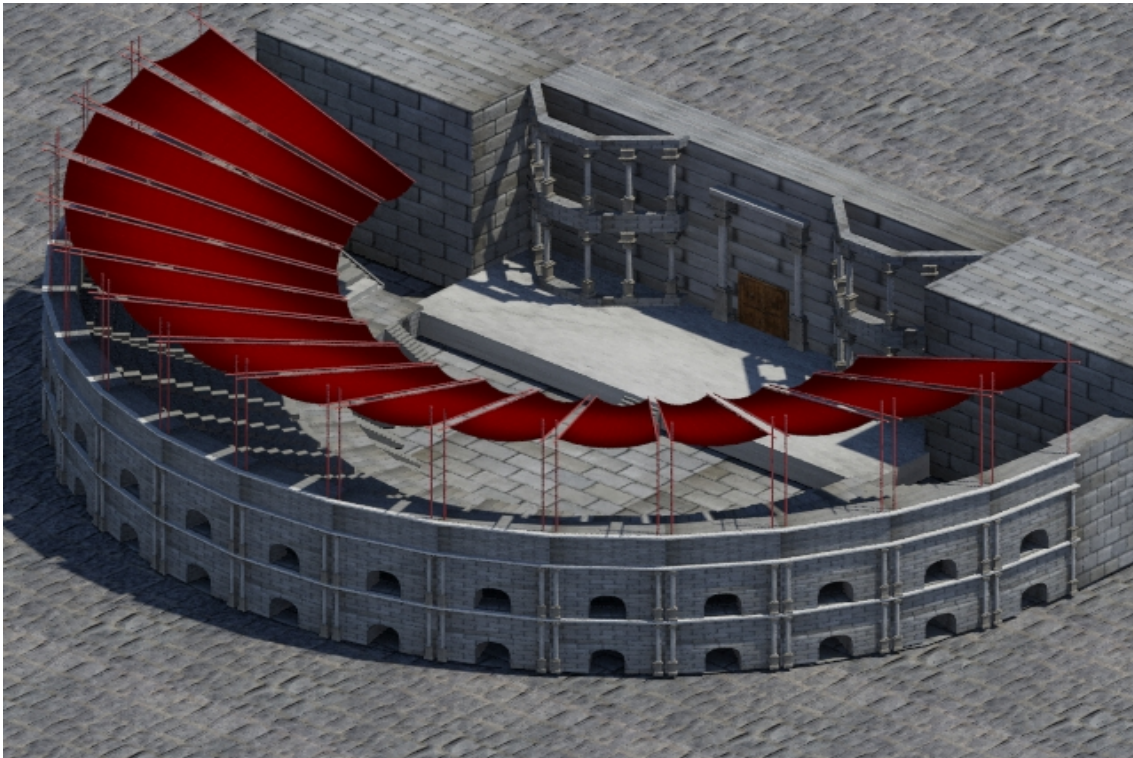


Figure 4.39: Aerial view of the theater.



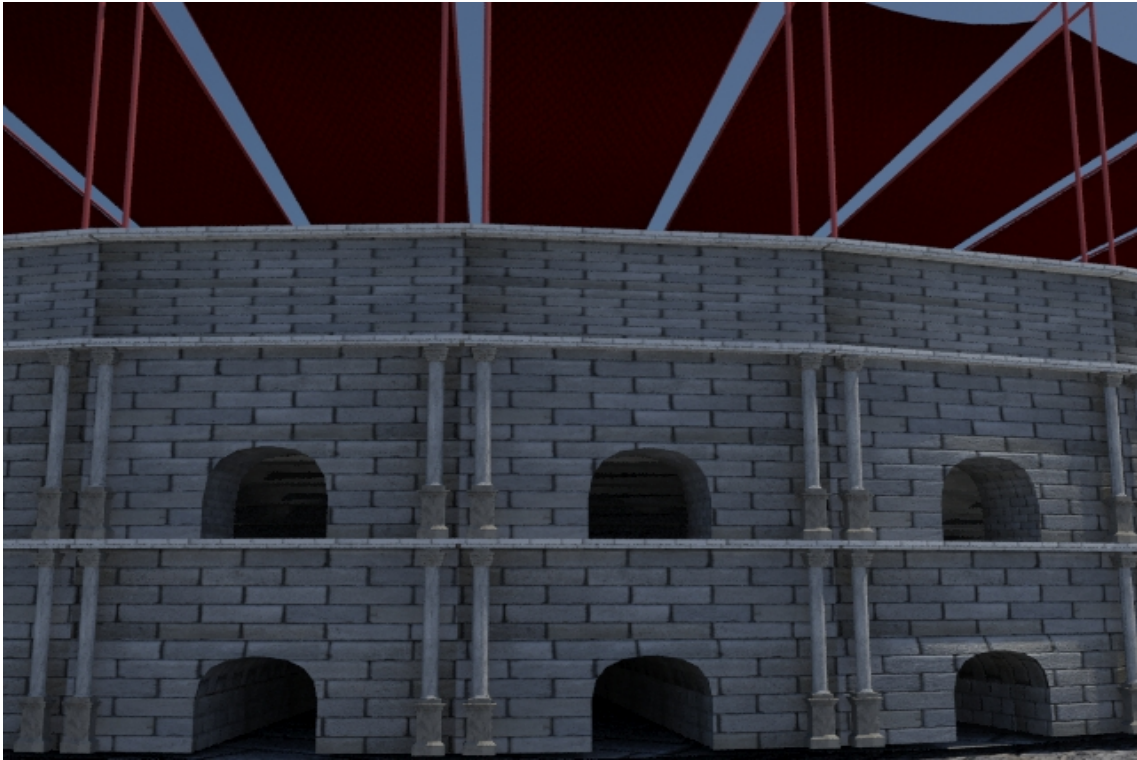


Figure 4.40: Front view of the theater.

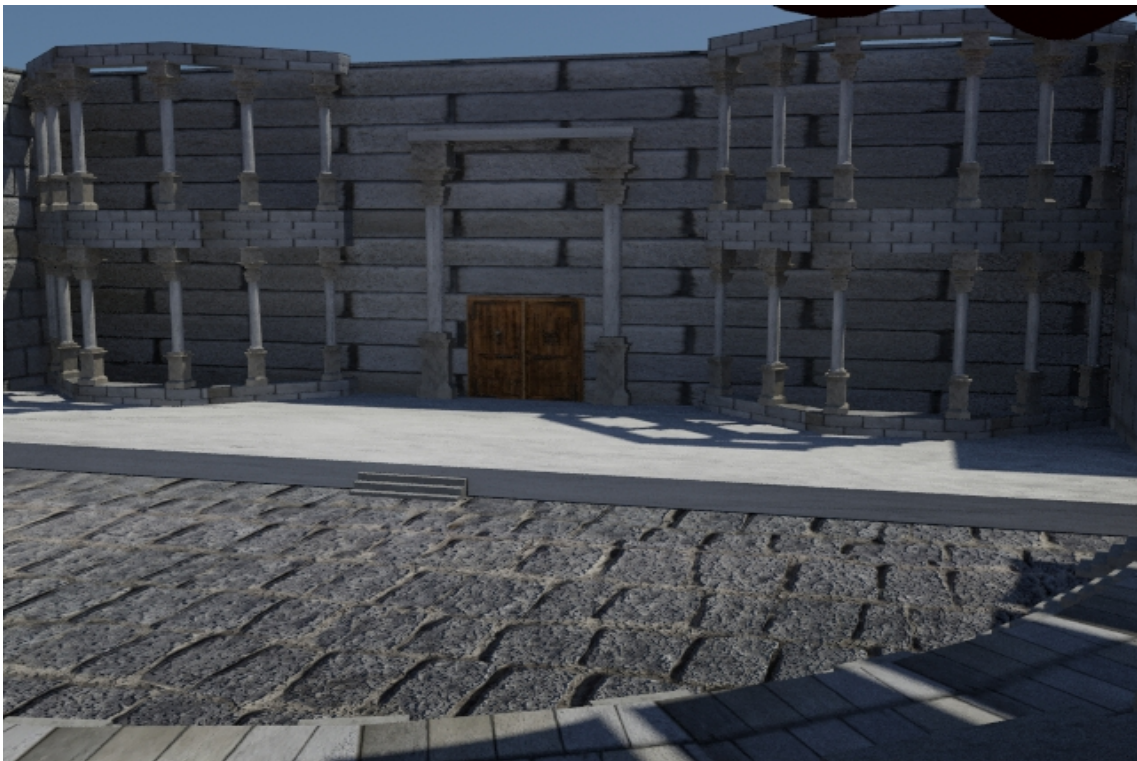


Figure 4.41: Render of the stage from the stands.

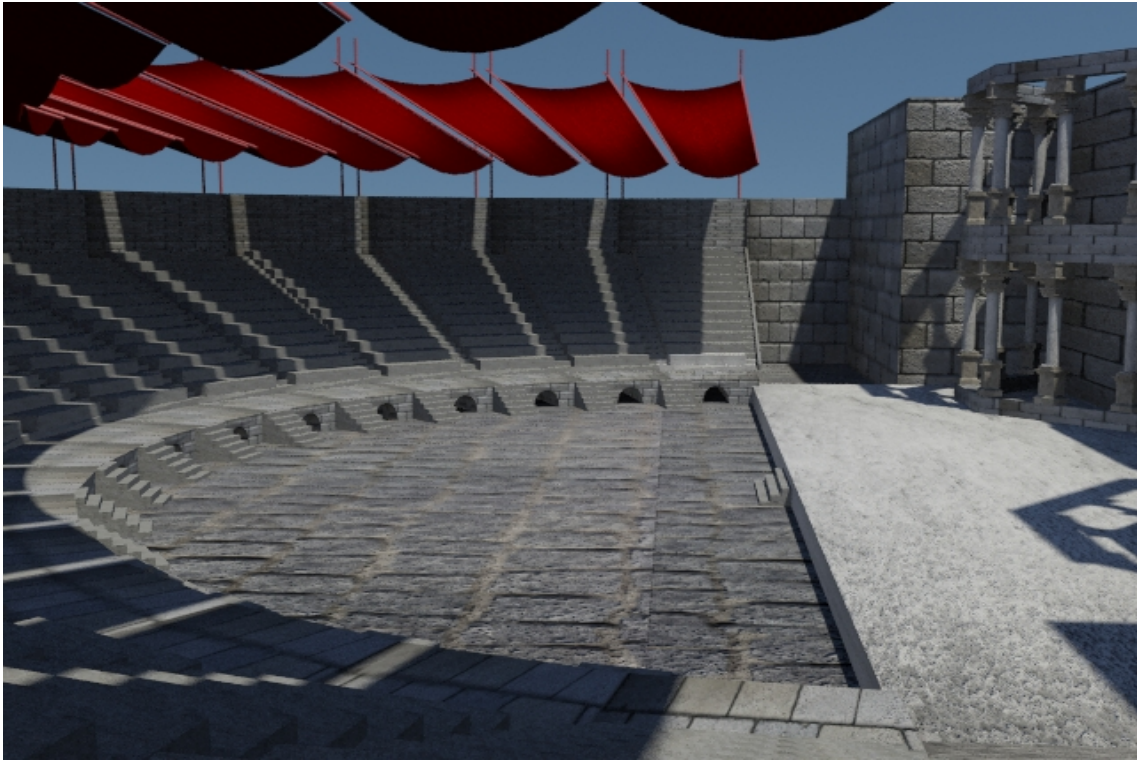


Figure 4.42: Render of the stands.

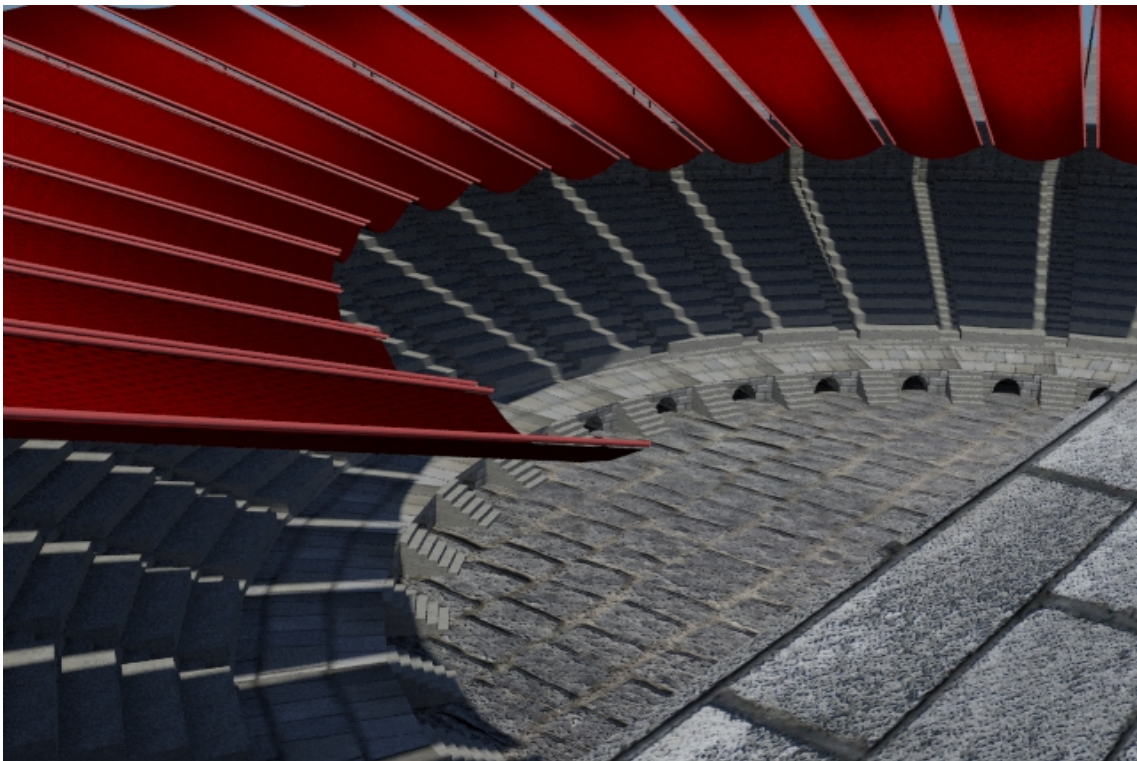


Figure 4.43: Aerial view of the stands.



## Forum

The forum is the central zone of the city, constituted by a rectangular square where were the institutions of government, market and religion. In the forum were the most important buildings, such as Curia Hostilia, the market, some temples and even many of the arches of triumph raised in the city. In this center most of the events of the city happened: votes in the senate, judgments, executions, rites of sacrifice to the gods, etc. The forum in this project is not based on a real forum, but is designed according to the most common elements of the forums, as shown in figure 4.44 [21]. In figures 4.45, 4.46, 4.47, 4.48 and 4.49 images from the resulting forum can be appreciated.

**Time invested in modeling and texturing the forum: 8 hours**

### El Foro

- La ciudad romana estaba rodeada por una muralla y su trazado urbano se establecía con cierta regularidad, siguiendo el modelo etrusco y helenístico hipodámico, en torno a las dos calles principales perpendiculares, el cardo (N-S) y el decumanus (E-O). Es esencial en la ciudad, como centro de la vida política, religiosa y administrativa y de la actividad comercial. El foro es el gran espacio donde confluyen las vías y donde se sitúan los edificios más importantes como la curia, los principales templos, las basílicas, las termas, los arcos de triunfo,

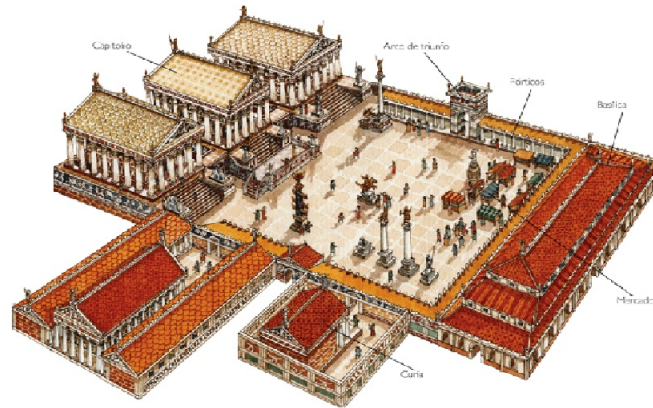


Figure 4.44: Map of a common Roman forum.

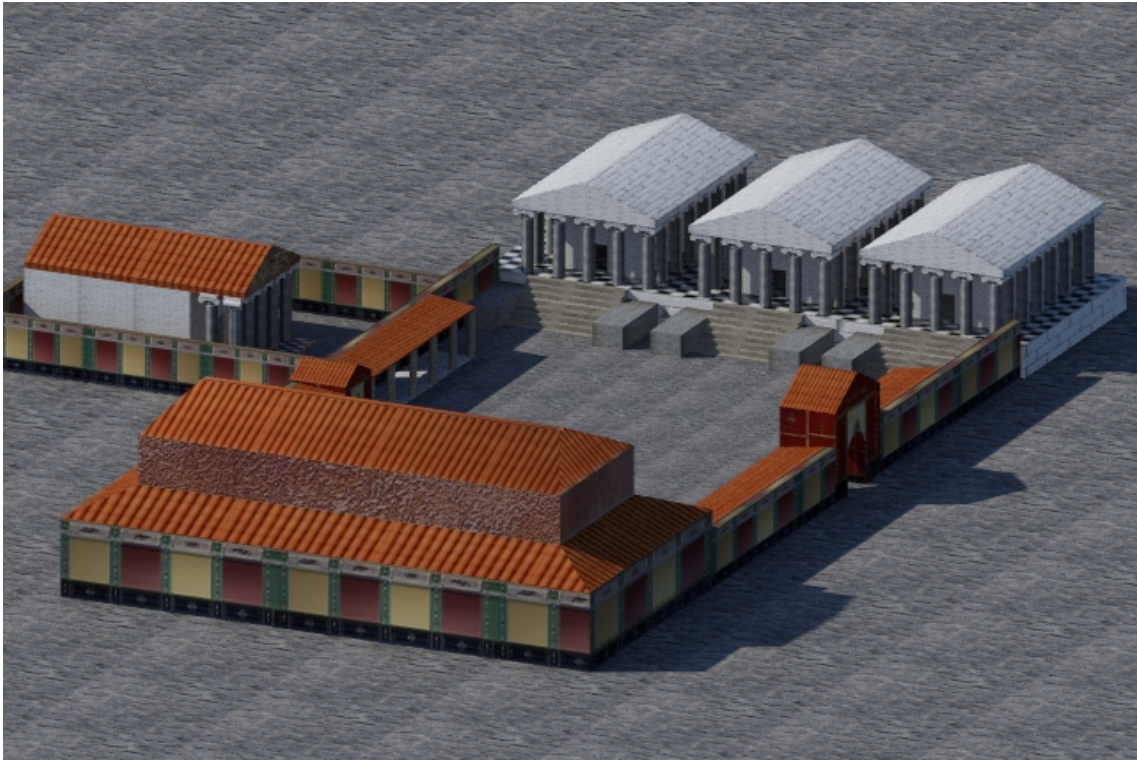


Figure 4.45: Aerial image of the forum.



Figure 4.46: Image of the forum square.





Figure 4.47: Render of the temples.



Figure 4.48: Picture of the porches of the pillars.



Figure 4.49: Render of the inside.

### Wall and gates

The walls and the gates of the city had the function of defense in case of siege. The gates used to be defended by two great towers where ballistas and archers were posted, as well as rocks to throw and boiling fish. The models of the door and the wall in this project are based on the game Imperium 3, as it is illustrated in figures 4.50 and 4.51. In figures 4.52, 4.53, 4.54 and 4.55 renders of the gate can be appreciated. Figures 4.56 and 4.57 images of a small part the wall are shown, because to place the wall in the scene, to be able to have the length that the player wants, only one piece has been modeled in 3DS Max. So, the engine only has to load the model once and then clone it by code.

**Time invested in modeling and texturing the walls and gates: 6 hours**



Figure 4.50: Image of the walls in Imperium 3.



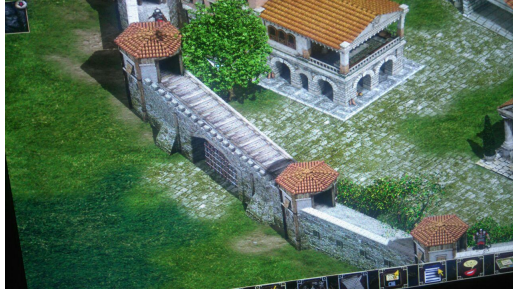


Figure 4.51: Image of the gates in Imperium 3.

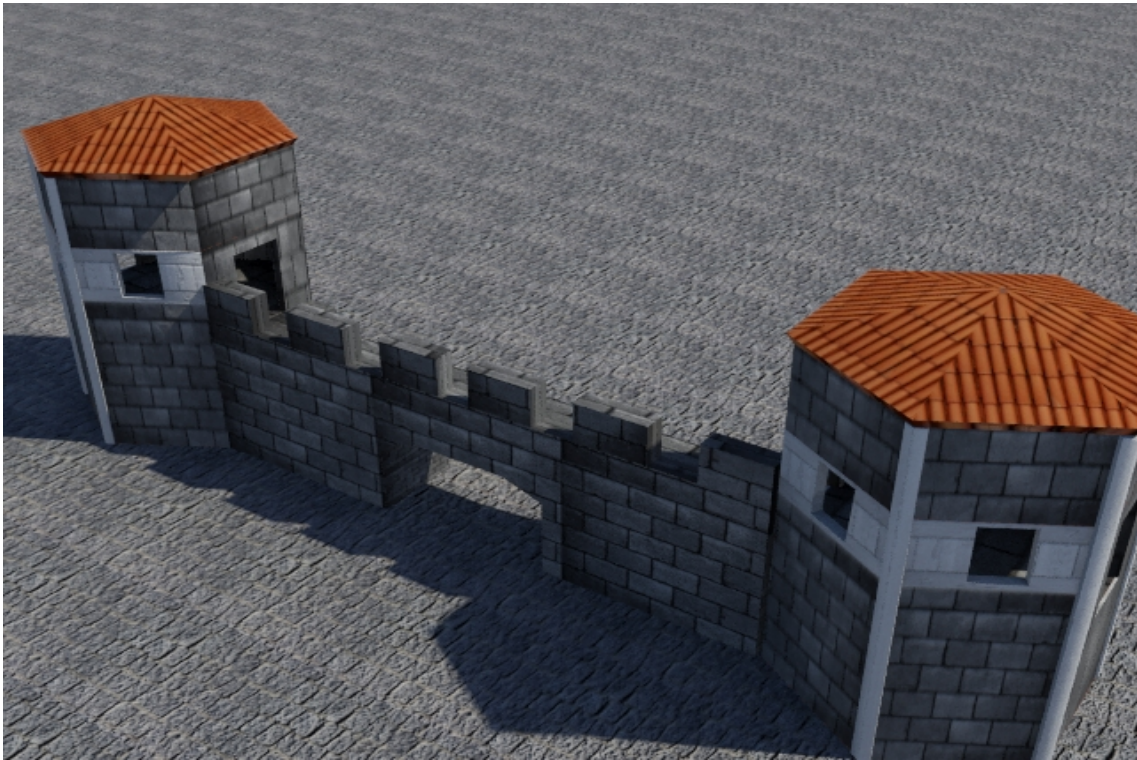


Figure 4.52: Aerial view of the gate.



Figure 4.53: Back view of the gate.



Figure 4.54: Another view from the back of the gate.



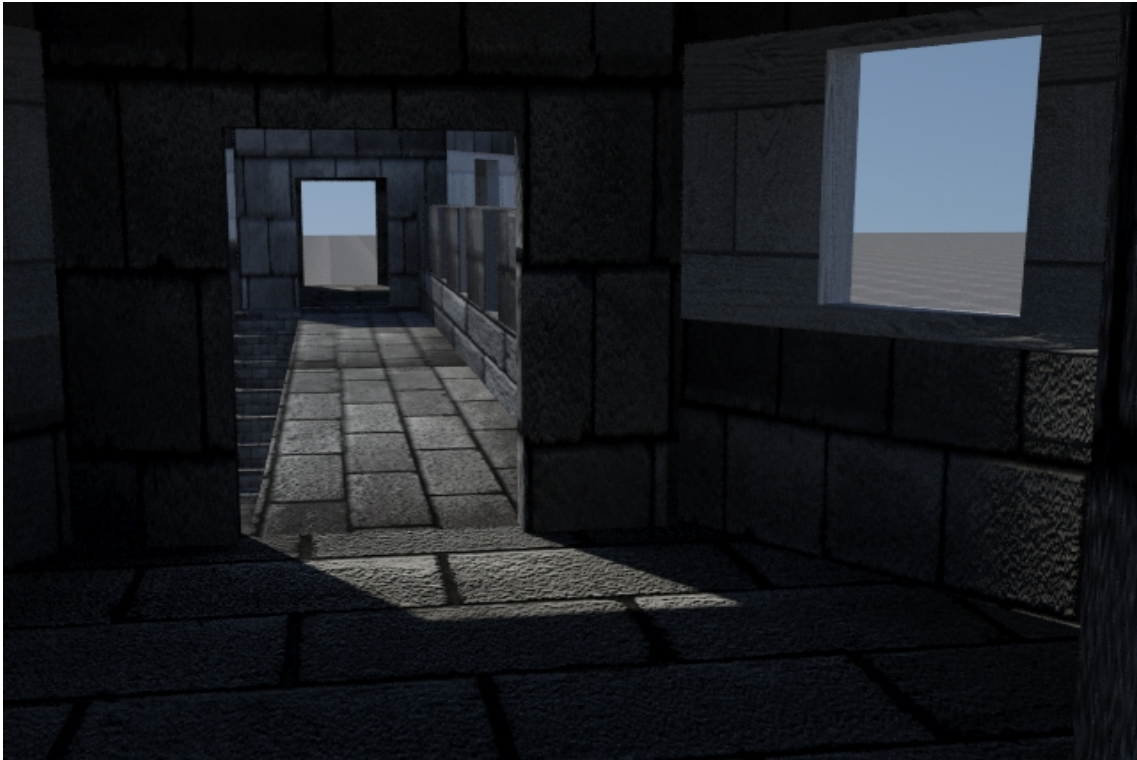


Figure 4.55: Render of the gate from within.

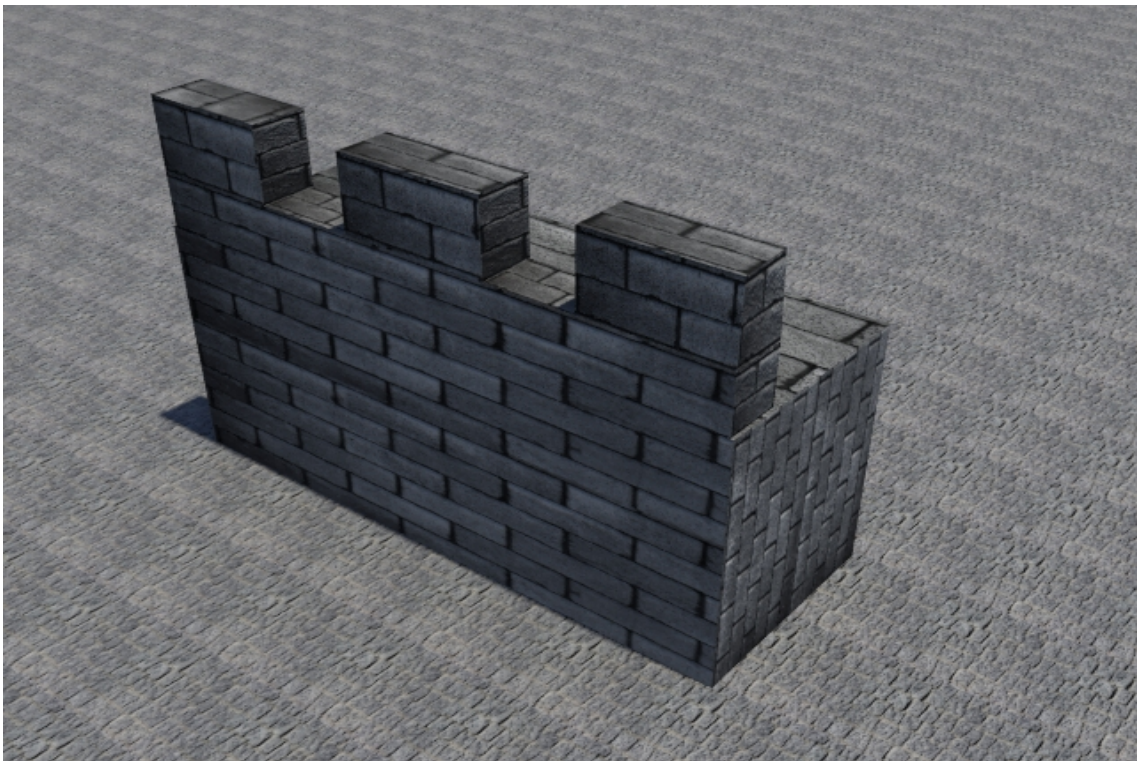


Figure 4.56: Front view of the walls.

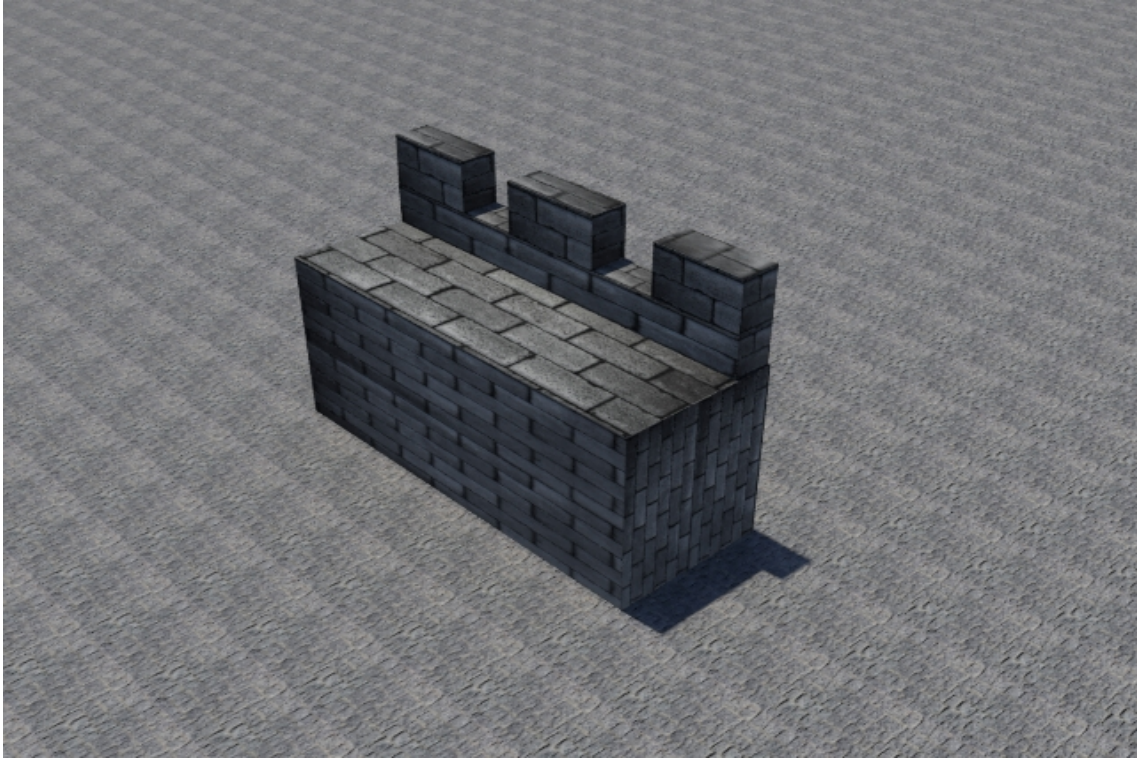


Figure 4.57: Back view of the wall.

### **Aqueduct**

The aqueducts were of the most important structures of the city, since they had the function of facilitating the access of water in many points of the city, so that any citizen could easily access to some source or some point to collect water. They consisted of large reservoirs that collected rainwater and were connected by channels for the distribution of water between reservoirs. In figures [4.58](#), [4.59](#) and [4.60](#) renders from the aqueduct can be appreciated. This is the same case as the wall, explained before, since the player can drag the aqueduct to make it as long as he wants.

**Time invested in modeling and texturing the aqueduct: 4 hours**



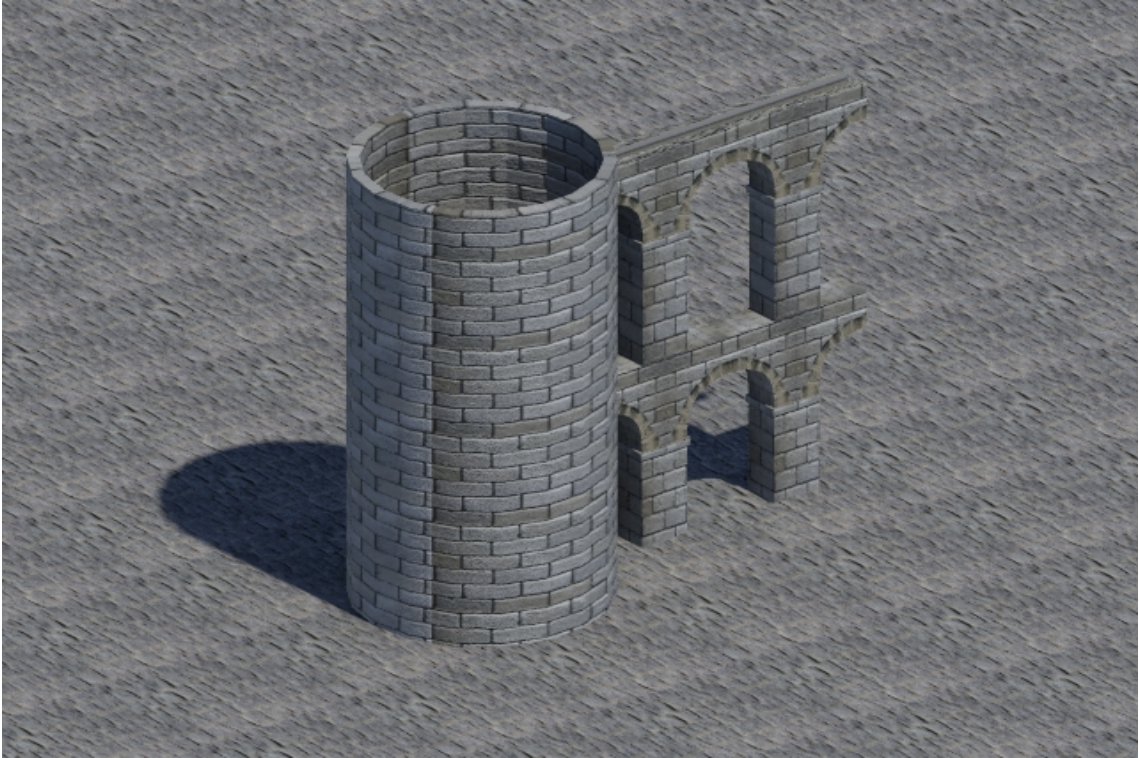


Figure 4.58: Aerial view from the aqueduct section.

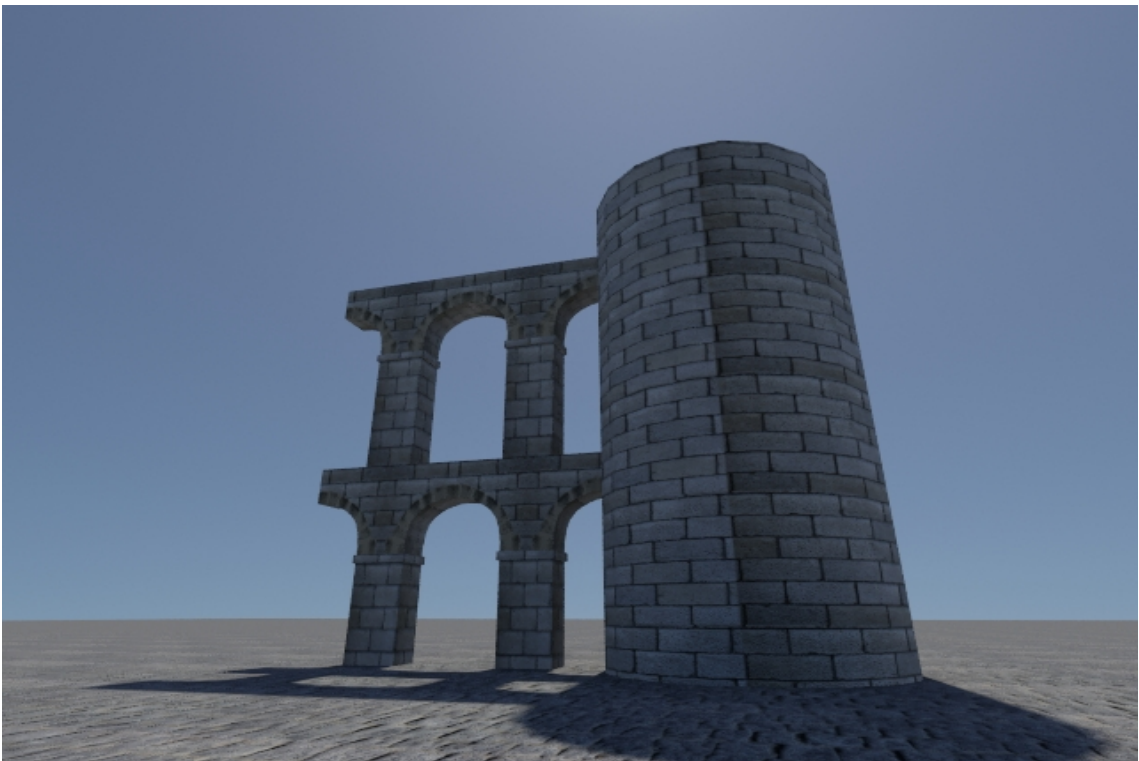


Figure 4.59: Side view of the aqueduct section.

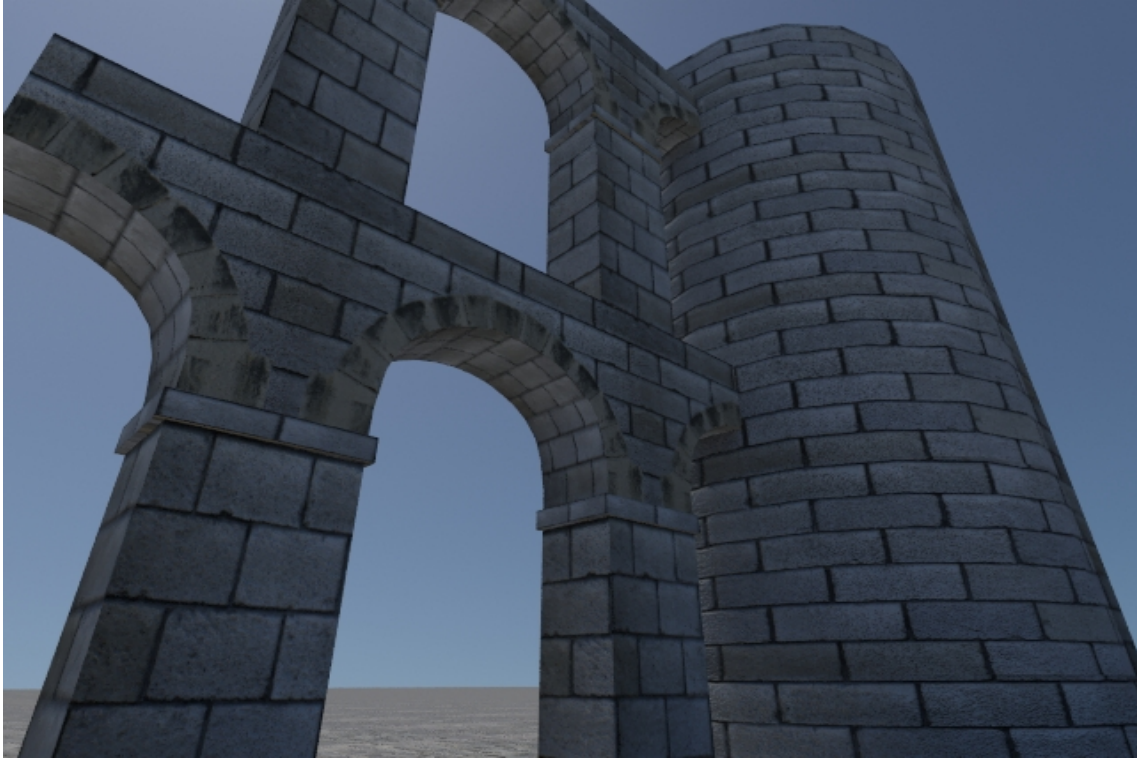


Figure 4.60: Back view of the aqueduct section.

### 4.1.2 Characters

As for the characters, to save on time two templates have been modeled, one for male characters and another for women, ie, two characters without clothing have been modeled in order to reuse the same model for all characters. As for the texturing process, there are some different aspects to the process described above for buildings. Firstly, as in the process of texturizing in buildings, a material for the model and a 'png' or 'jpg' image of size 1024x1024 containing all the textures to be used in the model is created. Then, once the 'Unwrap UVW' modifier has been added to the model, it is necessary to 'unwrap' the mesh just as in the buildings, but in a different way: you have to tell the modifier the seams, that is, where and how the mesh will be unwrapped in order to adjust the texture to the mesh. In figures 4.61 and 4.62 two images are shown in which the green lines representing the seams of the mesh are observed, and the figure 4.63 shows the 'unwrapped' mesh in the texture. Once the templates are finished, different types of clothing and objects have been modeled to complete the three types of characters in this project.

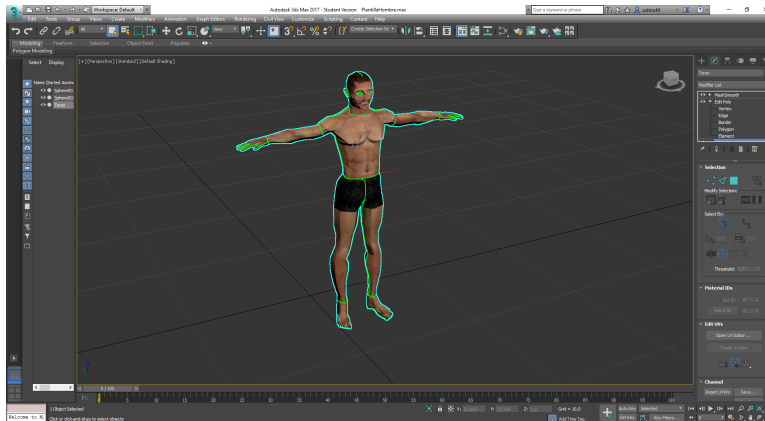


Figure 4.61: Screenshot from the front of the template, where the seams are highlighted in green

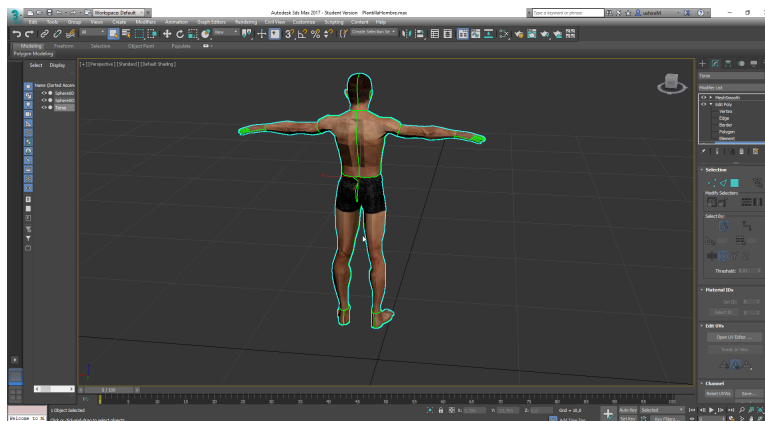


Figure 4.62: Screenshot from the back of the template, where the seams are highlighted in green

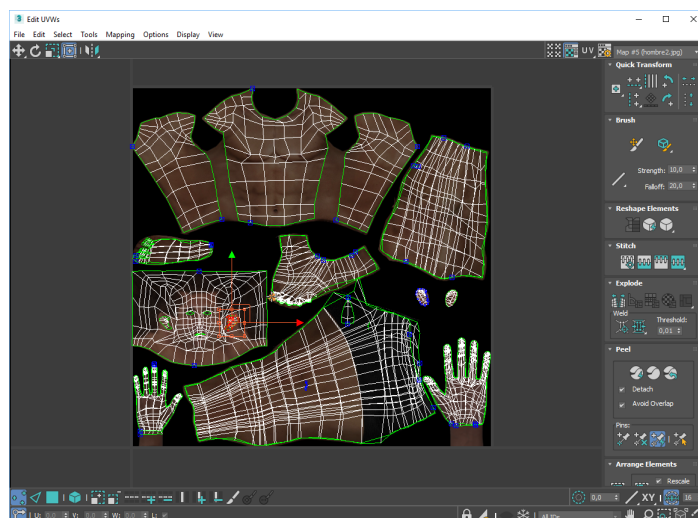


Figure 4.63: Screenshot of the UVW editor with the unwrapped mesh on the texture



### Male template

In the figures 4.64 and 4.65 are illustrated rendered images of the template for male characters. Also shown in figure 4.66 are the textures used.

**Time invested in modeling and texturing the male template: 12 hours**

### Female template

In the figures 4.64 and 4.65 are illustrated rendered images of the template for female characters. As shown in figure 4.67 are the textures used.

**Time invested in modeling and texturing the female template: 12 hours**



Figure 4.64: Front view of the templates



Figure 4.65: Back view of the templates



Figure 4.66: Image of the textures used for the male



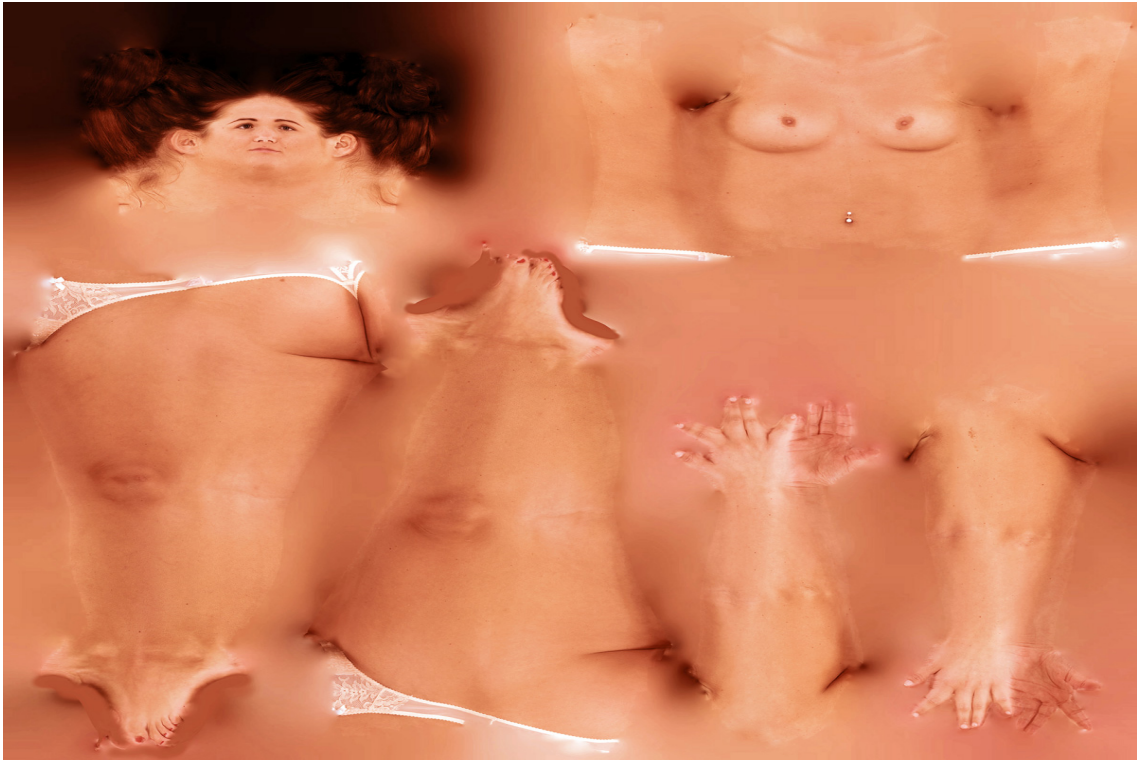


Figure 4.67: Image of the textures used for the female

## Legionary

Legionaries were the main component of the Legions of Rome. They were soldiers of heavy infantry made up of Roman citizens over 15 years of age. They were trained in a hard daily training where discipline and order were the main pillars of training.

For this model only the men's template has been used, since only men could be legionaries in the old Rome, and the following elements have been modeled: The armor, helmet, skirt, a sword and a shield. In figures 4.68 and 4.69 are rendered images of the legionary with all the mentioned elements except the sword and the shield. These two elements, illustrated in the figure 4.70, are two models apart from the character that are introduced in Unity instead of 3DS Max, since they can generate errors when animating the character.

**Time invested in modeling and texturing the legionary: 6 hours**



Figure 4.68: Front view of the legionary



Figure 4.69: Back image of the legionary





Figure 4.70: Image of the sword and the shield

## Patrician

The patrician families were the citizens of the upper class in the Roman Empire, the nobility, who had many privileges, among the most important to participate in the debates and votes of the Senate, to decide on the course of history in Rome. The name of 'Patricio' comes from the Latin word 'pater' in reference to the founders, that is to say, the first parents of Rome.

In this model, two different togas have been modeled, one for the male patrician and the other for the female patrician, and the texture of the template, illustrated in the figure, has been modified to fit the patrician more in line with the profile of the time. In figures 4.71 and 4.72 images of both patricians are shown.

**Time invested in modeling and texturing both patricians: 8 hours**





Figure 4.71: Front view of the patricians



Figure 4.72: Back view of the patricians



## Citizen

In this project the term 'citizen' refers to the middle and lower classes of ancient Rome. These classes were formed by free men, libertos and slaves. Free men were middle-class citizens with some economic power, they used to be merchants. The freedmen were former free slaves, although their state was free, continued to the service of some family performing tasks of slave in exchange of a salary. Finally, slaves were the lowest class of ancient Roman society without any right. They lived in the domus or villa of a patrician family doing all the pertinent tasks. In figures 4.73 and 4.74 renders of the citizen can be appreciated.

**Time invested in modeling and texturing the citizen: 4 hours**



Figure 4.73: Front view of the citizen



Figure 4.74: Back view of the citizen

## 4.2 Programming

This section will explain the programming part of this project. The project was developed in Unity 3D, which uses a C sharp scripting system. A script has been created for each game mode attached to the game's camera, which will act as a character. Each of the programmed parts will then be explained.

### 4.2.1 Building view

This is an isometric view of the camera in which buildings and terrain are viewed from above. The camera makes use of two components for its movement: the canvas and a script. The camera moves in eight directions depending on the mouse pointer, for example, if the mouse pointer approaches the right side of the screen the camera will move to the right, if it approaches the left side it will move to the left, etc. This is due to the 'event trigger' component of the canvas, placed on the four sides and the four corners of the canvas so that, when the mouse enters the trigger, it executes the corresponding function in the camera's air movement script to That initiates the movement where it corresponds. In the figure [4.75](#) a canvas image is shown in the unity editor with its 'event trigger'.



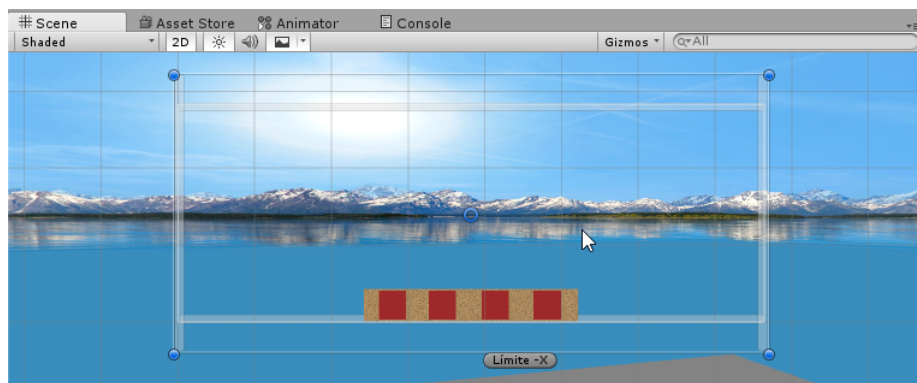


Figure 4.75: Image of canvas in Unity editor.

## Building placement

The first step for the building placement is adding to every building the following components in Unity:

- **Box collider:** With the 'trigger' option turned on.
- **Rigidbody:** This component will allow collision detection.
- **Script:** This script will have the function of checking the 'trigger' of the collider added to check that the current position of the building on the ground is suitable for placement.

With these components added to each building, each building object must be added to the 'prefabs' folder to instantiate them when necessary, thus the building becomes a 'prefab' [22] for unity.

As for the camera, has added as a component another script to control the building placement. This script is in charge of having the 'prefabs' and instantiating them when you press its corresponding button on the HUD. Once the building is instantiated, it will follow the mouse pointer through the scene, in this way the player can place the building on the ground freely.

The buildings to be placed must fulfill the following condition: That there is no building inside the added trigger with the collider in the building to place, as seen in the figure 4.76. This is because a safe distance is kept so that buildings do not overlap when they are placed or the entrance is obstructed.

The following figure 4.76 illustrates an example of several buildings placed on the ground.

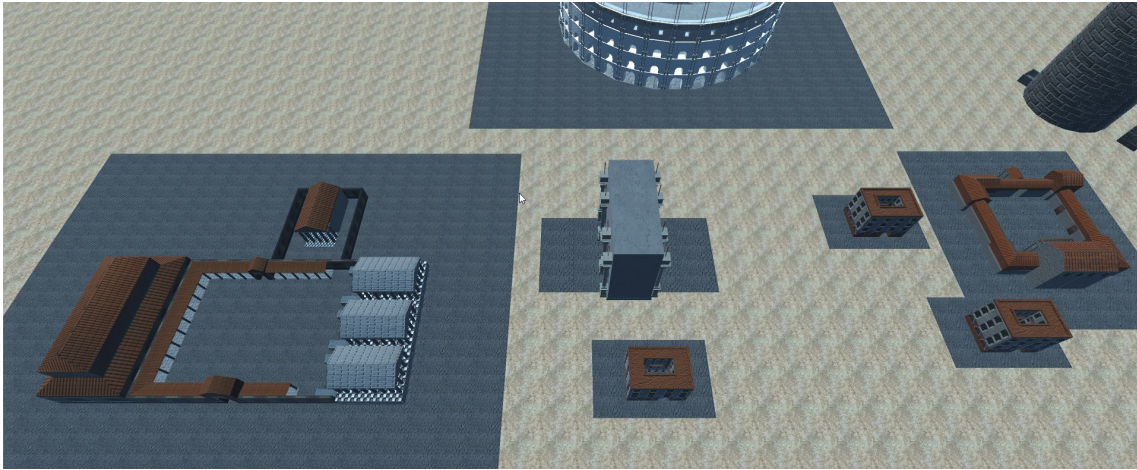


Figure 4.76: Image of the aerial view with some buildings placed on the ground.

### Transition between modes

This functionality is activated with the 'V' key on the keyboard and is responsible for the transition between the two game modes and to activate and deactivate the necessary components to change the gameplay. First, it makes the transition from top position to a person's height in the terrain and, once at the desired height, rotates the camera in real time to switch from isometric view to first person view. It then deactivates the script added to the motion camera in the build view and activates the second script of the camera movement: the first person movement. On that way, changing the scripts changes the gameplay and controls. Finally, once the scripts have been exchanged, the collider and rigidbody [23] of the camera are activated to activate collisions with the elements in the scene and deactivate the HUD of the building mode. In the figure 4.77 an image of the camera is shown in building mode and in the figure 4.78 the camera is shown in first person mode.

This transition performs the same process but reverses the transition from first-person mode to build mode.

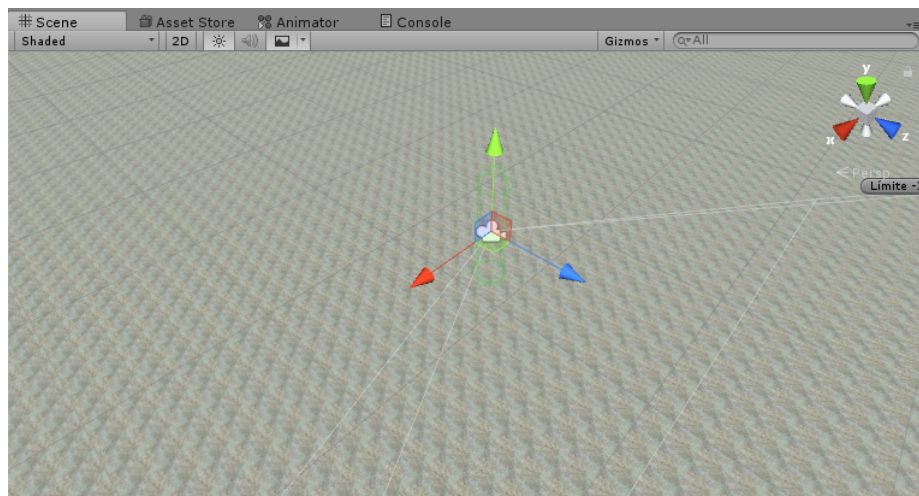


Figure 4.77: Image of camera in building mode.



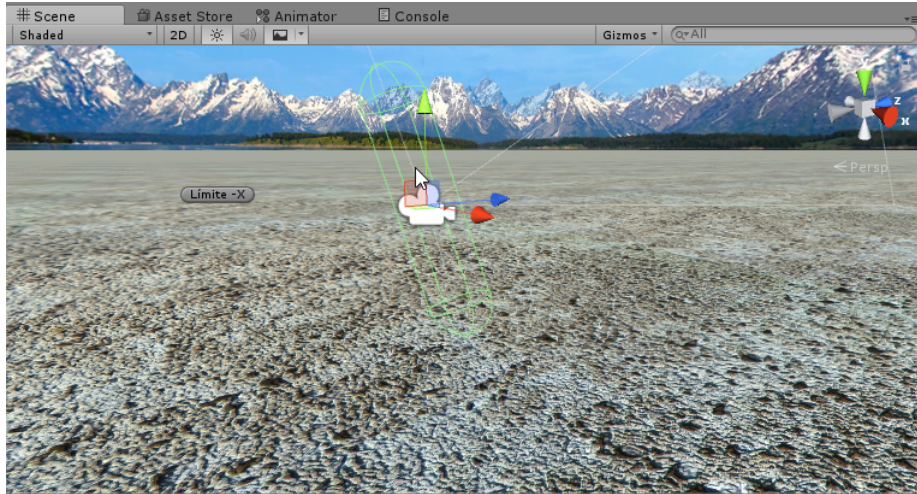


Figure 4.78: Image of camera in first person mode.

### Trailing buildings

Some buildings, such as the aqueduct and the wall, have only been modeled as part of the structure, as shown in the image 4.58. This is due to the fact that during the game these two structures can be extended infinitely by the terrain cloning in the same direction, as shown in figure 4.79. To do this, each building is added the following elements:

- Another script that controls the placement of a different form, which will be explained later.
- A waypoint as a child, which will indicate the position of the object to be cloned.
- A raycast of Unity [24], from the parent building to infinity, which will tell the object to clone the direction and rotation to take.

As soon as the left button is pressed on the ground once the building is selected for the first time, the first part of the building will be placed in the indicated place and, in turn, will rotate following the mouse pointer. Once this first step is done, the position of the mouse pointer will be controlled and the collider of the building will be used as a border, and if the mouse exceeds this border, the building will be cloned again taking into account the position of the waypoint stored before and the direction and rotation of the raycast of the previous piece. These clones are performed whenever the mouse pointer slides, until the left mouse button is pressed to place the building permanently.

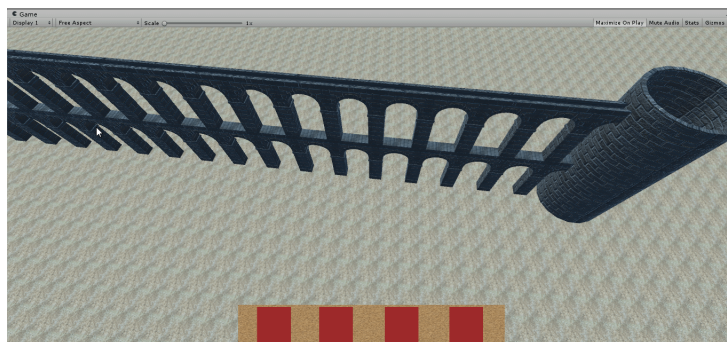


Figure 4.79: Image in-game of the aqueduct.

## Change the terrain texture

As soon as a building is placed in the building mode, except with the basic structures and with the defensive structures, a roadway texture is applied around the building, scaled according to the building size. In the previous figure 4.76 an image is shown with an example.

### 4.2.2 First person view

As soon as the 'V' key of the keyboard is pressed while in the building mode, as explained in the section in 'Transition between modes', the script that controls the movement in first person is activated in the camera and the building movement script is deactivated, in addition to deactivating the HUD and activating the components 'capsule collider' [25] and 'Rigidbody' to control collisions with the world. Thus, it changes the gameplay and the perspective of the player.

This view is about a simulation of a person's movement. The camera is positioned at a height around a person of 1,70 meters of height, being the player immersed in the city as it is illustrated in the figure such. The movement that simulates the legs is controlled by the 'WASD' keys of the keyboard, ie 'W' to advance forward, 'S' to move backwards, 'D' to move to the right and 'A' to move towards the left; and the rotation of the camera, which simulates the look of a head, is controlled by the mouse movement. In the figure 4.80 a first-person perspective image is displayed.



Figure 4.80: First person view.

### 4.2.3 Artificial Intelligence

As for Artificial Intelligence, in this project there will be characters that will automatically perform different routes in the city. In each public building (Amphitheater, Theater, Forum, Triumphal Arch and Circus) there is a map of waypoints that delimit these routes to the characters. In such waypoint maps, each waypoint contains a script where other waypoints are assigned neighbors to form an unmanaged cyclic graph. In the figures 4.81 and 4.82, images of the two stored graphs in the Forum are shown. As we see in the figures, in the case of the forum there are stored two graphs, one for the outside of the forum and another for the interior.



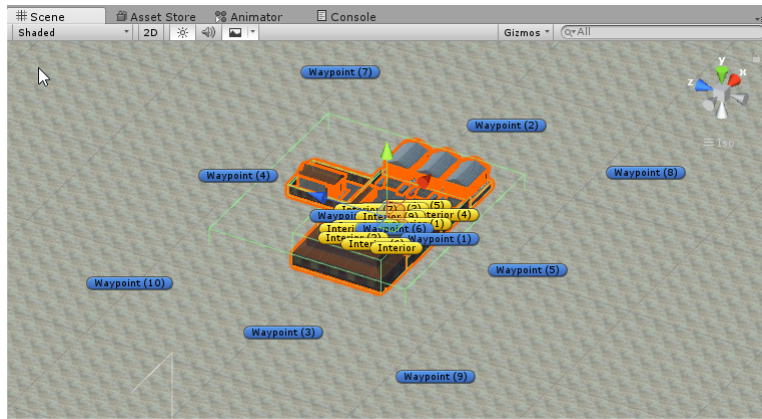


Figure 4.81: Image of the Unity editor of the external graph of the Forum.

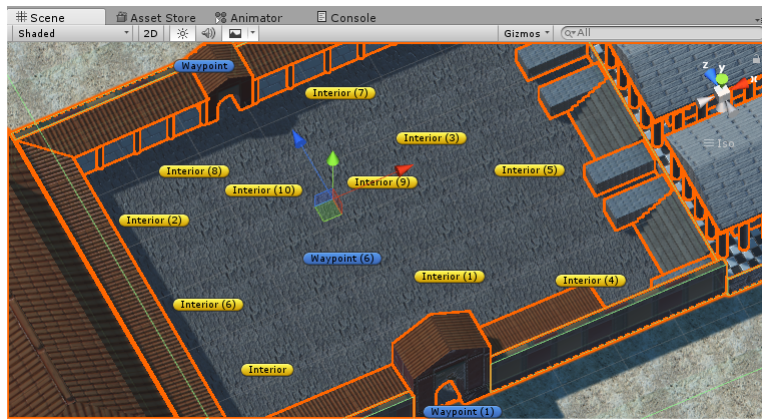


Figure 4.82: Image of the Unity editor of the internal graph of the Forum.

As soon as a dwelling is placed on the land (Domus, Villa or Insulae), if one or more public buildings are placed on the terrain, four characters will appear for each dwelling and will choose their destination randomly from the public buildings in the area. They will head towards their buildings using the NavMeshAgent from Unity[26]. As soon as the character is close enough, he will enter the graph and will head to the first waypoint he has found in the building where he was going. Once the waypoint is reached, the character will choose, again randomly, his new destination among the neighbors of the waypoint reached and so on, traversing the whole graph in a random way. In this way, it is assured that each character has its own route different from that of the other characters.

As for the types of characters that appear, it depends on the type of building that is placed: In the Domus and Villas will appear patricians, while in the Insulae will appear citizens. As for the legionaries, in an exceptional way, these will appear as soon as the city wall is placed.

In the figures 4.83, 4.84, 4.85 and 4.86 some images of the characters doing their own routes while the city is being built are shown.

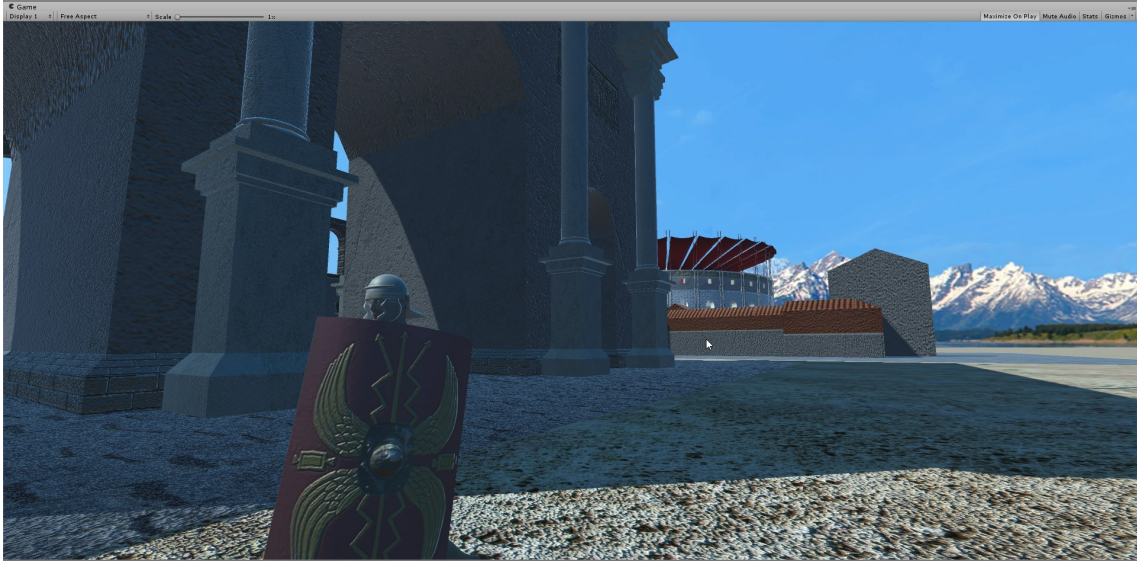


Figure 4.83: Image of the first person view with some buildings placed on the terrain.

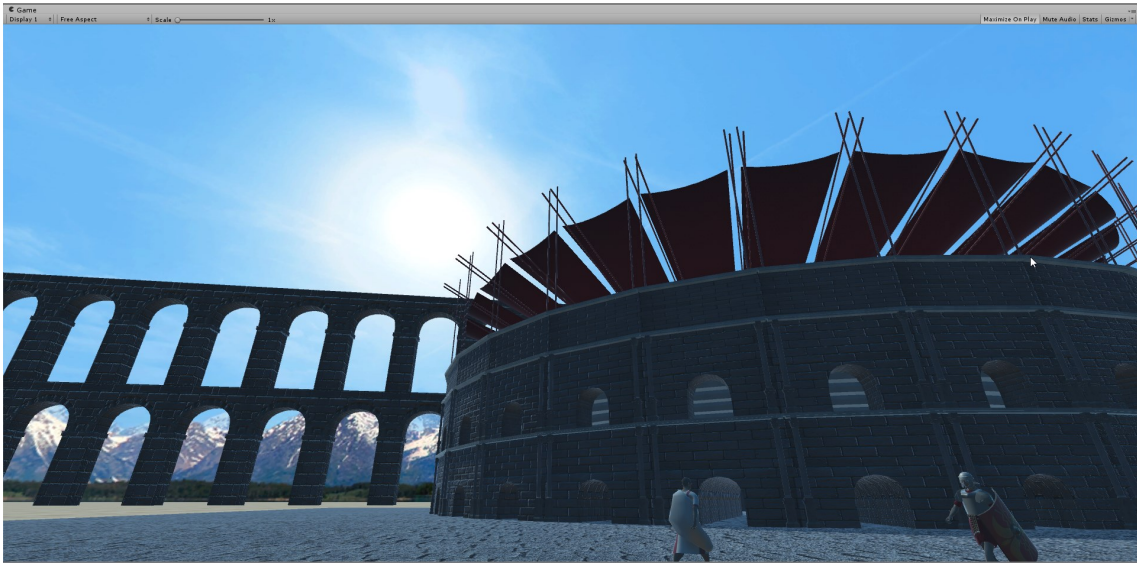


Figure 4.84: Image of the first person view with some buildings placed on the terrain.





Figure 4.85: Image of the first person view with some buildings placed on the terrain.

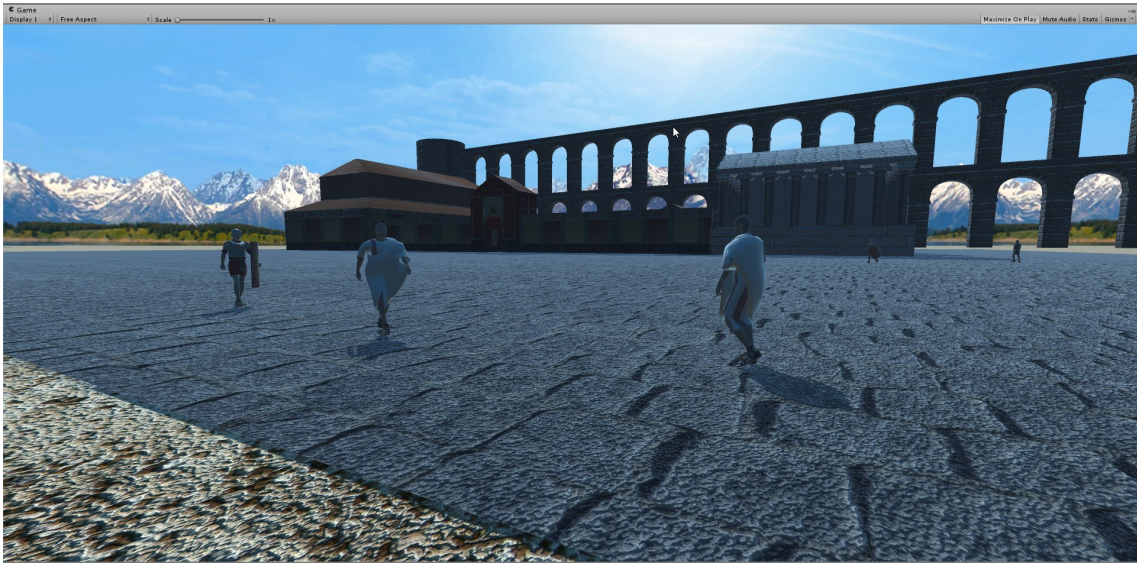


Figure 4.86: Image of the first person view with some buildings placed on the terrain.

#### 4.2.4 HUD

As for HUD, it appears only in the building mode and has the function of selecting the buildings to give the command to instantiate them in the scene. The HUD consists of Unity Image UI [27] elements combined with Button UI [28] elements for each building. Buildings are separated by type (dwellings, public buildings, basic structures and defenses), and each type has a background image with as many buttons as there are buildings in that type. These Images UI are initially deactivated, since there is a general Image UI with four Button UI, one for each type of building and, if pressed, the Button UI corresponding to the type of building is pressed and is displayed up.

## Chapter 5

# Results, Testing y Evaluation

### 5.1 Results

Taking into account the expected results described in Chapter 1, it should be noted that the following objectives have been satisfactorily fulfilled:

- **Learning of building types and their classification:** In building mode different types of buildings and structures in the city are appreciated.
- **Immersion in the built city:** In the first person mode the desired immersion has been achieved in the city, being able to explore each building of the city and see its structure, size and elements.
- **Introduce life in a city of the Roman Empire:** Once the player builds the city and explores it in the first person mode, the objective of representing the city life will have been achieved, since each house will generate characters of different kinds that will be making their routes through the city.

With these objectives fulfilled, it is considered that the results have been the expected ones described in the technical proposal of this final degree project, having recreated in a dynamic 3D virtual world those elements that characterized the cities of the Roman Empire, besides being able to use videogames as a way to bring history in an interactive and immersive way to people of any age.

As an implicit objective in this final degree project, it is expected that this project helps to promote videogames as a didactic tool for learning history of any era more specifically and not as general as in classrooms. For example, learning about the lifestyle and the customs in a city built by the people that preceded us in the world.

### 5.2 Problems encountered

Although much of the development of this project came about in a 'direct' way because of the initial organization of the tasks and a clear idea of how to carry out the programming tasks, important problems arose that delayed the development of this project and made it necessary to quickly search for a solution to avoid big wastes of time.



One of the problems arose during the development of the trailing buildings, the cloned buildings did not have the right rotation and were in the same position with respect to the Y axis, this caused that the aqueduct and the wall sank in the ground, not matching the first piece placed. This problem was solved by creating a Unity raycast with direction on the X axis from the first piece placed towards infinity, in that way the cloned pieces of the model took as reference the position and the rotation of the raycast to match each other.

Another problem that arose during development in Unity was the change of the terrain when placing a building on the ground. Placing the floor plane of the building with the new terrain texture on the ground produced visual artifacts, because the polygons of the plane overlapped with those of the terrain. This was solved by adding 0.01 to the Y axis of the plane so that they were not at the same exact height and the polygons did not overlap.

During the development of the task of changing the terrain as soon as a building (explained in the section 'Changing the terrain texture') of the previous chapter, the possibility of changing the terrain texture directly in the terrain options of Unity was considered, but this task required modifying the vertices of Terrain and proved to be a very complicated task. Instead of this process, it was solved by creating a texture as a 'Prefab' and instantiating it taking into account the position of the building and the height of the terrain but adding 0.01 (problem solved in the previous paragraph) in the Y axis, and in that way the goal was achieved but in a simpler way.

As for the problems of the art part, after a study of the remaining tasks and the time available to develop this project, introducing the skeleton in each character and animating the characters would take more time than expected, since it is a costly task and involves many adjustments in the bones of the characters to solve the errors. This problem was solved with the help of Adobe Mixamo, since this program automatically inserts and adjusts the skeleton in the model and exports it in a 'fbx' file to be able to edit animations in 3DS Max as planned. This helped to avoid the problems that arise when adjusting each bone of the skeleton to the model and to begin directly to edit the animations of the characters.

As a general problem in all buildings, some models had to be optimized with the 'Optimize' modifier of 3DS Max, because placing many buildings in the scene in Unity raised load of polygons excessively. This affected the performance and the frames per second of the game. Also, the Unity 'Occlusion culling'[29] optimization technique was activated, which consists of not rendering what the camera can not see in the scene.

Finally, in some buildings during the modeling process in 3DS Max the center of gravity of these was displaced, not remaining in the center of the model. This generated an error when exporting it as 'fbx', and importing it to Unity deformed the mesh. As a solution, the 'fbx' had to be reimported back to 3DS Max to manually center the center of gravity of the building.

## 5.3 Testing

As for testing in this project, the largest number of tests have been performed in the artificial intelligence part, although tests for the building placement system and the transition between game modes have also been necessary.

In the case of AI tests, once they were programmed and the corresponding graphs were placed, the public buildings were placed one at a time to check the behavior of the AI step by step in order to correct the routes according to the route errors in each building. Once the AI of an individual building functioned correctly, the AI was tested by adding more and more buildings to verify that the graphs were exchanged correctly.

As for the building placement system, the tests consisted of placing buildings close together to check that they were not placed if the safety distance was not met, placing the buildings and checking that they fit well at the height of the ground and that from the First-person mode worked collisions well with walls, so as to prevent the camera from crossing the wall.

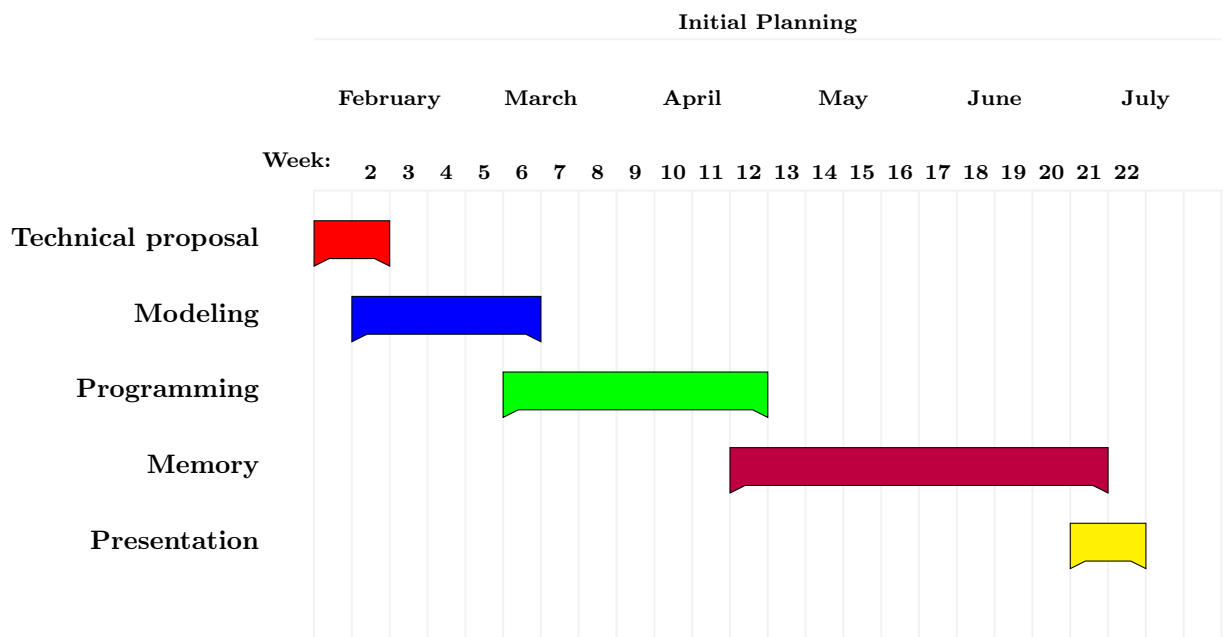
Finally, during the development of the transition between game modes, the tests in the Unity scene served to adjust the number of degrees of rotation of the camera and the speed at which the camera should travel the distance when descending to the ground and vice versa.

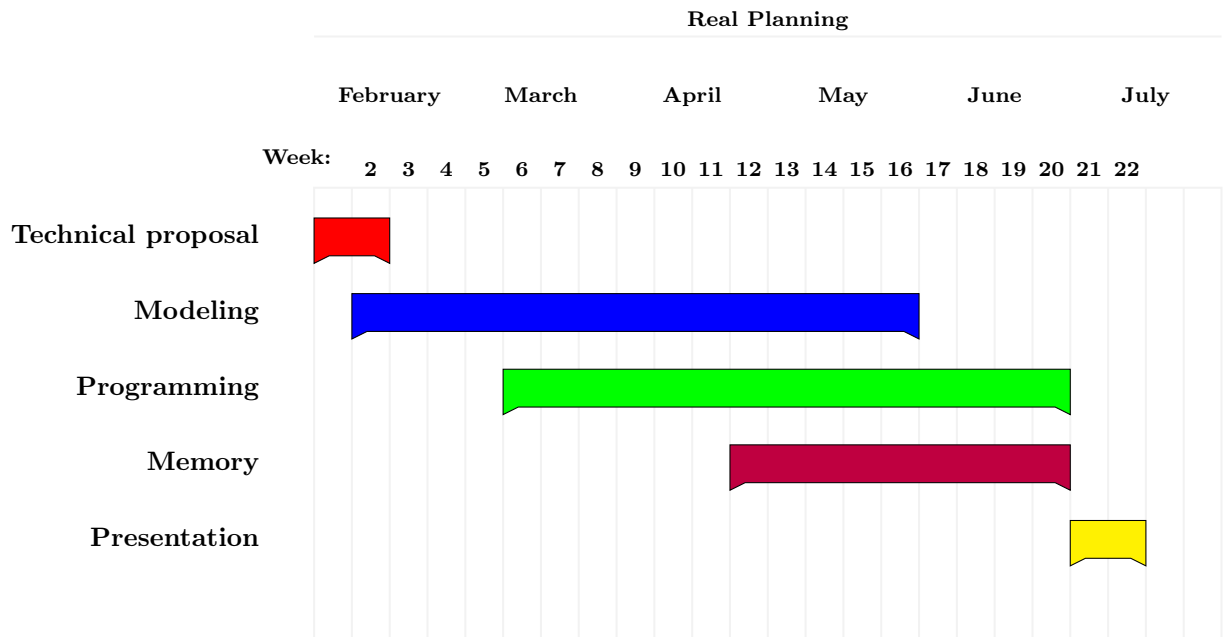


# Chapter 6

## Project deviations

In this chapter two gantt diagrams are shown in which the amount of time invested in each part of the project is reflected. Each week represents 28 hours of work, 4 hours of work per day. The gantt diagrams are, respectively, the cost estimated initially and the actual cost of the work.





As shown in the diagram, much more time has been invested in the modeling and programming parts, especially in modeling, since in order to provide a good visual experience more time has been invested in adding details to each 3D model of the project. More time has also been invested in the programming part because of the problems that have arisen during development and the change in the behavior of artificial intelligence.

# Chapter 7

## Conclusions

Designing and developing this final degree project has been a great learning exercise for 3D design and programming in the Unity game engine. Much of this final degree project has been to design, model and texturize different buildings and characters, for that reason I could say that the most useful subjects related to this part of the project have been:

- **3D Design (VJ1216)**

In this subject I acquired the basic knowledge to use the program 3DS Max, like how to use the different modifiers for modeling and for texturizing.

For the design of this project, I have achieved the objectives of this subject, such as:

- Ability to design and create graphic elements.
- Knowledge, design and use efficiently the most appropriate types and structures of data to the resolution of a problem.
- Knowledge and application of the necessary tools for the storage, processing and access to Information Systems, including web-based.

- **Character Design and Animation (VJ1226)**

In this subject I used 3DS Max again to model characters and also add skeletons to animate them later. I also learned how to optimize a 3D model and I realized that the polygons of a model were an important part to take into account when optimizing a videogame.

With the characters designed and animated for this project I have managed to achieve the next objective of the subject:

- Ability for the design and creation of animated characters.

- **Graphic Expression(VJ1212)**

This subject has been very useful to me, since I acquired the basic knowledge to model a building, to take into account its proportions and measures to later add them to a scene.

The next objective has been fulfilled in this final degree project:

- Capacity for spatial vision and knowledge of graphic representation techniques, both by traditional methods of metric geometry and descriptive geometry, and by computer aided design applications.

Another important part of the project was programming in the game's Unity game engine, the AI of the characters and the scene and HUD designs. For these tasks, the knowledge that have been very useful to me were those of the following subjects:



- **Game Engines(VJ1227)**

In this subject I discovered the game engine Unity, very useful to develop videogames in 3D, and I acquired the basic knowledge to use it. We also perform different practices with various types of videogames, learning how to work with the Unity gameobjects and with the functions and components available in the engine.

The next objectives of this subject have been satisfactorily fulfilled with the development of this final degree project:

- Ability to design and construct models that represent the information necessary for the creation and visualization of interactive images.
- Ability to evaluate, use and extend game engines.

- **Artificial Intelligence(VJ1227)**

In this subject I learned the basic concepts to make an Artificial Intelligence work in a videogame, as well as different techniques for 'pathfinding', 'decision making' and 'AI strategy'.

I fulfill the next objectives of this subject:

- Knowledge and application of basic algorithmic procedures of computer technologies to design solutions to problems, analyzing the suitability and complexity of proposed algorithms.
- Knowledge and application of basic principles and basic techniques of intelligent systems and its practical application.

Given the subjects mentioned above, their objectives fulfilled and the knowledge learned during these years of degree, I have been able to acquire the ability to learn by myself concepts not taught in this degree. During the development of this project I had to program functionality that we have not seen in the degree, that is why I acquired knowledge for myself through the internet and, above all, through the Unity [30] engine manual. It could be said that it has been a way of personal improvement in my knowledge about the design and development of videogames.

Since I was very young, I have always had two great passions: Videogames and History, specifically the age of Ancient History, the Roman Empire. In this degree we have studied subjects of many types, very useful for the design and development of a videogame, but it was the optional subject of fourth course, 'Foundations for Didactic Videogames Design (VJ1238)', in which we saw how to use Videogames with a didactic purpose. Nowadays there is a lot of didactic games of all kinds, even some games deal with the learning of history, as is the case of the 'Imperium' saga, which deals with battles of the Roman Empire, and the 'Assassin's Creed' saga that deals with events in a more subtle way, both videogames sagas quoted in chapters 1 and 2. With the knowledge acquired in the subject 'Foundations for Didactic Videogames Design' and these examples, and knowing the existence of the playable part of the game 'Metal Gear Solid V' also mentioned in chapters 1 and 2, I decided to make this final degree project, as a way to fuse elements of the quoted videogame sagas to focus the learning of history in cities and their elements at the time Of the Roman Empire.

As for the future work of this final degree project, there are many ways in which it can evolve. Maintaining the objective of learning history through videogames, for a future work more levels that encompass other times could be introduced, since this project only has a level which focuses on the era of the Roman Empire. To do this, other buildings and characters should be designed according to the chosen time.

A new level type could be added that instead of being a free visit, as it is in this project today, it would be a guided tour, that is, a character controlled by the artificial intelligence that explains each one of the Elements of the city and/or historical events to the player as he follows him through the city observing it while listening to the guiding character.

Another way to extend this project would be to do everything mentioned in the previous paragraphs and develop the project in virtual reality, since Unity has support for this mode. That way, it would get a total immersion of the player in the city in each one of the levels mentioned.

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