Infrastructure Management Game

Level 1

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Contents

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1 Introduction

1.1 Overview

Infrastructure systems are the backbone of our society. They are an integral part of our lives. Without roads, electricity, freshwater or the internet, our lives would not be the same. Although we use them daily, we hardly think about how they work and what measures are necessary to maintain their functions. In this project, you will develop a game that deals with the maintenance and management of our infrastructures and brings this closer to the player. As an infrastructure manager, the player has to manage a given water supply system. He has to choose from various maintenance measures and find the optimal strategy to allocate his limited resources to different assets. As a game developer, it is your task to develop realistic assets with which the player can interact. Your primary focus is on different degradation processes and failure mechanisms that the player has to fight successfully. Besides the graphics, you also have to develop animations and interactions to bring the game to life. Game development is an iterative and interactive process. Although each of you will work on your own asset, teamwork is allowed, even encouraged.

1.2 Project Details

The project aims to develop a game asset that will be part of an infrastructure management game. The game asset will be part of a water supply system. In the first semester (level 1) you will deal with the game design of the assets (appearance, functions, attributes, interactions, costs, etc.). In the second semester (level 2) you will deal with the creation, programming and implementation of the assets.

1.2.1 Level 1

Level 1 deals with game design and ends with presenting the final asset concept at the end of the semester. Level 1 starts with exploring different games to get an overview of different game mechanics, styles, game systems, platforms. This is followed by research into potential game assets, i.e. the components of the supply network that could be used for the game. After this research, each of you will be assigned a game asset, which you will develop over the course of the semester so that it can be implemented in Level 2. This includes the collection of reference materials, plans, costs as well as the elaboration of the functions that this asset provides to the system. Since the game concept is based on the degradation and failure of the individual assets, suitable failure mechanisms must be found that can be represented in the game engine (i.e. mathematical models). In addition to the failure, we need maintenance measures that counteract or eliminate the damages. Since the player has only a limited amount of resources at his disposal, you need information about the costs, time, material, etc., needed for the maintenance measures. All this information is collected and processed at the end of level 1 to form the basis for the work in level 2.

1.2.2 Level 2

Level 2 deals with the implementation of the developed game asset. The first step is to create a 3D model that can be displayed in the game. The syles and references developed in level 1 should serve as a starting point. The modelling includes not only the asset in its functional state but also the modelling of a broken object. After the completion of the 3D model, texturing takes place. Texturing allows you to make the model look more realistic by adding colours, designs and textures. In this stage, you need to understand UV mapping and how textures are used in different applications. Now that the texturing and lighting are completed, the next step is to render the scene. After an isometric

image of the object has been created, it is now imported as a game asset into the Godot game engine, where the asset is given life. Through various scripts, the object ages and fails over time. The player can also set actions that repair the object but cost corresponding resources.

2 Assessment and marking of the Project

2.1 Experience Points

XP	Grade [%]
2000	100
1400	90
1000	80
800	70
600	60
500	50
400	40

Table 1: Experience vs Grade.

The evaluation of the project is based on experience points gained. Table 1 gives an overview of how experience points can be converted into percentage points. Experience points are accumulated throughout the project. The number of experience points gained depends on the performance. You can carry out different tasks with varying degrees of complexity. The tasks are divided into so-called badges, which are assigned to specific subject areas.

In total, you can achieve 1100 experience points in level 1, 900 through badges and 200 awarded by me as a bonus. In level 2 additional 1100 experience points can be achieve.

2.2 Badges

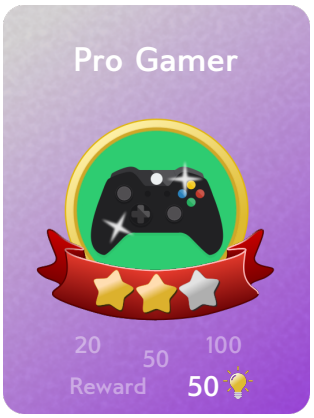

Figure 1: Sample badge *Pro Gamer* with two stars obtained.

Tasks that are necessary for a successful evaluation of the project are thematically divided into so-called badges. For each badge, there are three different levels of difficulty, which are marked by stars. To get a certain number of stars, you must fulfil specific criteria for each badge (criteria can be found here). According to the number of stars, there are corresponding experience points. For example, one star in figure 1 corresponds to 20 experience points, two stars to 50 experience points and three stars to 100 experience points. The number of experience points per star may vary from badge to badge. Experience points per star are not accumulated, i.e. if you reach three stars as a *Pro Gamer*, you will receive 100 and NOT 20 + 50 + 100 experience points.

2.3 Leader-board

An anonymous leaderboard with the current number of stars and experience points is published online at regular intervals.

2.4 Continuous Evaluation

You can earn badges in different orders. It is also possible to improve badges afterwards. For example, in week one, you complete the tasks to make one star. In week four, you have some time to work on the task from week one and earn your second star.

2.5 Work Plan

Basically, it is up to you when you do your badges, but I suggest the following work plan that you can follow.

The project guidance I offer will follow this work plan. This means that questions on the particular topics will be dealt with in the respective weeks.

2.6 Overleaf

Your work takes place online. You will receive an Overleaf document from me by completing the corresponding tasks. Overleaf is an online text editor for LaTeX. You will work with LaTeX for this project. If you have never heard of it, don't worry, I will give you a short introduction at the beginning of the project and support you during the project.

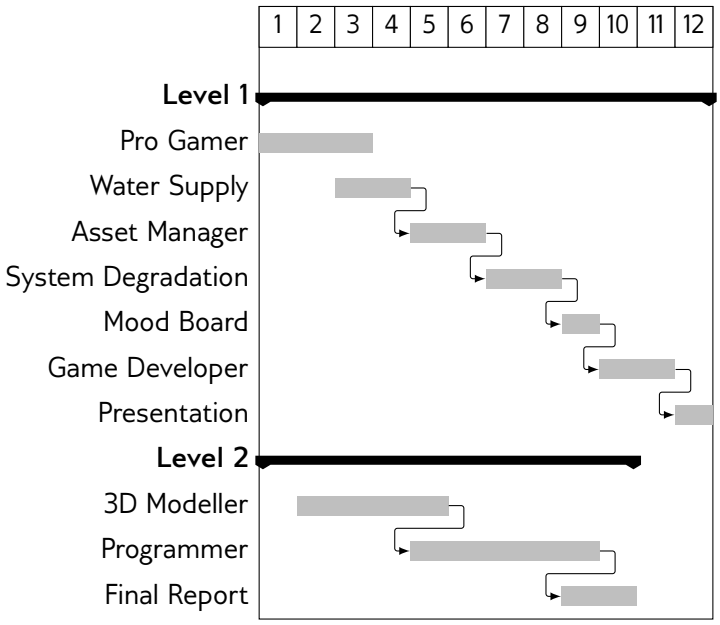

Figure 2: Gantt chart of level 1 and level 2.

3 Badges

In level 1, you can gain nine badges.

3.1 Pro Gamer

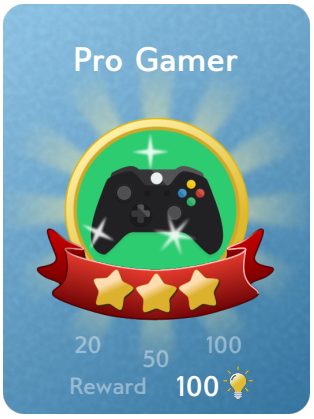

Figure 3: Pro Gamer

To create an excellent game, you need to know the subject matter. That's why you'll get to grips with several Infrastructure and City Builder games by playing them.

- ⋆ Your task is to find and play three (3) Infrastructure Management and City Builder games. You are free to choose the game platform (e.g. PC, PS4, IOS, Android, etc.). Please note that there are also excellent open-source and free-to-play games that are worth playing. For each game, write a summary of 250 to 300 words maximum, covering the following aspects, among others: what is the concept, how is the game design, what are killer features of the game, what is the game loop, what are magic moments, what are game features that fit your project, etc. For each game, include two (2) in-game screenshots that best describe the game.
- ⋆⋆ In addition to the above, choose one (1) essential game asset for each game and describe it in detail with 100 words maximum. What is its function, how is it integrated into the game, what animations take place, what different states can such an object take, what are the most essential elements, how can the player interact with this asset, change it, etc. For each game asset, include one (1) in-game screenshots that best describe the asset.
- ⋆⋆⋆ In addition to the above, play one (1) additional game and analyses one (1) essential game asset for the additional game. Attach the corresponding images.

Figure 4: Water Supply

3.2 Water Supply

In this infrastructure management game, the player has to manage a water supply system, where he has to provide sufficient quality and quantity of freshwater to his customers. To set up a realistic water supply network, you need to know more about the individual parts of the system.

- ⋆ Your task is to find six (6) different components (assets) of a water supply system. Describe the function for each asset with less than 50 words and

find one (1) representative image for each asset.

⋆⋆ In addition to the above, find for each of the six (6) identified assets in ⋆ one (1) textbook, scientific paper or technical report, which gives more detailed information on the asset and/or its properties. (A specified source (e.g. textbook or paper) can only be used once, i.e. even if the source mentioned multiple components, it could only be associated with one component from ⋆)

⋆⋆⋆ In addition to the above, find four (4) additional components and corresponding sources (text books or scientific papers).

3.3 Asset Manager

Figure 5: Asset Manager

In the infrastructure management game, you are responsible for developing and implementing one specific game asset, which your supervisor will give. You will be the lead developer and hence should know as much as possible about your asset. Among others, you should ask yourself questions such as:

1. What is there purpose of the asset in the water supply network?
2. What is the functionality of the asset, how does it work?
3. What is the input to the asset?
4. What is the output of the asset?
5. How can the performance of the asset be measured?
6. What are the estimated costs for new construction/ maintenance/ reconstruction?
7. What is the typical size?
8. What is the typical service life
9. What are the sub-systems of the assets?
10. Who usually is managing such assets?

⋆ Answer the 10 questions above for your own asset. Do not use more than 50 words per answer. Add the source of your information, e.g. homepage, book or paper you got the information for your answer.

⋆⋆ In addition to the above, find ten (10) additional questions you would like to ask an industry expert regarding your game asset.

⋆⋆⋆ In addition to the above, also provide answers to your proposed questions as well as the link to the sources).

3.4 System Degradation

Figure 6: System Degradation

A key component of the infrastructure management game is the degradation of the system; i.e. over time, the performance reduces and in the worst case, the asset will break down and causes severe problems to the managers. The player will have to identify the failing components and plan prevention measures to avoid such situations in the first place. Among others, you should ask yourself questions such as:

1. How does the asset degrade?
2. What is a typical failure?
3. How can the failure be fixed?

4. How much does it cost to repair such a failure?
5. Are there any signs of a possible failure (e.g. rust)
6. What is a good model for such a failure?

$\star$ Find two (2) common failures of your asset and answer the questions above for each failure with less than 200 words. Provide links to the sources of your information (e.g. technical reports, homepages, papers, textbooks). Find two (2) pictures for each of the considered failures.

$\star\star$ In addition to the above, think about one (1) failure discussed in $\star$ which you would like to implement into the game. With less than 300 words, describe why this would be interesting for the player, how this could be implemented, challenges for the implementation, how potential animation would look like, and any other thing you would consider for the asset.

$\star\star\star$ In addition to the above, find a mathematical model which describes the degradation process and the failure of your asset. I.d. this model should be able to be implemented in the game to give the player a realistic representation of the real world.

Figure 7: Mood Board

3.5 Mood Board

Game designers use mood boards to illustrate the style they wish to pursue visually. A mood board is a type of visual presentation or 'collage' consisting of images, text, and samples of objects in a composition.

- ⋆ Create a mood board for your game asset with at least five (5) images in a software of your choice (e.g. Inkscape). Your mood board can be A4 or A3 in size. Upload the final mood board to overleaf as a pdf file.
- ⋆⋆ In addition to the above, create an art style guide used to communicate to the artists and animators what the game should look like and how to achieve that goal. This can include colour schemes, font and sounds collections.
- ⋆⋆⋆ In addition to the above, develop your own concept art piece of your game asset to convey your idea for the use the game before it is put into the final product. Concept art is not only used to develop the work, but also to show the project's progress to others.

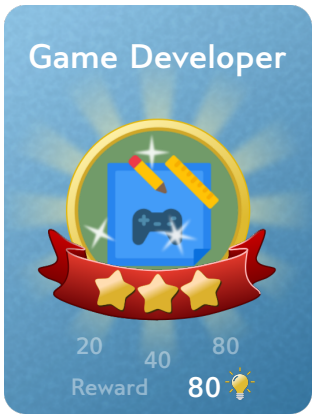

Figure 8: Game Developer

3.6 Game Developer

Now all the information about the functionality and potential failures of your assets are collected. Furthermore, visuals and concept art gives the first impressions of your final asset. Since game development is a team effort, you should share your work with your colleagues.

Therefore, prepare a one (1) page A4 document which summarizes your asset. Try to include enough information about your vision without overwhelming the viewer. Information about your asset's overall look and feel, the story and characteristics, and some gameplay features, along with an executive summary of your asset. Be as creative as possible; there is no word limit.

You get a reward of 50 XP if you hand in your document on time.

Your peers will give the stars for this batch in a voting process. I.e. each of you can cast a vote for the best document.

- ⋆ the two persons with the least votes
- ⋆⋆ the two persons in between
- ⋆⋆⋆ the two persons with the most votes

An additional 50 XP can be rewarded from the supervisor.

Figure 9: Presentation

3.7 Presentation

An important skill of any game developer is to communicate your ideas. In the midterm presentation you get the chance to present your work to your peers, discuss and get feedback.

You get a reward of 50 XP if you hand in your presentation on time.

A good presentation incudes:

1. Should be clearly presented and well explained. Questions should be answered competent.
2. Visuals should be understandable and in high quality.
3. The presentations should be finished within the given time limit.

- ⋆ One (1) of the points above is fulfilled
- ⋆⋆ Two (2) of the points above are fulfilled
- ⋆⋆⋆ Three (3) of the points above are fulfilled

An additional 50 XP can be rewarded from the supervisor.

Figure 10: Feedback

3.8 Feedback

Receiving feedback is essential, but also giving constructive feedback should be learned. As an active member of the team, you should provide valuable feedback to your peers.

- ⋆ Rank the Game Asset document of your peers based on your preferences. Provide for each of your peers three (3) bullet points you liked on their documents and three (3) bullet points you think there is potential for improvement. This ranking will be used to determine the starts in batch Game Developer.
- ⋆⋆ In addition to the above, give written feedback up to 50 words to each of the five (5) presentations given by your peers. Highlight the strength of their presentations and suggest parts they could improve in the next presentations. Please be polite; we all want to improve.
- ⋆⋆⋆ In addition to the above, write comprehensive feedback on two (2) game developer documents from your peers. Highlight the strength and share your ideas of extension and possible improvements. Mention challenges you might expect by the implementation and give suggestions on how to mitigate these challenges. Share your thoughts with a maximum of 300 words. The supervisor will do the allocation of the documents.

Figure 11: Social Media

3.9 Social Media

Public engagement is vital for a successful game but also for you to share and show your skills. Nowadays, social media is a great tool to share ongoing work with a broader audience.

- ⋆ Post four (4) messages regarding your project and the progress of a social media platform of your choice. Add a screenshot of the post to the overleaf document. It's recommended to have some time between the different posts to show some progress.
- ⋆⋆ In addition to the above, write a short blog post with a minimum of 250 words about your project.
- ⋆⋆⋆ In addition to the above, create a short video, i.e. about your progress, work, ideas, projects, tools, etc.

If you do not have a social media account or you do not want to share this project on your private one, please create an alias account or provide the potential text in the overleaf document.

Figure 12: 3D Modeller

3.10 3D Modeller

The aim is to create a 3D image of your asset in a 3D software of your choice. The mood board, the style guide and your concept drawing should help you do this.

- ⋆ Create a 3d model for your asset. The model should capture the asset in a working state (e.g. no damage). The level of detail should be sufficiently high such that a layperson can identify the asset clearly. Add textures and lighting to your scene. The final asset should be rendered as an isometric image from 4 different sites.
- ⋆⋆ Create a 3d model for your damaged asset as identified in the badge *System Degradation*. The damage should be clearly visible. Use textures and lighting to create an isometric image that can later be used in the game.
- ⋆⋆⋆ Create an animation for your asset. Either in its working condition, after the damage occurred or the transition from a working to a damaged asset. This can be either i) a "smooth" animation, e.g. using animation tools in blender or similar software tools, or ii) several key-frames showing the asset in certain deterioration stages.

The XP points shown represent the number of points that can be achieved by meeting the minimum requirements. Based on the quality of the provided work and the contribution of your own ideas, up to 30 XP per star can be awarded additionally.

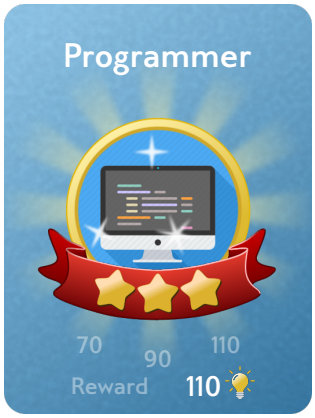

Figure 13: Programmer

3.11 Programmer

The final step is to bring everything together in the game engine. For this project, the Godot game engine will be used. An open-source engine with a programming interface similar to python (gd script).

- ⋆ Create an isometric game board, where your asset can be visualized. Create a UI with at least two buttons for building and operating your assets. If the building mode is active, the player should be able 1) to place the asset on the game board via mouse control (e.g. click at tile and place asset); 2) to remove the asset by clicking on an existing asset, (bonus) change the orientation via keyboard inputs (e.g. left or right arrow to rotate object). In the operating mode, the play should be able to click on the asset and get some operational conditions based on your identified properties.
- ⋆⋆ Create a time variable that represents the ageing of the infrastructure. Implement a (your) simple degradation model where the asset changes after a certain playtime to a worse condition state (damaged asset). Update the information in the operating mode.
- ⋆⋆⋆ Add a third mode for maintaining the asset. If the player is in this mode, he should be able to repair broken assets when clicking on them. At least two different options for the repair should be provided. Maintenance action should take some time to be finished and should cost resources.

The XP points shown represent the number of points that can be achieved by meeting the minimum requirements. Based on the quality of the provided work and the contribution of your own ideas, up to 30 XP per star can be awarded additionally.

Figure 14: Final Report

3.12 Final Asset Report

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3.13 Bonus Points