



Design and Development of Video Games Degree

- Technical Report of the Degree Final Project -

**Design and development of a 3D PC video game with simulation  
construction and real-time resource management**

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## **Abstract**

The objective of this Technical Report is to present the project that has been developed in the context of the subject VJ1241 - Final Degree Project. Specifically, this work focuses on the design and development of a 3D video game for personal computer (PC) in which the player assumes the role of a construction company manager.

The player will be able to obtain construction contracts and will manage these works taking into account different important elements of construction.

The key to success in the game is to carry out the works in the city without any inconvenience and to achieve a positive reputation in the city.

The novelties that I am trying to propose are the management of construction resources in real time, simulating the real management that exists on the construction site and its drawbacks.

The results have been better than I thought and have fulfilled my expectations. It has been a very rewarding experience.

Keywords: Construction, Strategy, Management, Resources, City, RTS, Simulator, Working Progress.



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## Chapter 1

# Technical Proposal

### 1.1. Introduction and work motivation

Now that all the subjects of the video game design and development degree have been passed, it is time to focus on the final degree project that allows us to combine and apply all these skills that we have learned over the years to develop a project in which all these learned skills are demonstrated.

My desire is to participate in the video game industry as a developer and designer so my video game presents several aspects of video game design and development that I want to work on in the future.

Many video games focus on immersion and simulation. Both ecosystems and cities, as well as management systems. These games are known as RTS (Real Time Strategy). My video game presents several of these notions from the point of view of a person who manages the constructions that take place in a city.

The differentiating factor of my game is that once the city starts to be built the player must focus on resource management so that these constructions are carried out without any problem in the order and time frame determined. The gameplay will be based on a system of resource management and consideration of the time requirements of the game.

The motivation to generate this game came to me because my brother has a construction company and I know the management of such companies. My main idea is to generate a simulator in which a person with interests in creation and management of construction companies can understand how these companies work inside and know how to perform a correct management of the various works and at the same time my intention is also to generate a fun game in which people who have no interest in knowledge of construction companies can have fun enjoying a dynamic, versatile and entertaining game.

Several aspects of my games embrace elements of RTS, but also take into account several elements of "Point and Click" and classic resource management games with isometric views.

## 1.2. Related subjects

The most related subjects are:

- Diseño 3D (VJ 1216).
- Diseño de Personajes y Animación (VJ 1226).
- Motores de Juegos (VJ 1227).
- Inteligencia Artificial (VJ 1231).
- Algoritmos y Estructuras de Datos (VJ 1215).
- Fundamentos para desarrollo de Videojuegos Didácticos (VJ 1238).

## 1.3. Objectives

Thanks to everything I have learnt during the degree studies, I have been able to initiate myself into video games design and development. As my personal main interest is to work as game developer, the main objective of this Final Degree project is to design a small-scale video game in which I can evaluate, apply and improve my recently achieved skills and also gain new abilities while enjoying what I am working on.

The final aim is to keep improving the video game after finishing the degree in order to obtain economical profit from it, although this intention is out of the scope of the project due to time and budget limitations.

Concretely, the main objectives to be satisfied by the video game developed in this project are:

- To represent, on a small scale, an isolated city where several city elements are depicted
- To represent a correct temporal system and with dynamic game times where the player can have a pleasant level of difficulty and at the same time a challenge for him.
- Generate a good simulation of resource management for the construction of the various works of the city.

## 1.4. Tasks list and timing

The following list describes the tasks that have to be completed along the project, including their temporary cost estimations:

- Model and texturize the playable terrain (55h.)
  - -Model the plateau mesh
  - -Texturize the plateau mesh.
  - -Model the elements of the map(buildings, roads, etc).
  - -Model and texturize the terrain details.
  
- Generate the NPCs System (40h)
  - -Model and texturize the NPCs elements (vehicles)
  - -Create a waypoints system
  - -Generate the AI system of movement of vehicles.
  
- The main character (main camera) (35h)
  - -Generate in Illustrator a map.
  - -Create a main character movement(the movement of the main camera)
  - -Create a drag system.
  - -Create a clickable minimap.
  
- Implement the canvas system (30h)
  - -Create element of interaction (HUD)
  - -Create a Rent window
  - -Create a General Information Window
  - -Create the panels of the different constructions
  
- Implement the day/night cycle and the timer (20h)
  
- Generate the menu system (15h)
  
- Create the audio of the game (10h)
  - -Create the menu song.
  - -Create the gameplay song.
  - -Generate the sound effects of the game.
  
- Implement the resources management system (35h)
  
- Document composition (60h)

## 1.5. Tools

A description of all the tools which will be employed to accomplish the previously described tasks is provided in this section.

- Programming tools:

- Unity 3D [1]. This tool will be used to join all the asset models in blender, to create the game level and also to implement the different scripts and game events, using the programming language C#. Unity will also be employed to ambient the scenery. Someother Unity utilities will also be used, such as occlusion culling for avoiding drawingobjects that should not appear on the screen, or the Navmesh for creating the game'sAI.

- Visual Studio [2]. This tool will be used to create the scripts of the game.

- 3D modeling and texturing tools:

- 3ds Max [3]. This tool will be used to create the 3D models of the map.

- Illustrator [4]. This tool will be used to edit the 3D model's textures and to drawsome icons.

- Photoshop [5]. This tool will be used to paint the 3D model's textures directly on the 3D models and the 2D UI elements.

- Tools for preparing the documents:

- OverLeaf [6]. This is the Latex distribution used to compose the Technical Proposal, theGame Design Document (GDD) and the final report.

- Version control system:

- Unity Collaborate [7]. It will be used to upload the different project versions, allowing work from various computers and also to recover previous versions, both for consultants for error correction.

- Google Drive [8]. It will be used to show all the pictures and animations created for this project.

## 1.6. Expected results

At the end of this project, it is expected to design a fully playable area, where it will be possible to manage resources for the different constructions of the city within the established time frame. It is intended to create an environment in which the player manages the works according to their needs for materials, labor, etc., and overcome the various setbacks that may arise to avoid any penalty.



## Chapter 2

# Game Design Document

### 2.1. Main features

The following list details the main features that the game will feature:

- Resource gathering in an adaptive ecosystem that changes at the end of each (game) week, depending on player actions
- -Resource management of different selected works with a time limit of completion.
- -Free movement over the city with different visualization commands and minimap.
- -Loan system with a time counter for its return and a 10% interest.
- -System of alerts in the works with penalties if they are not solved.

### 2.2. State of the art

As stated above, the key to the game is resource management and construction simulation.

There are other games that also implement the basis of this project: resource management and strategy, but from different perspectives.

For example, we can highlight SimCity [9], which allows the player to take control of various aspects of a city, management, energy supplies, leisure, etc. In this game, resource management is vital, as the survival of the city depends on it.

In addition, there is also Rise of Industry[10], which is a game in which you have to manage the momentum of a city by taking into account the right choice of resources.

The aim of the game is to achieve the highest and best development of the city and for this the choice of the best options in the resources that are presented is very important.

As a last example, the mythical Age of Empires [11], a game that laid the foundations of strategy and management of construction elements. One of its great references is also the isometric orthogonal view that generated a model of camera movement very characteristic of this type of RTS games.

The main difference of this project with respect to the existing and analyzed ones is the way in which the importance of contracts on demand is included. The vast majority of existing video games that include classic RTS variables base their success on resource management. However, in this project, apart from the important resource management, the time in which the work is carried out is also taken into account because the player works for a client and this work has to meet certain time standards (just like in real life).

On the one hand, the game takes very realistic considerations into account when carrying out the works, but this project also focuses a lot on entertainment, offering a dynamism in the management and a fluidity with the orders so that the player gets a playful challenge that he wants to overcome. Thus, the game is somewhere between a realistic construction simulation and an entertaining challenge to the player's agility.

## **2.3. Gameplay**

In this game, the player will be the general manager of a construction company and will have the option to carry out various construction works in the town. If these jobs go well, the company's budget will increase, but if they go badly, the budget will decrease.

For each job there will be the option to accept the contract, once accepted you will have to choose the different purchasing options to carry out the job. These purchases will determine the work, if you buy the cheap options you will save money but there will be more chance that these works will fail, but if you buy the more expensive options you will spend more money but the works will have better results.

Once the player accepts and buys the materials, he will be able to watch the progress bar of the accepted work being completed. At the same time, he will be able to choose other works and accept their respective contracts if he wishes to do so. Each construction site will have different purchase options and different progress bars. A construction site does not have to take the same amount of time to complete as a construction site. Each process is different.

If a site has a failure, the game will alert the player with a warning signal, this alert will provide the player with the failure that is occurring and which site they are in. Once this failure occurs, the player must fix it but has a time limit to do so. These solutions involve an additional cost of money and if they are not heeded the work will be restarted and the investment of the work will have to be done from the beginning making the cost higher. In addition, the player will get a penalty, which is negative. If the player reaches 5 penalties the game will end and the player will have lost the game.



When a failure is alerted the progress of the work is stopped.

If the alerts are fixed and the player does not run out of money the work will be completed properly. In case 3 works are completed the game will end with a positive ending for the player. This means that the player will have obtained a large amount of money and also a very high positive reputation level. The reputation in the city works like a kind of karma where if everything has been done correctly, the reputation level will increase positively, otherwise, if things have been done wrong, e.g. getting penalties, the reputation level will decrease.

The game presents among its endings, a negative one where either you have had a bad reputation due to 5 penalties or you have gone bankrupt due to not being able to get a second loan; and a positive one where all the works have been carried out successfully (in this case 3) and the monetary benefit is high. If this welfare is reached, the game will inform the player of the positive end but he/she can continue playing. In case of a negative ending the player will have to restart the game completely.

### 2.3.1. Controls

The player movement controls are available as long as there is no pop-up window on the screen and are detailed in Table 2.1. However, activating a pop-up window will block or unblock certain actions and make the use of the mouse more relevant; this is specified in Table 2.2 and Table 2.3.

Key	Action	Description
WASD	Move	Move straight, left, right or back, respectively.
SHIFT	Sprint	Switch from walking mode to running mode, or vice versa.
R/F	Zoom in/ Zoom out	Zoom in and zoom out respectively.
Q/E	Rotate	Rotate left and right respectively

Table 2.1: General Game Controls.

In addition to the controls detailed in the Tables, it should be noted that some of the camera movements are performed with the mouse in the desired direction. The use of the mouse includes a very important element in this type of game: dragging.

In addition, when pop-up windows are activated, it is possible to use the mouse for the selection of the player's choices with the left mouse click by pressing the buttons required by the player.

<b>Mouse Button</b>	<b>Action</b>	<b>Description</b>
Click center	Drag	Drag de movement of the camera in the drag mouse direction
Scroll center	Zoom in/ Zoom out	Zoom in and zoom out respectively.
Click Right	Rotate	Rotate left and right respectively
Click Left	Selection	Select every interactable button (Everytime activated).

Table 2.1: General Game Controls with the Mouse.

### **2.3.2. The Playable Character**

There is no playable character outside the player. In this game, the main character is the player himself, who plays the role of the general manager of a steel construction company.

The player can personalize his game by naming his company at the start of the game.

### **2.3.3. The Constructions**

There are 6 constructions to be made in the game. In this installment the game ends positively if 4 of them are completed.

These 6 constructions will be listed and detailed below:

- Pedestrian bridge: This construction is about manufacturing, assembling and painting a new pedestrian bridge over a motorway.

The contractor for this bridge is Atari City Roads S.A., the concessionary company that manages and maintains the city's roads and motorways.

The contracting company will award the player \$300,000 if the construction process is completed to perfection. The payment will be made in 3 installments as the player completes the work: \$100,000 each.

The completion process takes 1 week from the time of acceptance (in game time). The cost of the production of the artwork is approximately 35.000 dollars (purchase of materials, labor, etc).

- Industrial building: This construction consists of the manufacture and assembly of side panels and metal roof panels on a metal structure in an oil refinery.

The contracting company is REPLUNA S.A., the most important oil and gas distribution company in the city.

The contracting company will make a total payment of \$400,000 upon completion of the construction process. The payment will be made in 5 installments, each installment being US\$ 80,000.

The construction process will take 3 weeks to complete(in game time). The production cost of the construction site is approximately \$350,000.

- Telecommunications tower: This construction consists of the manufacture, assembly and erection of a city telecommunications tower.

The contracting company is IBERTROLA S.A., the company in charge of the management and distribution of electricity in the city.

The contracting company will make a total payment of \$100,000 upon completion of construction. This payment will be made in two installments and each installment is \$50,000.

The construction process takes 1 week to complete (in game time). The production cost of the construction site is approximately \$70,000.

- Vehicular bridge: This construction consists of the planning, manufacture, assembly, cementing and painting of a vehicular bridge over a river,

The contractor is the municipality of Atari City itself.

The total payment of the company will be 650,000 once the construction is finished. This payment will be made throughout the construction process in 10 installments of \$65,000.

The work is completed in 4 weeks (in game time). The production cost is approximately \$370,000.

- Shopping Center: This construction consists of the manufacture, assembly and installation of metal facades on the corners of the city's shopping center.

The contracting company is called LA AZUCARERA S.A., a company that runs a line of shopping centers in several cities and has a head office in Atari City.

The total payment from the company will be 825,000 upon completion of construction. This payment will be made over the course of the construction process in 6 installments of \$137,500.

The work is completed in 3 weeks (in game time). The production cost is approximately \$520,000.

- **Football stadium:**

This construction consists of the manufacture, assembly, installation and painting of the side panels of the city's football stadium.

The contracting company is called MARCELONA F.C., a company that manages the city's football team.

The total payment of the municipality will be 800.000 USD. This payment will be made in 8 installments of 100.000 dollars.

The work will be completed in 6 weeks (in game time). The production cost is approximately 480.000 dollars.

***In this version of the game there will be only 4 constructions enabled: Pedestrian Bridge, Industrial building, Football Stadium and Vehicular Bridge.***

#### **2.3.4. Playable Level**

The player can move freely around the town, depicted on the map in Figure 2.1, although not all details are displayed on it (alerts when a building site failure occurs do not appear in the first instance). This map will be used as a texture to select the area where the player wants to go at all times in the game.



Figure 2.1: Map level picture

In the map, the following elements are distinguished by colors:

- Parks and recreations, market in dark green.
- Houses and buildings, detailed in salmon.
- Water, indicated in blue.
- Infrastructures, set in purple.

### **2.3.5. Enemies: Alert System & Penalties**

There are no enemies in the game. The closest thing is a system of alerts that will make things difficult for the player and penalties that will increase the player's chances of having a negative endgame.

These issues will be explained and detailed below.

#### **Alerts:**

The alerts have a 40% chance of appearing randomly and appear once the works are accepted. The alerts are not specific to each work, that is to say, any alert can appear in any work. These alerts present faults in the work and when they appear they paralyze the work until the faults are solved.

The way in which these faults are solved is by improving the quality of the elements of the work and it always supposes an extra investment of money, but these improvements will be better specified in the following section.

The percentage of the possible occurrence of the alerts also varies according to the purchases made but this will also be specified in more detail in the next section.

The alerts due to the failure of the work are as follows:

- Workers have gone on strike! They demand more money to continue working. Give them a solution before they leave.
- The cement mix has broken down! The cement mix has been wasted due to poor quality or bad weather.
- The crane has broken down! The telescopic boom has stopped working, for safety reasons the construction site must stop until the problem is solved.
- The paint was of poor quality! It seems that the paint does not dry well on the metal, a better quality paint is needed.
- The electric generator has failed! Something has happened with the generator fuses, they have broken and this has left the site without power, a new generator must be obtained.
- The notary notifies that there has been an error in the contract and it must be accepted again! The work cannot continue until the new contract is confirmed.

- The workers' helmets are not the ones approved and accepted by the contractor! The work must stop until the helmets are renewed, safety is the most important thing.
- The scissor lift has stopped working! Something seems to be wrong inside, it is in urgent need of maintenance. It must be replaced.

Alerts have a time period of one day (in game time), once that day is exceeded, if the player has ignored an alert a penalty will be created.

### **Penalties:**

Penalties are part of a general "kharma" system of the game and are earned when alerts are ignored and bugs are not fixed within the given time period.

In the event of a penalty, a pop-up window will appear and the game will be stopped, notifying the player that they have a penalty.

In the upper left corner next to the company name you can see the kharma bar. In this bar you can see how many general penalties you have. On the other hand, you can see the number of completed works, but both progress bars are independent of each other.

If the player gets a total of 5 penalties the game ends up making the player's ending negative. Having 5 penalties means that the limit of negative karma has been reached, its narrative meaning is that the companies in the city will not provide any more work because the player's reputation level has decreased a lot.

## **2.3.6. Resources management**

Resource management is a key component of the game and the following will explain in detail how this works.

It should be noted that the player starts the game with an initial budget and at any time during the game has the opportunity to borrow money. These two issues will be explained in more detail in the next section.

Management will be used to consider the best purchase options, among others. The choice of purchases for the play will be enabled once the player accepts the play. The play progress bar will be positioned at 1% until the purchases have been made, then the progress bar will continue. This mechanic is carried out so that the first payment installment is made and the player always has money to start the necessary purchases for the construction site.

The general considerations are as follows:

1. When accepting the work consider the best purchase options: select between two options one of them on various aspects of the construction.
2. Take into account the delivery installments in order to have the necessary budget to accept new works or to solve mistakes if necessary.
3. Consider the loan option knowing that applying for a loan generates a monthly repayment with a percentage of interest added.
4. Consider the overall budget and know when the player is doing well financially and when he is doing badly, and be consistent with this information.
5. Manage the different alerts that appear knowing that depending on their purchase decisions a play will have more or less alerts.
6. Take into account the time of completion of the works, the times of the quotas and the times of the alarms, this makes him to be in constant verification of the works.
7. Know the karma system of penalties and completed works.
8. To take into account the system of balance between the 3 main branches of the work: Quality - Safety - Production.

With regard to the purchase or rental of the elements necessary to carry out the works, the following issues are taken into account:

- General equipment, with 4 different products, each product with 2 options.
- Safety equipment, with 3 different products, each product with 2 options.
- Elements necessary for quality, with a minimum and a maximum bar.
- Working Machines, with 3 vehicles to be needed, each vehicle with 2 choices
- Workmanship, with a minimum and maximum bar



The management of the 4 playable sites is as follows:

- Pedestrian Bridge:

Full charging	Instalments	Charge per instalment	Full payment	Weeks of duration
300.000	3	100.000	120.000	1'5

Payment:

Kind of elements	Option A		Option B	
	General equipment	Cement "Ducky"	10.000	Cement "SuperDux"
Metal "Mapisa"		23.000	Metal "CMetal"	28.000
Painter "Splash"		17.000	Painter "Goya"	21.000
Tools A		32.000	Tools B	35.000
Safety equipment	Life lines "Safety"	7.000	Life lines "God Saves You"	8.500
	Safety signals A	3.500	Safety signals B	5.000
	Personal protective equipment A	10.000	Personal protective equipment B	12.000
Elements necessary for quality	Minimum	4.000	Maximum	5.500
Working Machines	Electric generator "Chispi"	2.000	Electric generator "ElectroSmash"	3.000
	Scissor Lift "Piaum"	3.000	Scissor Lift "Gam"	4.000
	Crane "Plumita"	3.500	Crane "MaxPower3000"	5.000
Workmanship	Minimum	5.000	Maximum	8.000
TOTAL	-	120.000	-	150.000

- Industrial Building:

Full charging	Instalments	Charge per instalment	Full payment	Weeks of duration
400.000	5	80.000	180.000	3

Payment:

Kind of elements	Option A		Option B	
	General equipment	Metal Panel “Mapisa”	25.000	Metal Panel “CMetal”
Metal Beam “Mapisa”		38.000	Metal Beam “CMetal”	40.000
Painter “Splash”		22.000	Painter “Goya”	24.000
Tools A		35.000	Tools B	37.000
Safety equipment	Life lines “Vayakaka”	8.000	Lifelines “SecurityFresh”	9.000
	Safety signals A	5.500	Safety signals B	6.500
	Personal protective equipment A	12.500	Personal protective equipment B	13.500
Elements necessary for quality	Minimum	6.000	Maximum	7.000
Working Machines	Electric generator “Pikashiu”	3.500	Electric generator “ThorThunder”	4.500
	Scissor Lift “Boing”	4.500	Scissor Lift “Gam”	5.500
	Crane truck “Codorniz”	5.000	Crane “MaxPower3000”	6.000
Workmanship	Minimum	15.000	Maximum	20.000
TOTAL	-	180.000	-	200.000

- Vehicular Bridge:

Full charging	Instalments	Charge per instalment	Full payment	Weeks of duration
650.000	10	65.000	370.000	4

Payment:

Kind of elements	Option A		Option B	
	General equipment	Concret “Fiuuum”	74.000	Concret “McQueen”
Metal Beam “Metalsito”		91.000	Metal Beam “CMetal”	95.000
Painter “Me Resbalo”		42.000	Painter “Goya”	45.000
Tools A		57.000	Tools B	60.000
Safety equipment	Life lines “AccidentLovers”	14.000	Lifelines “SecurityFresh”	16.000
	Safety signals A	11.000	Safety signals B	12.500
	Personal protective equipment A	18.000	Personal protective equipment B	20.000
Elements necessary for quality	Minimum	12.000	Maximum	14.000
Working Machines	Electric generator “Pachirisu”	8.000	Electric generator “Gam”	9.500
	Scissor Lift “Boing”	10.000	Scissor Lift “Gam”	11.500
	Crane “Plumita”	9.000	Crane “MaxPower3000”	11.500
Workmanship	Minimum	24.000	Maximum	28.000
TOTAL	-	370.000	-	400.000

- Football Stadium:

Full charging	Instalments	Charge per instalment	Full payment	Weeks of duration
800.000	8	100.000	480.000	6

Payment:

Kind of elements	Option A		Option B	
	General equipment	Concret “Fiuuum”	83.000	Concret “McQueen”
Metal Beam “Metalsito”		100.000	Metal Beam “CMetal”	102.000
Painter “Me Resbalo”		64.000	Painter “Goya”	66.000
Tools A		78.000	Tools B	79.000
Safety equipment	Life lines “AccidentLovers”	18.000	Lifelines “SecurityFresh”	20.000
	Safety signals A	14.000	Safety signals B	15.000
	Personal protective equipment A	22.000	Personal protective equipment B	23.000
Elements necessary for quality	Minimum	16.000	Maximum	18.000
Working Machines	Electric generator “Pachirisu”	11.000	Electric generator “Gam”	12.500
	Scissor Lift “Boing”	12.000	Scissor Lift “Gam”	13.500
	Crane “Plumita”	14.000	Crane “MaxPower3000”	16.000
Workmanship	Minimum	48.000	Maximum	50.000
TOTAL	-	480.000	-	500.000

### 2.3.7. Budget & Rest System

The initial budget, the one the player has once the game starts, is \$100,000.

This amount can increase or decrease depending on the player's decisions. If it decreases to \$0, the player will be able to borrow \$100,000.

If the player has already applied for the loan, he/she will not be able to apply for another loan, and if he/she is left with 0 dollars again, he/she will automatically go bankrupt and the game will end negatively for the player. This is the second way to lose the game (the first is the loss of reputation through penalties).

The loan consists of 10 repayments, each repayment will be made per week (in game time), which means that from the moment the loan is borrowed it takes 10 weeks until all the borrowed money is repaid.

The amount borrowed has to be paid back with interest and this interest is 10%, i.e. a week you have to pay back one tenth of 100,000 plus 10% of 100,000.

$$(100.000/10 + 100.000*10/100)$$

### **2.3.8. Scoring: Kharma System**

The kharma system is a system that determines whether the game ends positively or negatively for the player.

If the positive bar (of completed works) increases to 4 (in the case of this version of the game) the game ends positively.

If so, the game ends and a window appears congratulating the player for completing the work and doing an excellent job.

If the negative (penalty) bar decreases to 5 the game ends negatively.

If so, the game ends and another window appears explaining to the player that the game is over because the player's company has run out of money.

### **2.3.9. Scoring II: Quality - Safety - Production**

The balancing system between Quality, Safety and Production serves to notify the player which sector the progress of each work is leaning towards.

This means that every construction site has its own personalized balancing system, and it depends on the purchases that have been made, because depending on the quality of the purchase, the inclination of this balance will be one way or another.

This purchase consideration is determined in the following way:

- Quality: Green
- Safety: Red
- Production: Yellow

General equipment	
Safety equipment	
Elements necessary for quality	
Working Machines	
Workmanship	

Working machines do not influence the balance.

## 2.4. Art and Graphics

### 2.4.1. Art Style

The game will be made with 3D models, both medium polygonal and low polygonal (for small or less relevant objects). The textures used for the 3D models will be cartoon style with flat colors. Regarding the cartoon style and the use of low poly models for less relevant objects, similar use cases can be found in current video games, such as . In addition, other recent video games such as "Tropico 6"[12] show the use of medium poly graphics and textures of similar quality.

### 2.4.2. User Interface

The user interface connects the game to the player via keyboard and mouse. Panels and buttons will be used for interaction and movement.

### **2.4.3. Menus**

The menus available in the game will be:

- Main menu. It includes:

- New game. This is the option to start a new game

- Instructions: It is the option that shows us an explanatory window to understand the purpose of the game and how to use the keyboard and mouse.

- Exit.

- Shopping menu. It includes:

- General materials: list of the general materials that the work needs to be carried out.

- Safety materials: list of safety materials that the work needs so that no accidents occur.

- Quality materials: a bar where the amount of investment in the quality of the work will be considered.

- Machines: here you can choose the machines to be used on the construction site.

- Workers: here you will choose the amount that will be considered weekly to the workers (this amount will be paid once the week is over, NOT AT THE BEGINNING).

### **2.4.4. Gameplay**

The indications available during the game are:

- Continuously variable current budget.

- General information button. This button will display a window with all the history of increases and decreases of money in the initial budget.

- The loans button. This button will show a window where you are given the option to accept a loan of 100.000 dollars.

- Bar of completed works. It is not empty, it is only filled each time the player completes 100% of a work.

-Penalty bar. It is not empty, it is only filled each time the player gets a penalty.

-General progress panel of the works. This panel is filled as the works are accepted and shows their progress without the need to have the window of each work open. If you click on any of these icons the game will open the window of that work and the camera will move there.

-Minimap. It is located in the lower left corner and details the entire map in a small box 100% interactive, where if you click on a point the game moves the camera directly to that point.



## Chapter 3

# Art, animations and effects

### 3.1. Models and textures

For this project, different 3D models and textures have been considered to represent the buildings, vegetation, warehouses, etc. Two models of each type are presented as a sample of the work carried out:

- Buildings:

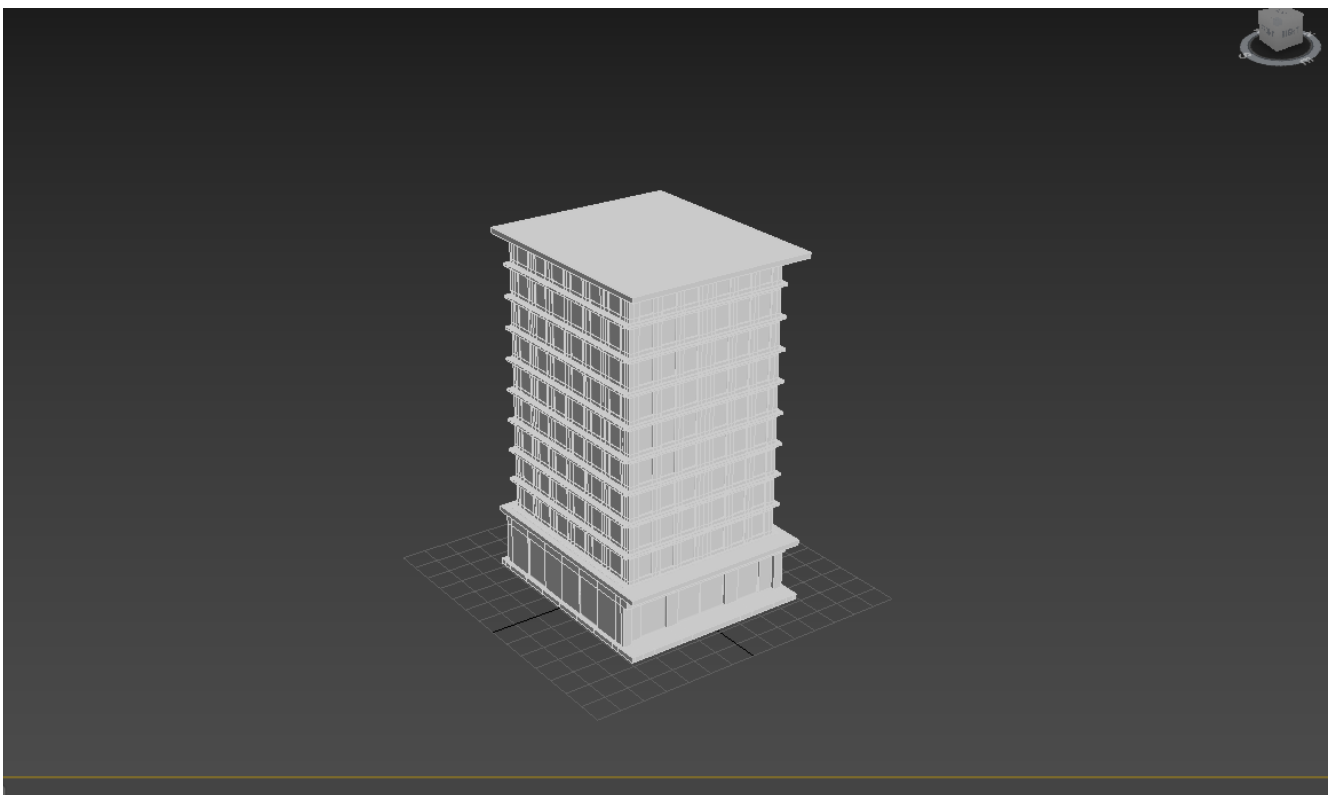


Figure 3.1: Square Building model.

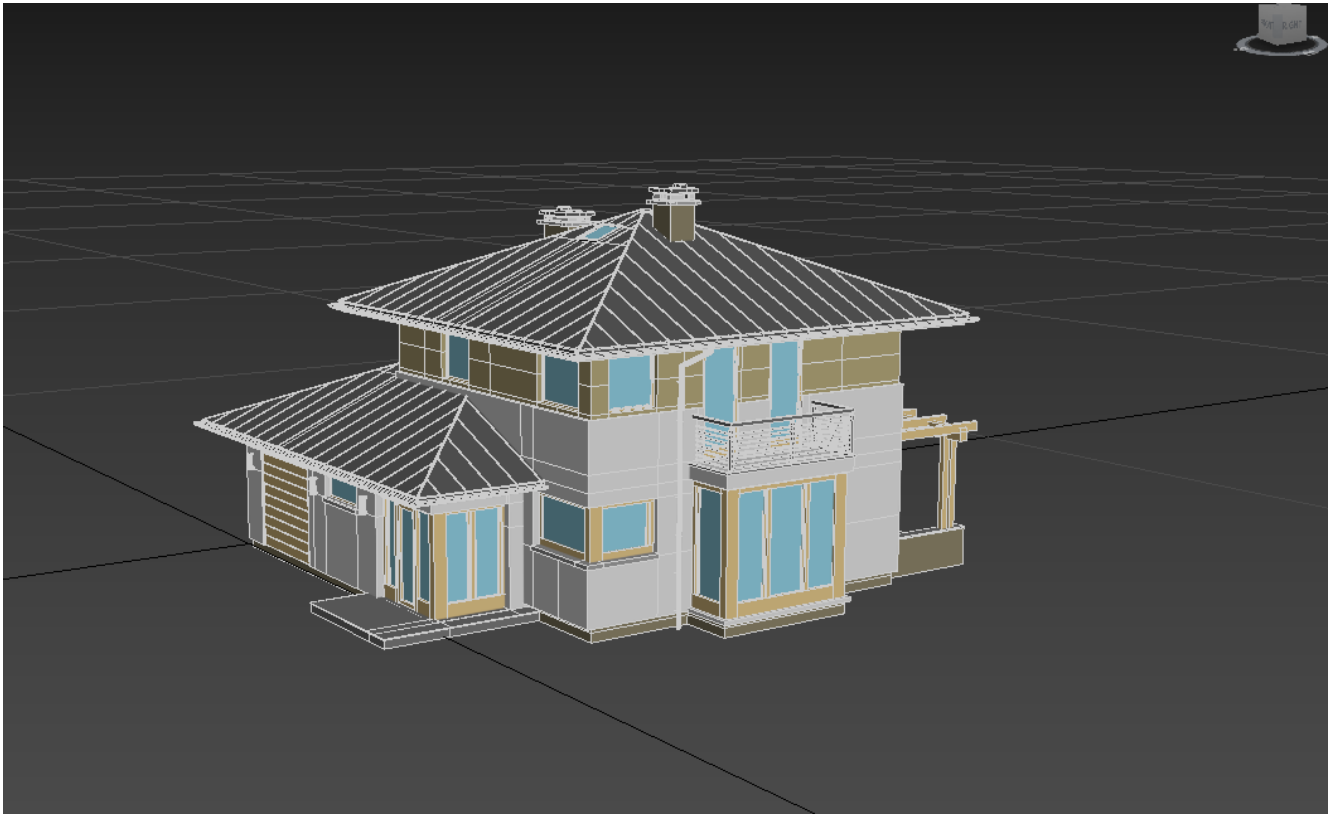


Figure 3.2: Modern house model.

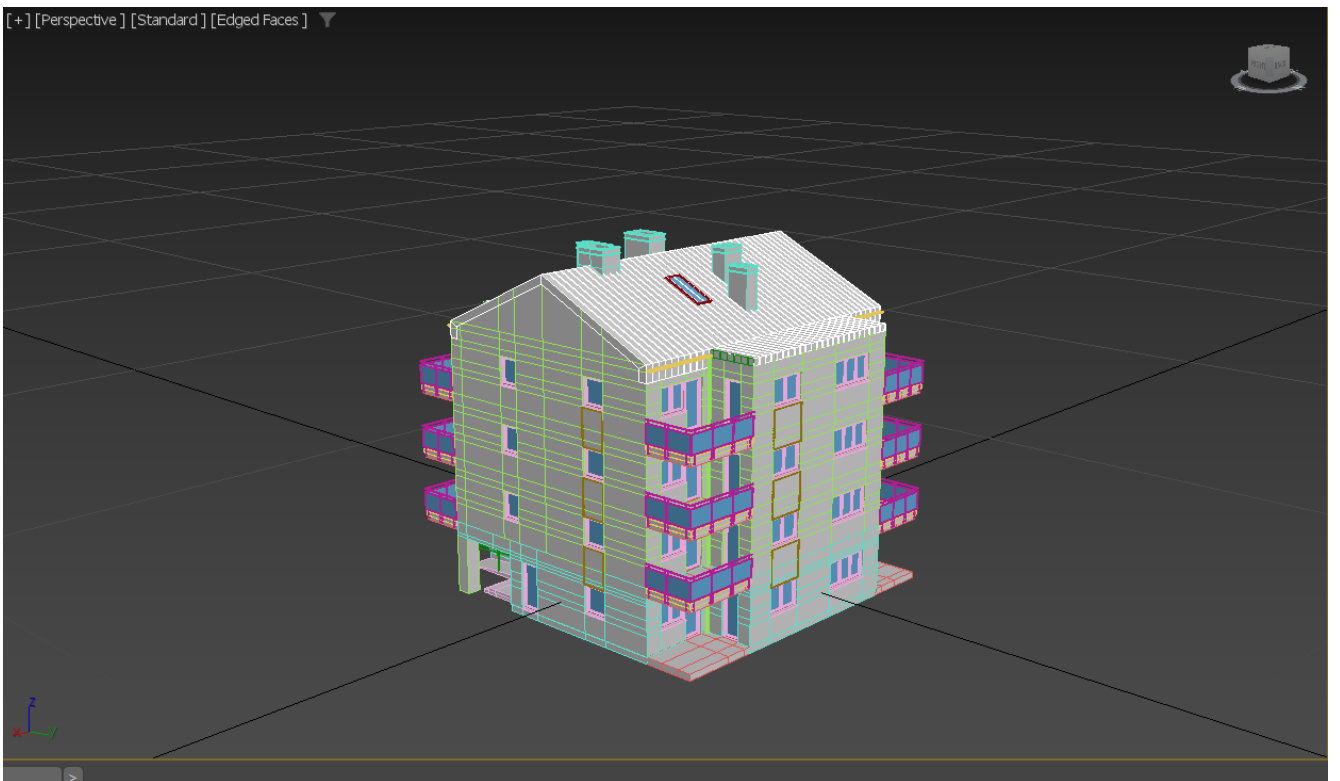


Figure 3.3: Little building model.

- Vehicles:

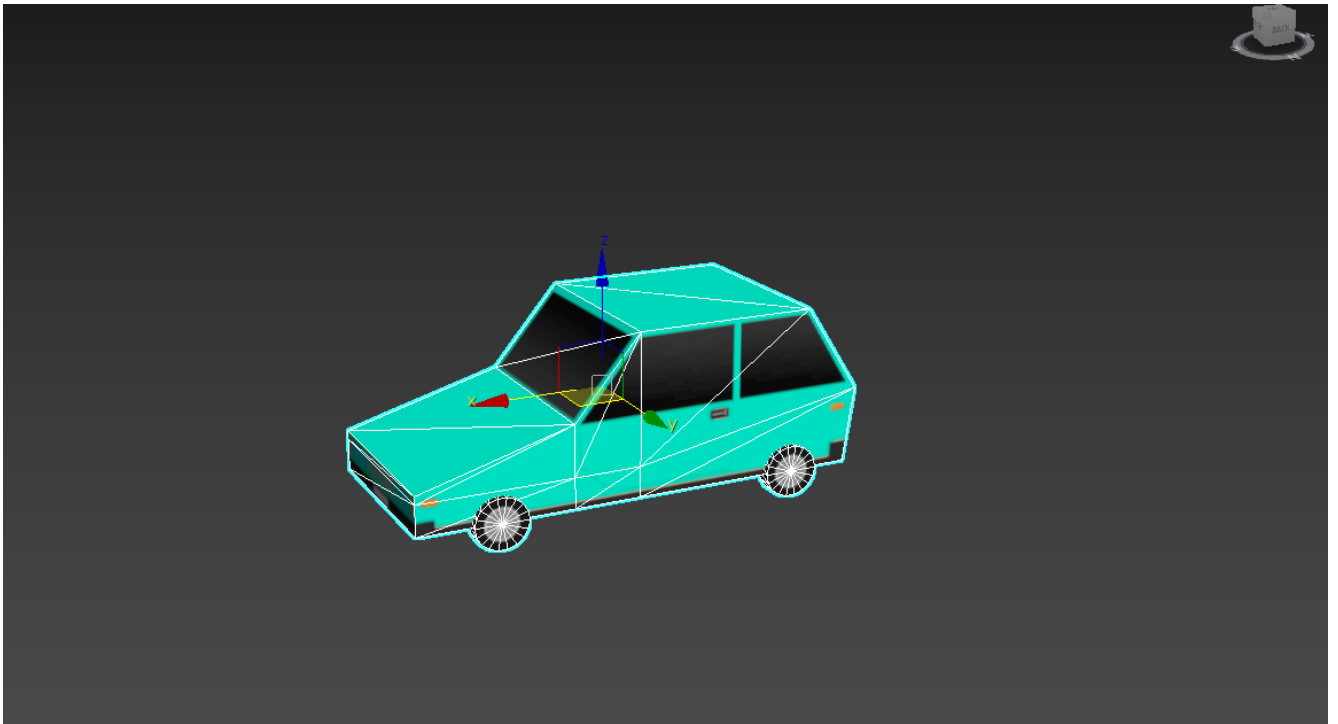


Figure 3.4: Car model.

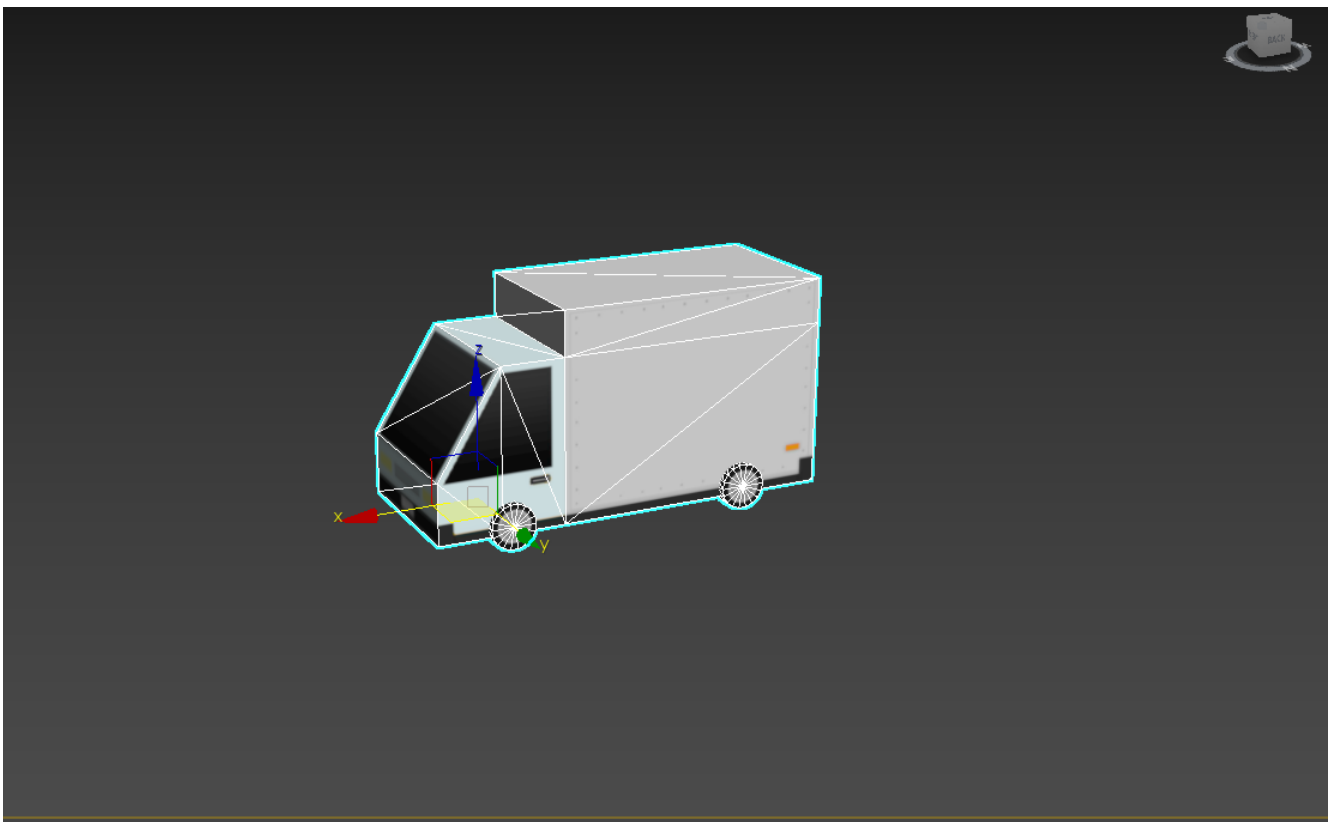


Figure 3.5: Truck model.

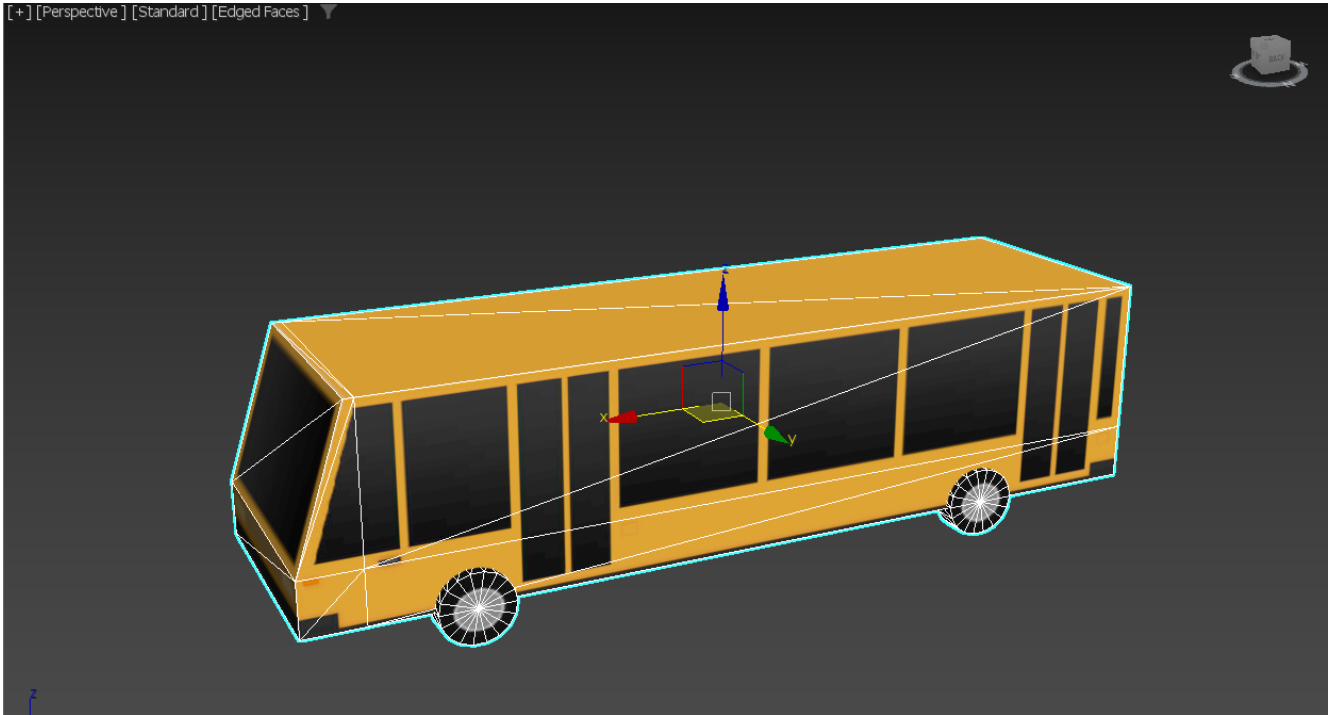


Figure 3.6: Bus model.

- Parks & Nature:

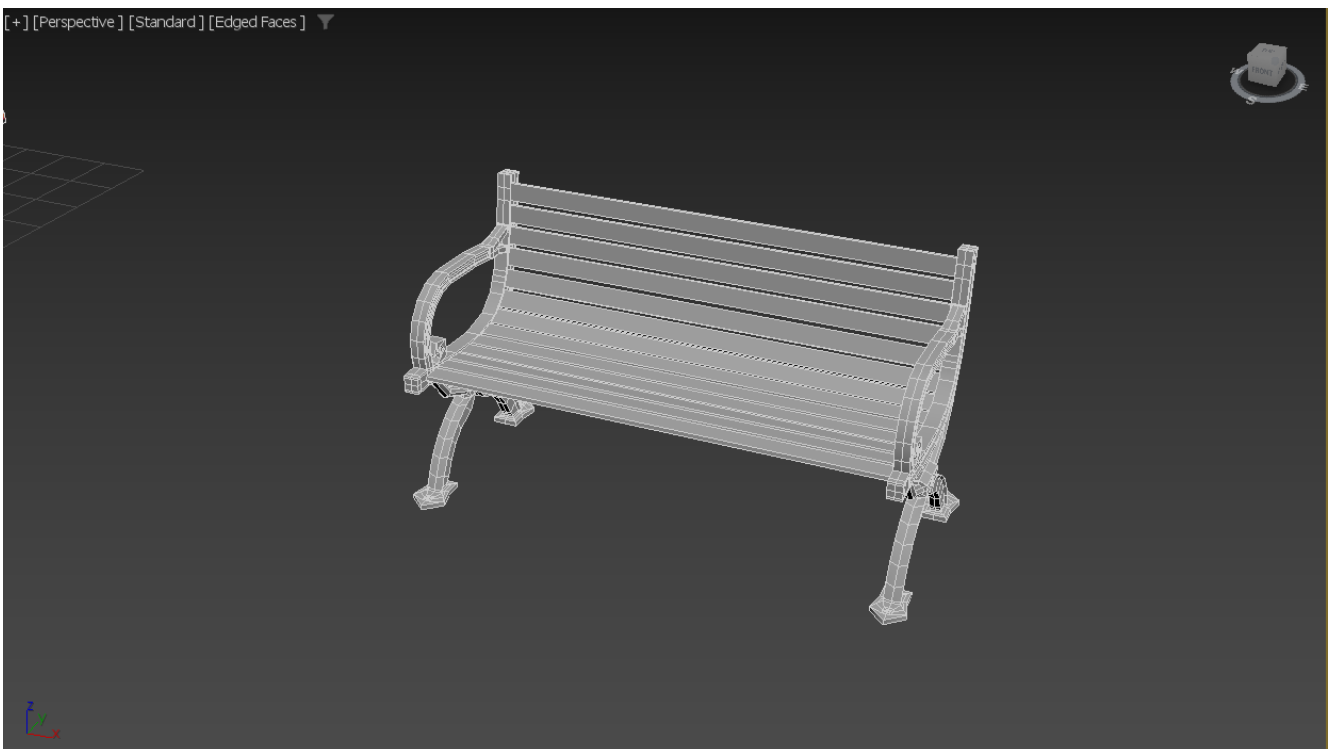


Figure 3.7: Park bench model.

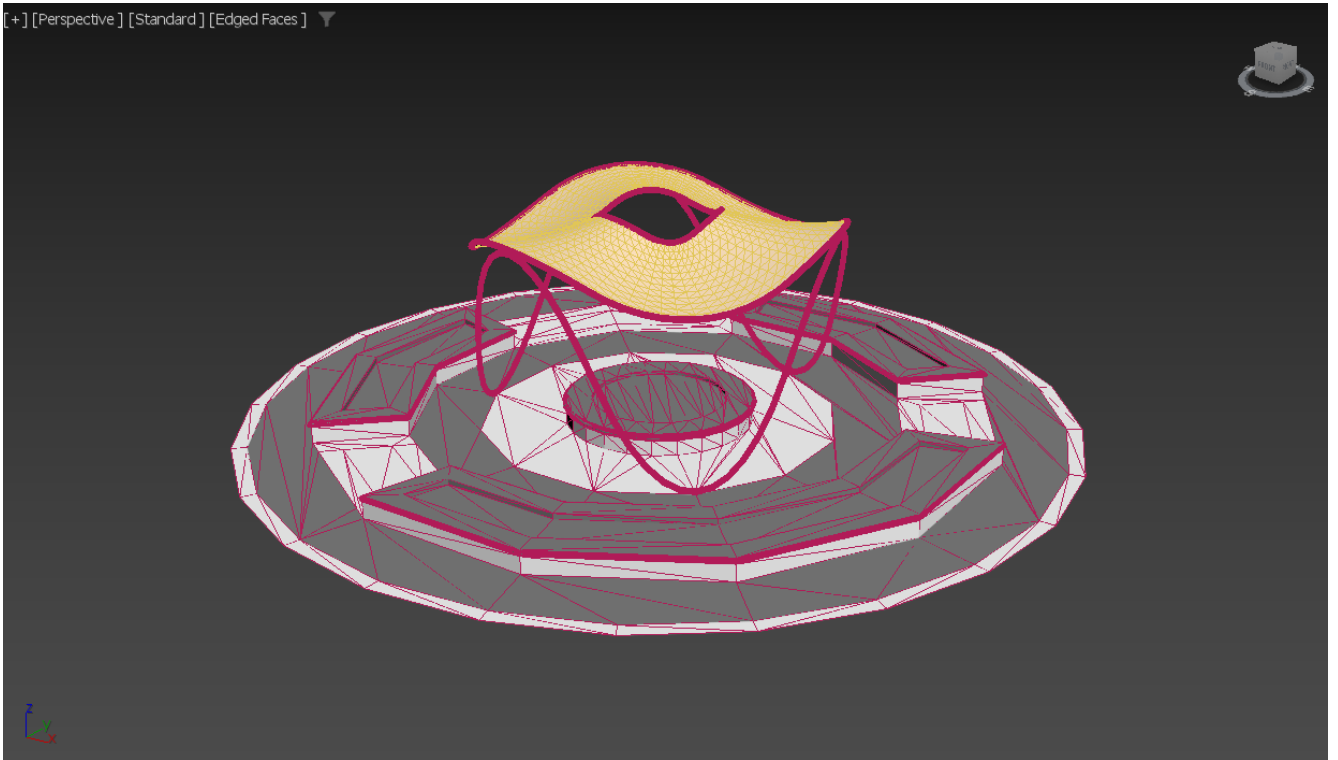


Figure 3.8: fountain in a plaza model.

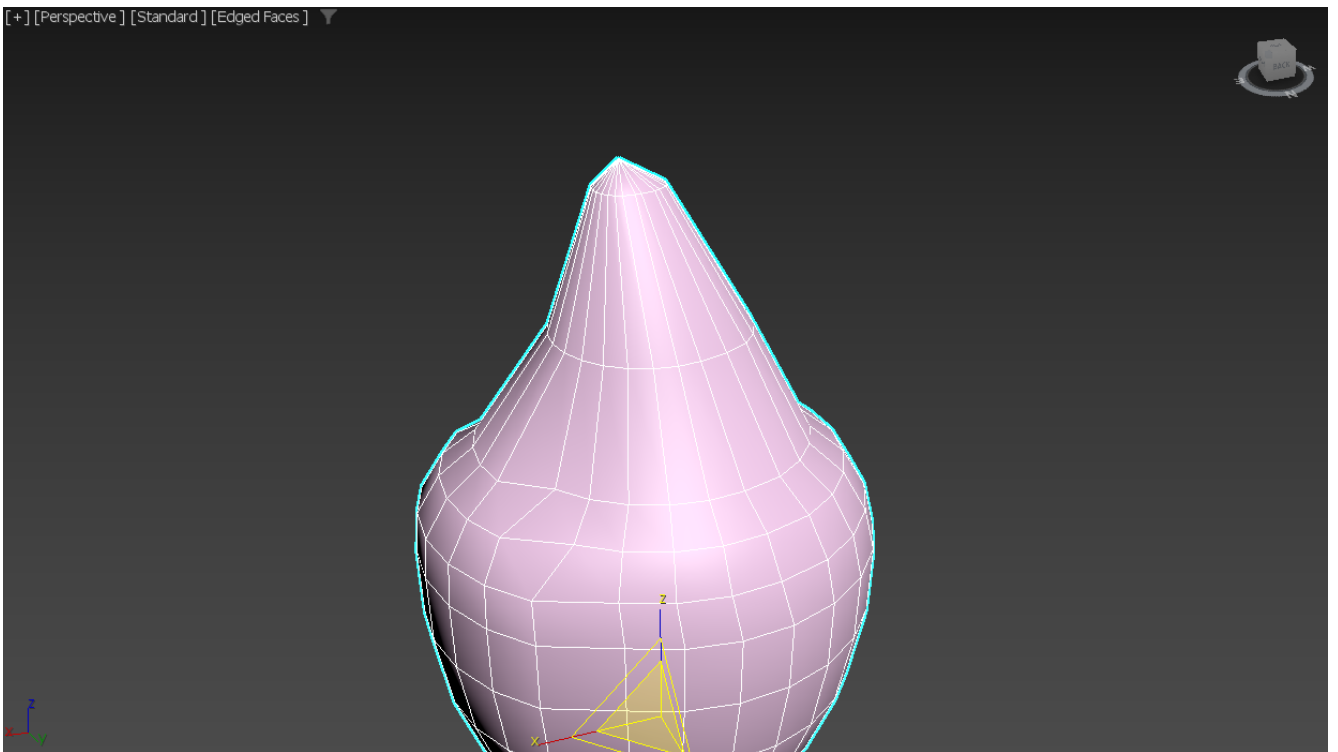


Figure 3.9: Mountain herbs model.

- Road elements:

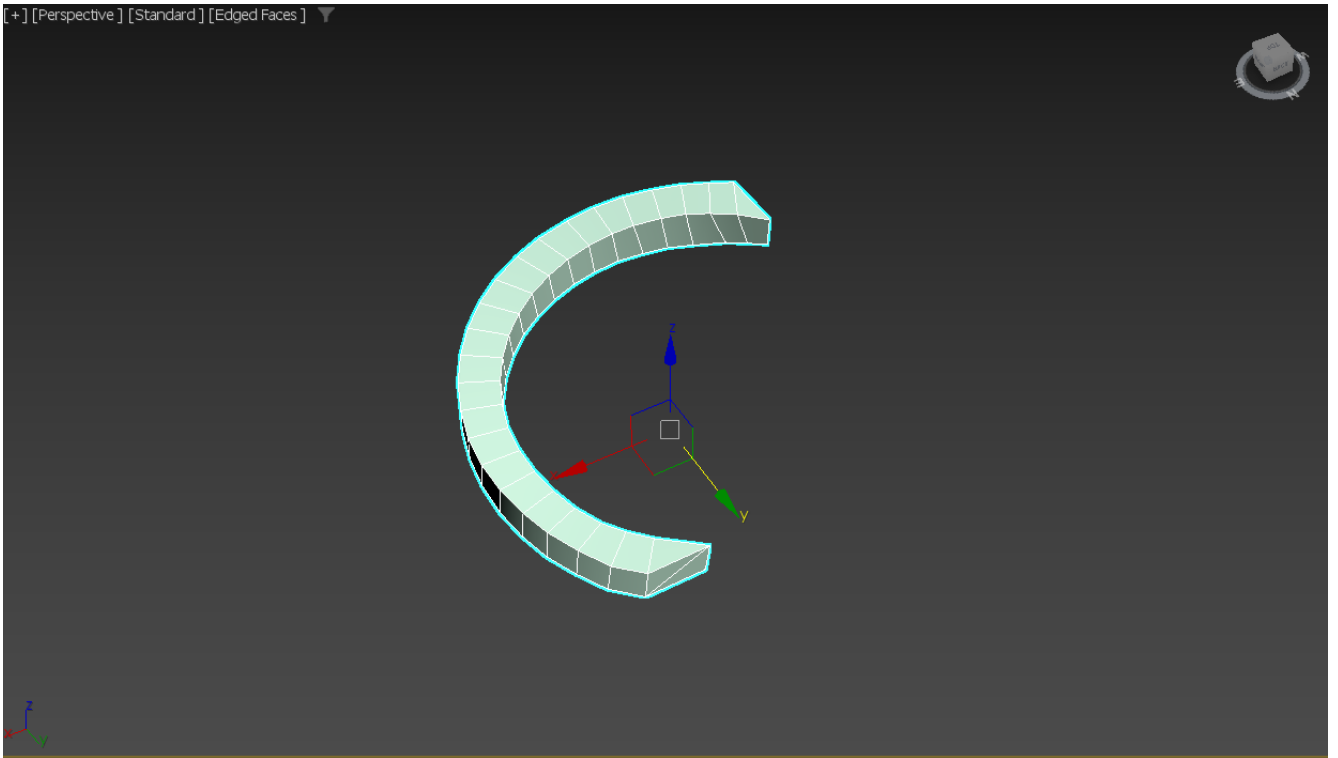


Figure 3.10: Unleveling Junction model.

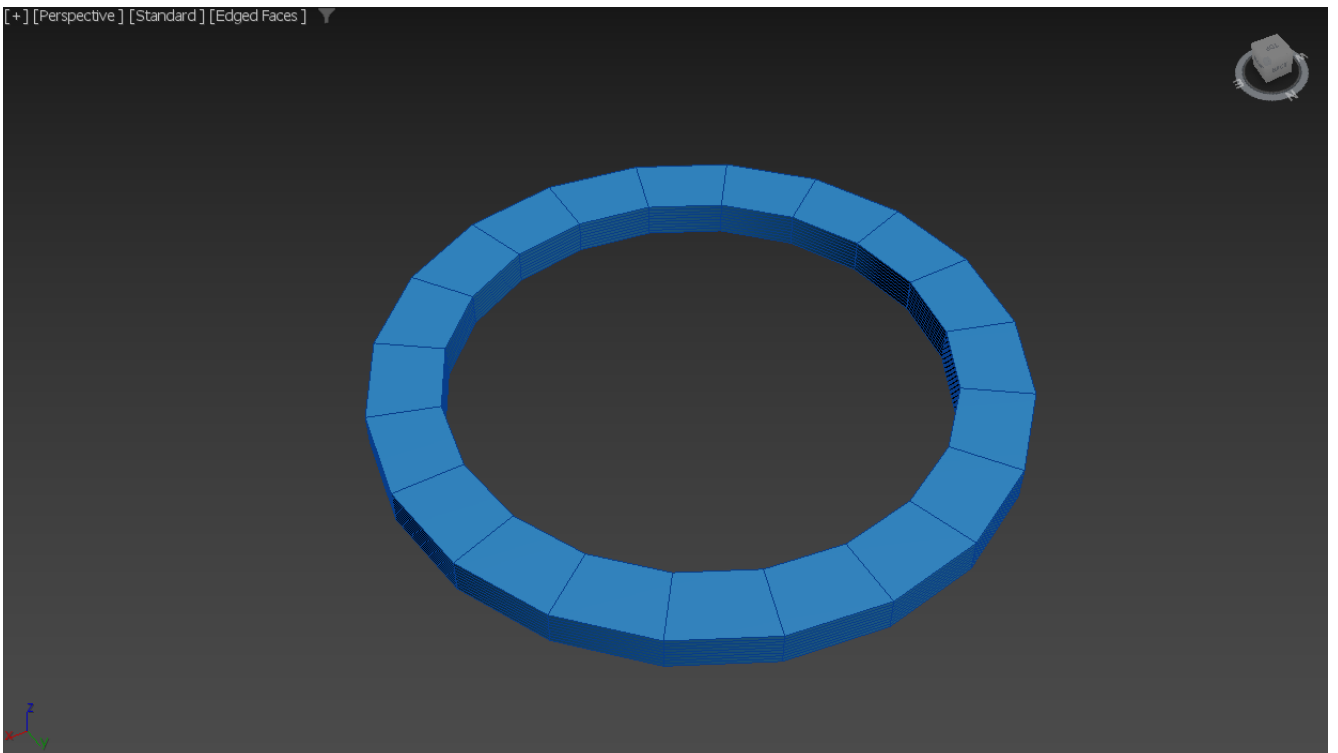


Figure 3.11: Roundabout model.

## 3.2. Animations

There is only one animation in the game, this animation was intended to display the minimap.

In the end it will not be used at all because in an update of the game it was considered to leave the minimap always visible.

## 3.3. Game World final results

All the assets created have been placed in the Unity project on top of the correctly textured terrain model to create the playable level of the game. As many elements are positioned on the screen, the optimization method offered by Unity called "Occlusion Culling" has been used. This method avoids rendering objects that are hidden by others in the scenario, and so more objects can be placed on the screen without affecting the frames per seconds.

In order to be able to use this method, the objects of the scene that will be affected have to be "Occluder static" and/or "Occludee static". Unity also automatically uses a method named "Frustum Culling", which does not render anything that is outside the camera's viewing range..



Figure 3.12: Game World picture 1.





Figure 3.13: Game World picture 2.



Figure 3.14: Game World picture 3.



The final result of the positioning of the assets and the use of the optimization techniques allow to achieve the final visual results of this project. The following pictures are samples of the achieved results.

### 3.4. Special effects and shaders

To achieve a more dynamic environment, particle effects have been included to simulate clouds around the map. These particles simulate clouds by taking advantage of the properties offered by the Unity particle system, such as "Emission", "Color over lifetime", "Size over lifetime" and "Renderer".

It is important to change the "size" and "rotation" values during the lifetime to simulate the effect of the cloud moving and changing slowly but constantly. Figure 3.15 illustrates the appearance of the clouds.

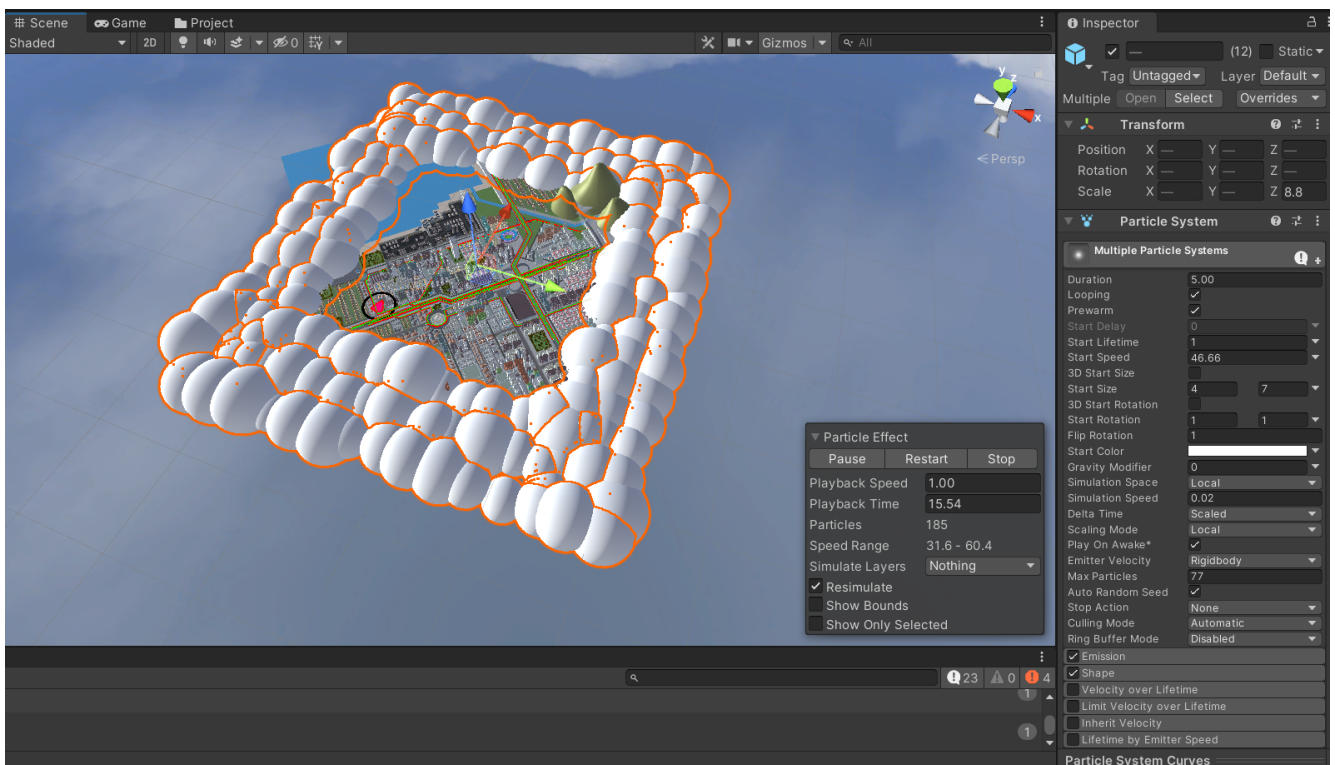


Figure 3.15: Particles simulating clouds effect.

Another special effect (created in the same way), are the smoke particles on the chimneys of the refinery. These are particles that are generated as a directed smoke or dust effect that uses noise and trace functions to create the different trajectories to move the particles in a seemingly random way. An example of the appearance of this effect can be seen in Figure 3.16.

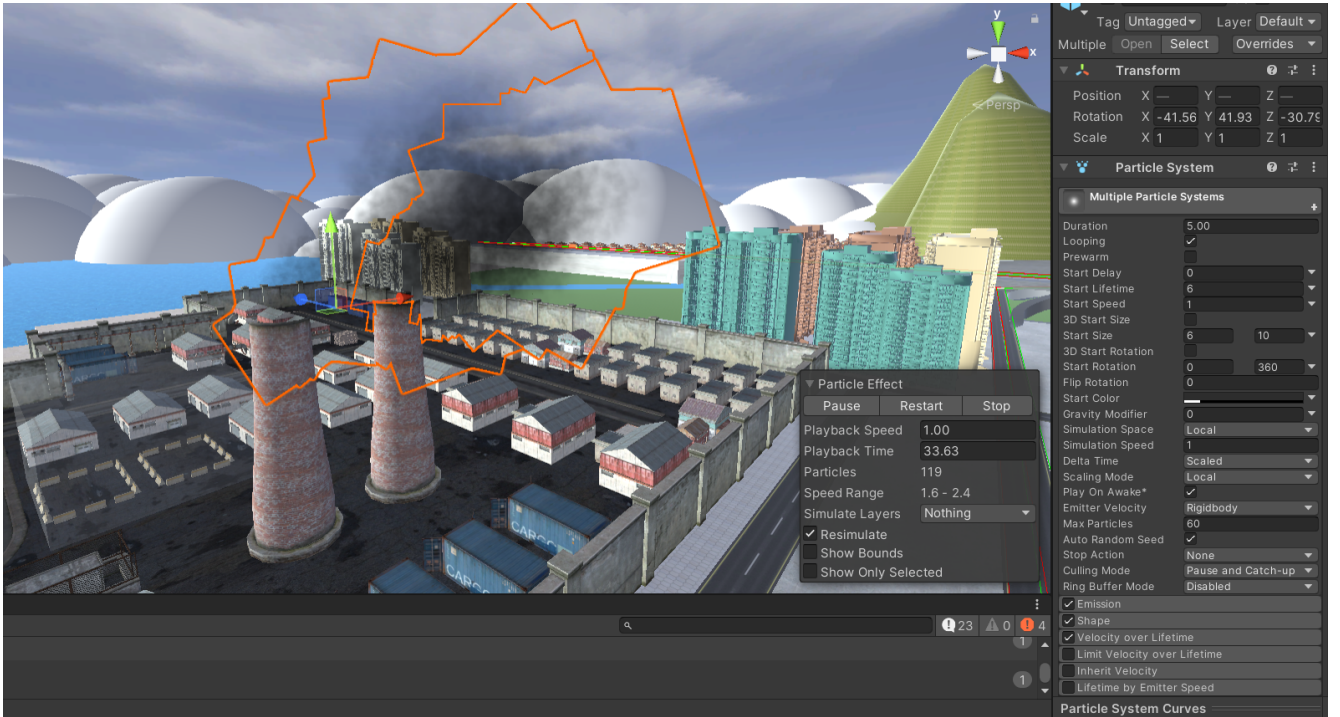


Figure 3.16: Smoke particles.

## Chapter 4

# Technical Specifications

### 4.1. System requirements and performance

The game has been developed using a computer with the following components:

- CPU: Intel(R) Core(TM) i7-8550U CPU @ 1.80GHz 1.99 GHz
- Graphic card: NVIDIA MX150 8GB VRAM.
- RAM: 12,0 GB (11,9 GB utilizable)
- Hard Drive: SSD 125GB.0 HD 1T
- OS: Windows 10 Home Single Language

On this computer, the game runs at a minimum of 60 fps at all times.

### 4.2. Repository

All the game assets can be found in the next repository, and all the scripts can be found in the “Scripts” folder:

<https://github.com/AronCold/BuildCraft2DavidCaceres.git>

### 4.3. Resource Management System

Resource management will require interaction with some elements of the city. Interaction involves opening and closing panels and accepting or viewing contracts.

HUD elements that need to be modified when accepting contracts or solving alerts are also to be taken into account, such as the radial progress bars and the budget.

### 4.3.1. Construction work system

The mechanism of the work system is detailed in the following lines:

- At the beginning of the game, no construction site is selected. The player can search for a construction site in the city and when he finds it, he can click on it with the "left click". If the player clicks on the building site, a window will appear with the main information about the building site and a button will suggest to accept the contract for the building site to start the building process.

As for the code, this use of the selection of works is carried out in the script "Selected.cs".

- When the player clicks on the "Accept Contract" button, the construction process starts at 1% and is kept on hold because the player has to select what kind of materials he wants for the construction site. This choice lasts as long as the player wishes and when he is sure he will click a new button "Buy".

All these choices influence the budget and are carried out in the script "NewConstruction.cs".



Figure 4.1: Contract Panel.

- Once the "Buy" button is pressed, the progress of the work continues, for the movement of the progress bar the script "ProgressBar.cs" must be used.

### **4.3.2. Scoring system**

- The scoring system is carried out by the script "GameManager.cs", both the counting system of completed works and the counting of penalties.

### **4.3.3. Rent system**

- The lending system consists of a loan of 100,000 and a weekly repayment of 10% plus interest of 10%. This system is implemented in the script "DineroPrestamo.cs".

## **4.4. Camera Movement system**

As for the camera movement system, an isometric view has been considered with a 45° rotation in the X axis and a 45° rotation in the Y axis. The movement will always be considered on these two axes at the same time. The usual rotation systems will be taken into account and for dragging, the position of the mouse will also be taken into account with the ScreenPointToRaycast method.

For this we will create a script to which we will attach the main camera of the game, and we will call it "CameraControlles.cs".

## **4.5. Cars AI**

For the AI system of the cars driving around the city, a waypoint guidance system has been taken into account, where cars follow a route following the order of the nodes that have been assigned to them.

For this purpose, the "Waypoints" and "" script has been created, but an additional waypoint creation format has been used to create the nodes.

### **4.5.1. Waypoint Editor**

The waypoint editor is an editor where the nodes are managed and displayed on the screen, and with the help of a Manager Window, any number of waypoint nodes can be added. The route is also easier to display because it is visible on the map and forms a coloured circuit. These elements cannot be edited or viewed by the player, but for the creation of the waypoint system there.



For the creation of this node editing system two different scripts were created: "WaypointManagerWindow.cs" and "WaypointEditor.cs".



Figure 4.2: Waypoint Editor Vision.

## 4.6. Sound Effects

In terms of sound, two original pieces of music have been chosen to serve as the main sound elements in the game.

First, the song "MusicaMenu.mp3" has been created for the opening menu scene of the game.

Then, the song "MusicaGameplay.mp3" has been created for the game scene once the game starts.

Both songs are original melodies composed with an electric guitar and amplifier and edited in Adobe Audition.

Both songs are looped.

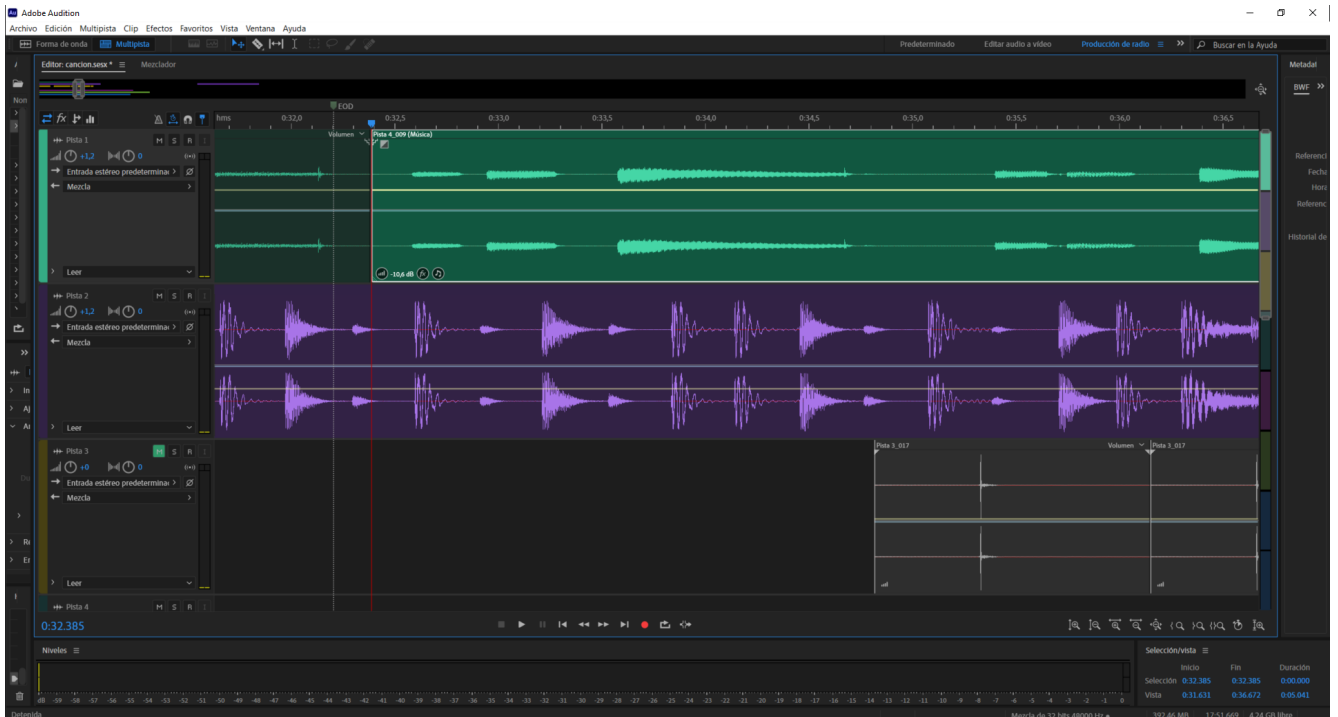


Figure 4.3: Game theme creation.

The rest of the sound effects are the usual city sound effects which are activated when the camera approaches them.

## 4.7. Quests System

This part of the game is responsible for acting as a link between all the scenarios, creatures and features of the game.

The game does not have a concrete search system. It only has a budget history to know when the budget was modified and how much it was modified. The script that carries out this history is "BudgetHistorial.cs".

## 4.8. Day/Night cycle

The cycle of day and night is a very important element in the game because this cycle marks the days and weeks and the consideration of the passage of time is very important for the realization of the works.

Each day of the game is 24 seconds of real life.

Hours, days, weeks, months and years are taken into account. It is very important to be precise in time so that the deadlines are correct.

For the creation of this cycle a new script has been used which has been called "daynightcycle.cs".

As for the weeks (24s\*7days), we remember these general deadlines of the game:

- Loan Repayment: 10 weeks.
- Complete Pedestrian Bridge: 1.5 weeks.
- Complete Industrial Building: 3 weeks
- Complete Vehicular Bridge: 4 weeks
- Complete Football Stadium: 6 weeks

## 4.9. Other scripts developed

- Minimap: A texture of the map as seen from above is generated orthogonally and positioned on the canvas to have a view of the map in the player's view.  
Script: "Minimap.cs".
- Select point on the minimap: A script is created to select any point on the minimap and transport directly to that point.  
Script: "ChangePosition.cs".
- Load Scene: The script is used to load the game scene or exit the game. A button is also provided in case you want to choose game options, in this case you can choose the "Instructions" option.  
Script: "LoadScene.cs".
- End Game: This script is used to end the game regardless of the ending that the player has experienced, if the ending is positive the script will show a window with the positive ending but if the ending is negative it will show the negative ending.  
Script: "FinishGame.cs".





## Chapter 5

# Narrative Design

### 5.1. Sinopsis

"Welcome to Atari City! A city where opportunities are the order of the day".

This city has an impressive exponential growth and there are many job opportunities. The city is located between the mountains and the sea and attracts many tourists every year. There is a lot of construction due to demand and many construction companies are fighting for contracts to carry out the works.

It is the perfect opportunity to get maximum profit and recognition for the player and his company. If the player accepts the jobs but does not know how to do them well, the reputation in the city will diminish and nobody will want to hire him.

Legend has it that a previous construction company lost all its money and went bankrupt despite borrowing money.

*The game has no further narrative elements.*

## Chapter 6

# Results Achieved

### 6.1. Accomplished tasks and real timing

For this project, an initial estimated list of tasks and timing was presented, but while the project was being carried out, some tasks were discarded due to lack of time, not expected tasks were included due to unplanned needs, and others took more or less time than initially estimated. A complete list of accomplished tasks and the actual time invested in them is provided:

- Model and texturize the playable terrain (70h.)
- Generate the NPCs System (40h)
- The main character (main camera) (30h)
- Implement the canvas system (30h)
- Implement the day/night cycle and the timer (10h)
- Generate the menu system (15h)
- Create the audio of the game (15h)
- Implement the resources management system (35h)
- Document composition (50h)

### 6.2. Improvements during the project

During the creation of the game there have been several unforeseen events, these are some of the several unforeseen events that occurred:

- The modeling of the city needed more detail than was originally considered.

- The selection of the minimap gave several errors and the whole layout of the canvas had to be changed, but in the end it was solved.
- At the beginning the camera was thought to be isometric and not rotate. During the creation of the game it was changed to a rotating camera and a more perspective view.

## Chapter 7

# Conclusions, future work and monetization

### 7.1. List of testers and errors found

When a beta version of the game was available, some people helped testing it, in order to find and solve existing errors.

The following lines list the testers and the main bugs they respectively found:

- Jesus Mayoral Itarte:
  - The textures of some road areas are not well dimensioned (fixed).
  - The alert solution button does not work (fixed).
  - A truck turns around itself, the path fails (fixed)
  
- Maria del Olmo Marco:
  - Clouds behave strangely (fixed)
  - The close button of the stadium construction site window does not close the window. It does nothing (fixed)
  
- Josué Cáceres Frías
  - The music sounds too loud (fixed)
  - The minimap selection does not transport the player to the place indicated (fixed)
  - Two textures overlap in the river area (fixed)

## **7.2. Monetization and project objectives**

This game was chosen out of all the games that were planned to be developed, because it was the one that allowed the most different and interesting tasks to be performed and the challenge could be increased with each new piece of work. It was also interesting to be forced to design all aspects of the videogame, because it made me learn more about each of these parts and also improve my perspective of what is needed when creating a complete video game from scratch.

The final goal of the project is to be able to make a city with a lot more interactive objects, without loading screens (which forces optimisation of all aspects) and with many objects, effects and animations playing at the same time.

All these objectives come together in one big goal, which is to be able to make a game that imitates the big games, but on a very small scale, using techniques that can be visualized in these games.

My personal goal is to achieve a future monetisation of this game by selling the game directly, without any additional paid content. There are several options to look at, such as crowdfunding, new developer opportunities on Steam [13] or mobile digital shops such as the Play Store [14].

## **7.3. Project future**

This project is part of a larger project on construction site simulation.

This new project has the input and assistance of a real construction company. The game can be used by real engineers to manage the production processes of their construction sites from a dynamic point of view.

## **7.4. Conclusions**

During this project some skills have been improved, like I have previously exposed. Furthermore Now I have a base project to improve over time, until getting a final and vendible version. On the other hand, the game development has had some problems and delays due to the learning process.

Most of these have been resolved successfully, so even if the game is not 100% as originally thought, it is very similar to the original concept and meets the requirements set in the section called “Expected Results of the Technical Proposal” and therefore satisfactory.



# Appendices



## Appendix A

# Dialogs and Clues

There are no dialogues in the game because there are no interacting npcs but there are hints and information for the player to understand what to do.

### A.7. Interactable objects and environmental clues

When the player is near interesting places, a text appears on the screen where it says "Interact". The following list details all the interactable elements and the information they provide:

- **Company name creation button:** "Hey, welcome to Atari City! Here you have the opportunities to conquer the world of construction and metal structures. Once you start, you can choose the building sites you want to build, but first... tell us, what is the name of your company?"
- **General information button:** "In this panel you will know the status of your budget and you will be able to see the income or outflow of money and the reason to always keep track of all your movements".
- **Selected from the pedestrian bridge:** "Greetings builder! We are the company Atari City Roads S.A., we want to build a pedestrian bridge to unite our citizens. What do you say, do you accept working with us?"
- **Selection of the industrial building:** "Greetings engineer! We are REPLUNA S.A., we would like to build new industrial buildings for our refinery. What do you say, would you accept to work with us?"

- **Selection of the vehicular bridge:** "Greetings engineer! We are the city council of Atari City, we would like to build a vehicular bridge over the river to connect our city with the world. What do you say, agree to work with us?"
- **Football stadium selection:** "Greetings Captain! We are Futbol Club Marcelona, we would like to build our first monumental stadium in the city. What do you say, accept to work with us?"
- **Loan notification:** "The application for this loan is for \$100,000. Remember: you will have to pay back 10% every week, plus 10% interest". Choose the loan only if it is your last option."
- **Victory notification:** "Congratulations, builder! You have successfully completed all the constructions, your reputation level is the best in town".
- **Notification of defeat due to penalties:** "What a disaster! You have 3 penalties, your reputation is on the floor. Nobody wants to hire you. Get out of town".
- **Notification of defeat due to bankruptcy:** "It's a shame... You have run out of money. Good money management is necessary to move forward.... Some other time..."

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