**“Tower Defense – Game Proposal”**

November, 2015

**Table of Contents**

[1 Introduction 5](#_Toc436214753)

[1.1 Project Vision 5](#_Toc436214754)

[1.2 Target Audience 5](#_Toc436214755)

[2 Detailed Game Description 5](#_Toc436214756)

[2.1 Concept Outline 5](#_Toc436214757)

[2.2 Advantages of Tower Defense 6](#_Toc436214758)

[2.3 Objective of the game 6](#_Toc436214759)

[2.4 Gameplay Mechanics 6](#_Toc436214760)

[2.4.1 Resources 6](#_Toc436214761)

[2.4.2 Quantitative Scoring System 7](#_Toc436214762)

[2.4.3 City Sewer System 7](#_Toc436214763)

[2.4.4 Turbine customization 7](#_Toc436214764)

[2.4.5 Wind turbine Placement 8](#_Toc436214765)

[2.4.6 Turbine 🡪 Grid 🡪 Water Pump connections 8](#_Toc436214766)

[2.4.7 Turbine maintenance 8](#_Toc436214767)

[2.4.8 Environmental events 8](#_Toc436214768)

[2.4.9 Nacelle turbine orientation 9](#_Toc436214769)

[2.4.10 Win/Fail state feedback 9](#_Toc436214770)

[2.4.11 Leaderboard 9](#_Toc436214771)

[2.4.12 Chapter selection menu 9](#_Toc436214772)

[2.5 Which are the core challenges of the gameplay? 9](#_Toc436214773)

[2.6 Description of events planning to be used 10](#_Toc436214774)

[2.7 What is the interactive structure that is being used 10](#_Toc436214775)

[2.7.1 Introduction to the game - Tutorial 10](#_Toc436214776)

[2.7.2 Introduction to the placement of turbines and grid integration 10](#_Toc436214777)

[2.7.3 Wind turbine customization 11](#_Toc436214778)

[2.7.4 Wind turbine orientation 11](#_Toc436214779)

[2.8 How and why is a leaderboard implemented? 11](#_Toc436214780)

[2.9 How difficult is the game? 11](#_Toc436214781)

[3 Product Design Aspects 12](#_Toc436214782)

[3.1 Technology Used 12](#_Toc436214783)

[3.2 Interaction sounds and theme music 13](#_Toc436214784)

[3.3 On-Screen Interface 13](#_Toc436214785)

[4 Action plan 13](#_Toc436214786)

[5 Test plan 14](#_Toc436214787)

[Test Plan of the Wind Turbine Game 14](#_Toc436214788)

[5.1 Introduction 14](#_Toc436214789)

[5.2 Target Audience 14](#_Toc436214790)

[5.2.1 Features 14](#_Toc436214791)

[5.2.2 2.2 Specific Information of Test Participants 15](#_Toc436214792)

[5.3 Requirements Need to be Tested 15](#_Toc436214793)

[5.3.1 Learning Objectives 15](#_Toc436214794)

[5.3.2 Other requirements 15](#_Toc436214795)

[5.4 Testing Methods and Standards 15](#_Toc436214796)

[5.4.1 The First Major Test 15](#_Toc436214797)

[5.4.2 The Second Major Test 17](#_Toc436214798)

[5.4.3 The Final Major Test 18](#_Toc436214799)

[5.5 Testing Schedule 19](#_Toc436214800)

[5.6 Weekly Short Tests 20](#_Toc436214801)

# Introduction

This game is aimed at students following the Massive Open Online Course of Wind Energy of the TU Delft. The aim of the game is to help teach students about the basics of Wind Energy while remaining entertaining. The reason a game is created for this is to help retain more students than the usual low amount of students that manage to finish the course.

## Project Vision

The scope of the project is to introduce the players to the concepts of wind energy and allow them to experiment with different options whilst keeping them entertained.

The project goals are:

* Create a game that will motivate players to explore the field of wind energy.
* Through gameplay a player should feel intrigued to finish the game.
* Allow players to experiment with the different challenges of designing wind turbines
* The game should introduce the basic factors of wind turbines in such a way that they are clearly conceptualized by the player through the gameplay.

## Target Audience

The target audience is an educated audience that has around 30 minutes daily to spend on this game. The audience age ranges from late teens to retirement age.

# Detailed Game Description

## Concept Outline

The concept that is presented is a tower defense-type game where the objective is to beat various challenges by designing turbines, managing resources and intelligently placing wind turbines in key locations. The aim is to successfully pump up waves of water that threaten to flood a city, in order to complete the game goal. Player actions include maintaining the wind turbines and adapting them to changing conditions for the purpose of optimization. Depending on his performance, the player can achieve a ranking on the leaderboard, where he can compare his performance to other players.

The gaming system is resolved around building, heavily customizing wind turbines and connecting them to the grid in order to power up actuators, which in turn will pump units of water. The pumps draw power from the grid. For example, the power of a water pump is determined by the distance between the turbine and the pump, and the efficiency of the turbine design.

## Advantages of Tower Defense

To enumerate, the advantages of tower defense are:

* Easy to pick up
* Direct feedback
* Clear game goals
* Due to the simple structure of the concept, features are easily added to complement additional goals
* Tower defense games have the important feature that players can provide slightly different solutions to the same problem
* Can pause the game to re-structure your strategy
* Clear overview of the entire game area because of the top-down perspective

## Objective of the game

The objective of the game is to prevent a city from flooding. A city is threatened by an overflowing river and the player has to get rid of the excess water by pumping it out of the river. In order to do this, he has to connect pumps to the electrical grid. The power on the grid is generated by wind turbines which the player has to design and place in order to efficiently power up his pumps. The wind speed depends on the elevation of the terrain, this means that the proper placement of turbines is a core aspect of the game. The power is distributed from the turbines to the pumps and the amount of power a pump receives determines its performance.

## Gameplay Mechanics

### Resources

The main currency in this game is Turbine Coins (TC for short). The currency will be used in most aspects of the game in order to resemble real life situations where everything has a value/cost. It provides a level of restriction that requires the player to manage his resources wisely, depending on his strategy. Poor management of TCs can lead to a quick failure of the game.

The TCs are earned when water is successfully pumped by the water pumps. The amount of TCs earned are proportional to the percentage of the city that has been flooded. For example if pumping one unit of water provides 200 TCs, a flooding of 25% will reduce the income to 190 TCs. This makes sure that in the end the players that do well for the most part of the game have a higher total cumulative income than players that flood their city right from the start.

### Quantitative Scoring System

The final score of the player is determined by the amount of TCs available and the buyback value of all the player’s assets, as well as how many design attempts he made. A scoring system is used to reflect the performance of the player throughout each chapter. This score reflects the efficiency and the choices of the player through the customization and placement of wind turbines. The final score will be published to the leaderboard.

### City Sewer System

In case of partial flooding of the city, the sewer system will automatically start working to reduce the water levels in the city. This will be a time based mechanic that will reduce the percentage of flooding by a set amount overtime. This system is in place to make sure that players are not punished for the entirety of the game for a single mistake they made. By reducing the amount of flooding in the city the player’s income will gradually go up again.

### Turbine customization

The wind turbine customization is a core element of the game where wind turbines can be designed using a few parameters. These parameters help the player learn about wind turbine rotor blades and the relevance of the **number of blades** on wind turbine efficiency. The player can also select and learn about the different **types of nacelles** that are used on wind turbines. He can learn about the different **types of powertrains** used to convert the wind energy into electrical energy and can see the impact of the **wind turbine height** on the construction costs and the wind turbine energy output. Finally, the player can **dimension the wind turbine blades** to learn about the effect of the size of the blades on the overall wind turbine output.

Throughout the game, a player can design new wind turbines based on these parameters. To start a design, a player selects one of the preset sizes of turbines. Then he can select his choices regarding the components of the turbine. To see the potential performance of his design, the player presses the ‘calculate’ button, which will cost him some money. The price of this calculation goes up for each modification of this design. This is to discourage trial and error exploitation of the feedback.

### Wind turbine Placement

The wind turbine placement is a core game mechanic. Each location has a different elevation which affects the efficiency of the wind turbine. The higher a wind turbine is placed the higher the output of the wind turbine will be. On the opposite, wind turbines that are placed on low ground will have a lower output. Furthermore, the construction cost of a wind turbine will rise with elevations.

### Turbine 🡪 Grid 🡪 Water Pump connections

The turbines will be connected to the water pumps through an electrical grid connection. This grid connection will be used to distribute electricity to the water pumps from the wind turbines through transformers. Wind turbine can only be connected to transformers, similarly for pumps. Furthermore, all transformers can be connected to each other, forming a grid. The transformers have a limited capacity and evenly distribute the power to the connected pumps.

Additionally, there will a power loss incurred by the distanced that the power has to travel from the wind turbines to the pumps.

### Turbine maintenance

Every wind turbine wears out over time, this is based on durability level. When a durability reaches 0% the wind turbine needs to be repaired. This repair takes a certain amount of “long” time. Additionally, the wind turbines can be repaired at any time along the game for a fixed fee. This extra fee will also speed up the repair compared to the “long” repair. At 0% durability the wind turbine will automatically shut down and initiate maintenance for free for the “long” repair. This maintenance can be sped up through a fee.

### Environmental events

Environmental events are introduced in the game to challenge the player. These environmental events can:

* Damage the wind turbine’s durability
* Speed up the water units
* Speed up the interval between the changes of wind direction

These events will be announced to the player shortly before they happen, so they can take precautions.

### Nacelle turbine orientation

The orientation of the nacelle on top of the wind turbines can be adjusted to accommodate for the changes in the wind direction by the player. This shall affect the power output of the wind turbines.

### Win/Fail state feedback

When the game ends, the game gives feedback on the performance of the player. There will be hints on areas where the player could improve. This will help the player understand what learning objective he has not fully mastered. The final score a player achieved is compared to the maximum score possible for a specific scenario. If a player’s score passed a number of threshold values, this will be reflected in the number of stars. For example, >90% of the maximum gives a 3 star rating, >60% gives a 2 star rating and >30% gives a 1 star rating. This affects the replay value because the player can directly see his own improvement when he replays a chapter.

Additionally, players will receive specific feedback on different aspects of the game: Wind turbine positioning, wind turbine customization and wind turbine operation. This feedback is a 3 star scoring system which is based on comparing the optimum performance player can attain to his actual performance. The same star system is used here.

### Leaderboard

The players is scored on a leaderboard on a chapter basis. The way the player score is calculated is mentioned earlier in the report. This leaderboard ranks all players for each chapter, allowing the players to see how much better they could have done and to introduce a sense of competition between the different players.

### Chapter selection menu

From the main menu, the player can start different chapters. New chapters are unlocked after successfully completing earlier chapters. Players are gradually introduced to new game mechanics, so the complexity of the chapters goes up as the player progresses.

## Which are the core challenges of the gameplay?

The game focuses on:

* Decision making speed
* Turbine, grid, pump placement precision
* Efficient turbine design
* Optimizing the turbines placement based on the level design conditions
* Turning the turbines to accommodate changing wind directions (for turbines that are able to do that)
* Efficiently integrating all assets in the electrical grid.
* Design efficient turbines without trial and error.

## Description of events planning to be used

* The wind direction will change from time to time. The player will be required to rotate his turbines accordingly to accommodate for that change. Optimizing the direction of the turbines will maximize the power output of the wind turbines. This adds an active element in the gameplay part, providing a challenge and reward while teaching the player about the different effects on the performance of turbines.
* There will be an event system introduced, which will incorporate events such as an earthquake or a sudden flood and the player will have to react to these events with an optimization of the respective mechanic affected. For example, in case of an earthquake the maintenance level of the wind turbines will decrease, suddenly the player will have to invest his efforts into repairing the wind turbines to keep the pumps working. This adds a level of active strategy and unexpectedness because the player will have to constantly keep in mind the possibility that an event might happen, like in real life.

## What is the interactive structure that is being used

The game will have a chapter system which gradually introduces new concepts in order to achieve the desired learning curve.

### Introduction to the game - Tutorial

The first chapter will be the introduction to the game. This chapter shall present the concept of tower defense to the player with the use of only one wind turbine. During this chapter, the player is to understand that he has to save the city placed at the end of the river by removing the water from an overflowing riverbed. This introduction to the game limits the number of wind turbines the player can place on the map. In this chapter, only one wind turbine is allowed.

The player is then only allowed to place this wind turbine along the banks of the flooded river. This windmill is used to pump the water out of the river to save the city.

### Introduction to the placement of turbines and grid integration

The second chapter of the game is the first chapter that presents the mechanics of wind turbines powering pumps to pump out water. Within this chapter, the player will learn where to place wind turbines for maximum efficiency with respect to height and construction costs. The player will also learn about grid integration through the placement of transformers and pumps. Finally the player will learn about power loss through the transportation of electricity over certain distances. The wind turbine to be used during this game is a default wind turbine that cannot be modified by the player in any way.

### Wind turbine customization

The third chapter of the game will introduce the customization part of the game. As mentioned earlier, the customization of wind turbines allows the player to design their own wind turbines. The player is then meant to build the most efficient wind turbine cost wise and power output wise.

### Wind turbine orientation

The fourth chapter of the game introduces the player to wind turbine orientation and to wind directions. In this chapter, the player becomes more active and is able to rotate the nacelle at the top of the wind turbine to make best use of the wind. The player therefore has to learn about the wind direction and must be able to, as the game is playing, orientate his wind turbine to maximize his energy output.

## How and why is a leaderboard implemented?

Competition is a common system used in games for the purpose of challenging each other and give players an incentive to improve. In this respect, players are encouraged to figure out ways to overcome the limitations of their own designs. The leaderboard can be seen from the start menu and right after finishing a game.

## How difficult is the game?

The game is required to be easy in the introductory part, and then it would scale based on the learning objectives.

In any case, that a player would find himself lost or stuck, help will be available through an educational system, which will provide information on different topics.

The game is designed in such a way, that the difficulty of the gameplay is influenced by two factors. Them being:

1. The complexity of the level design, meaning difficulties in power distribution, amount of water units that the player has to pump, the flow rate and the weather conditions.
2. The amount of options a player has in respect to designing the turbines to be sufficiently efficient.

To properly create a strategy for every level design, the user is allowed to pause the game, in order to create new designs, place new turbines, and redistribute power.

# Product Design Aspects

## Technology Used

Taking information from the commissioners about the browsers that the target audience use:

* Chrome 50%
* Firefox  14%
* Safari 10%
* IE 5%
* Edge 1%
* Opera 1%

It can be seen from the statistics which browsers the MOOC users utilize. Approximately 85% of people in our target audience are using web browsers through desktops.

We chose HTML5 as the base of our game instead of flash because HTML5 game can be played not only on PC, Mac and devices based on Android or iOS, but also on Firefox OS and all the others that support HTML5 standard. This significantly increases number of potential customers. What’s more beyond HTML5, WebGL is needed to draw graphics that can be accelerated by GPU on the canvas element of HTML5.

In our game, we aim to develop an interesting tower defense game that enable the players to build customized wind turbines and try the physics and mechanism out during the game. Consequently, various engines for physics, animations, particle systems are needed in the implementation of all this functions in our web game. Considering team size, workload and the game scale, we choose to use Unity as our game engine, which allow us to handle the physics simulation, animation control, user interface creation and audio management in a single game system. The latest Unity 5 can successfully export the game onto the web platform supported by HTML5 and WebGL. What’s more, Unity 5 is useful for the future multi-platform development.

## Interaction sounds and theme music

We will use audio cues to give the user feedback about his actions and the state of the game and additionally we will have music to create an engaging atmosphere.

## On-Screen Interface

The user interface shouldn’t interrupt the flow of the game experience that a user will be having. If any, it should promote it. Unity 5 provides a separate 2D user interface system that allows the developers to build 2D user interface without interacting the 3D effect of the game play.

# Action plan

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Action | Time Period | Resources | Deliverables | Person Responsible | Requirements |
| 1 | Kick-off | 9.11-13.11 | Commissioner Meetings & Team Discussions | Game Synopsis, {team,action,test} plans | Whole Team |  |
| 2 | Game Design | 16.11-20.11 | Meeting Content，Course Content | Game Design Document | Papamanolis | 1 |
| 3 | Initial Game Specification | 23.11-27.11 | Game design document, course content | Draft of all the game features we will implement | TBD | 1, 2 |
| 4 | Technology Testing & Development | 23.11-30.11 | Game design document, Course Content |  | Whole Team | 2, 3 |
| 5 | Gameplay Structure | 23.11-4.12 | Game Design Document, Course Content, Tutorials, Team Discussions |  | Whole Team | 2, 3, 4 |
| 6 | First playable | 23.11-4.12 | Tutorials | First playable | Whole Team | 4, 5 |
| 7 | Presentation | 7.12-9.12 | Game design document, First playable | Presentation | TBD | 2, 3, 4, 5, 6 |
| 8 | Integration with Audio | 7.12-18.12 |  |  | Baksteen | 2, 3, 6 |
| 9 | Beta | 7.12-18.12 |  | Game prototype | Whole team | 2, 3, 6, 7, 8 |
| 10 | Bug Testing/Test Results | 4.1-15.1 |  | Release, Project Documentation | Whole team | 2, 3, 6, 9 |
| 11 | Wrap up | 4.1-19.1 | Game design document, | Presentation of final product | TBD | 2, 3, 9, 10 |

# Test plan

Test Plan of the Wind Turbine Game

## Introduction

This document is a user testing plan for the educational wind turbine game. These tests are used to get the feedback from the target audience and test whether it meets the requirements, then helps to improve the game.

It contains the following items:

* Give the information of the target audience of this game.
* List the requirements required by the commissioner.
* The time of the installation of the game to the target users’ platforms.
* The arrangement of instructing the participant to understand how to play this game.
* The schedule of letting target users participate in the testing.

## Target Audience

### Features

The target audience is defined by the commissioner, which has the following features:

* Educated (With at least a Bachelor’s degree).
* Doesn’t necessarily have background knowledge of wind turbines.
* Has less than thirty minutes of absent minded time.
* Age range from late teens to retirees.
* Has no trouble with English reading.

### 2.2 Specific Information of Test Participants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Age | Gender | Job | Educational Background |
|  |  |  |  |  |

% The specific information of every participant will be generated later.

## Requirements Need to be Tested

### Learning Objectives

Since this game is built to help the players learn the knowledge of wind turbines better, it is necessary to achieve all these learning objectives:

* Students are able to analyze locations for the best placement of wind turbines.
* The student reflects on what factors are important in the cost of wind energy.
* The student can understand the energy conversion process
* The student can integrate different components of a drive train in one system.

### Other requirements

Besides the learning objectives, these features also need to be tested:

* Game should give an intuition of real life physics
* Game should be entertaining/fun/addictive.
* Game should be open-ended (after the end of the learning curve, the player still has the possibility to play in “full” mode or other modes).
* Game should give useful hints to help players to know the learning objectives better.

## Testing Methods and Standards

### The First Major Test

Participants: we want at least 10 target users can participate in this test and all of them should give a effective feedback.

Date: the first major test should be held when the first playable version is released, which is scheduled for the 4th of December.

Location: since this is an online game, we don’t need to let all participants gather at a same place.

Duration: 15 minutes per map.

|  |  |  |
| --- | --- | --- |
| Target Requirement | Methods | Expected Results |
| Game should be entertaining/ fun/ addictive. | * Ask every participant what they enjoyed about the game, and what annoyed them. | * Graphics need improvement, tweaking the difficulty, gameplay feedback is unclear. |
| All learning objectives. | * After the first play, give the players a questionnaire with several questions related to these learning objectives. Most of them are multiple choice questions and provided by the lead tester. * After the playtest, the participants are asked to solve some more difficult questions. Also, these questions are provided by the commissioner. | * More than a half of participants can solve these basic questions of wind turbines. * All participants can answer 70% of these questions easily. |
| Game should be physics based. | * Some of the participants are chosen from the commissioners. They will give an analysis after this test, which reflects this point. | * All participated commissioners think this game is physics based. |
| Game should give useful hints to help players to know the learning objectives better. | * Questionnaires about the hints will be given to participants. | * Most participants think hints are useful. Few think hints are annoying. |

### The Second Major Test

Participants: we want at least 10 target users to participate in this test and all of them should give feedback. 5 of them have participated in the first major test, 5 of them never experienced this game before.

Date: the first major test should be held when the beta version of this game is released, which is scheduled for 18th of December.

Location: since this is an online game, we don’t need to let all participants gather at the same place.

Duration: As long as they want.

|  |  |  |
| --- | --- | --- |
| Target Requirement | Methods | Expected Results |
| Game should be entertaining/ fun/ addictive. | * We don’t tell the participants the specific time they need to experience the game every day. The participants lets us know how long they played the game. | * More than 7 participants spend at least 10 minutes on this game. |
| All learning objectives. | * The participants are required to solve some questions about wind turbines. These questions are provided by the commissioner. | * All participants can answer 70% of these questions. The average performance of those who never experienced the first version of this game is worse than the average performance of the participants in the first major test. |
| Game should be physics based. | * Some of the participants are chosen from the commissioners. They will give an analysis after this test, which reflects this point. | * All participated commissioners think this game is physics based. |
| Game should give useful hints to help players to know the learning objectives better. | * Questionnaires about the hints will be given to participants. | * Most participants think hints are useful. Few think hints are annoying. |

### The Final Major Test

Participants: we want at least 10 target users to participate in this test and all of them should give feedback.

Date: the first major test should be held when the final version of this game is released, which is scheduled at the 15th of January.

Location: since this is an online game, we don’t need to let all participants gather at a same place.

Duration: As long as they want.

|  |  |  |
| --- | --- | --- |
| Target Requirement | Methods | Expected Results |
| Game should be entertaining/ fun/ addictive. | * We don’t tell the participants the specific time they need to experience the game every day. The participants lets us know how long they played the game. | * More than 7 participants spend at least 10 minutes on this game every day. |
| All learning objectives. | * And these days, all participants are asked to solve some questions about wind turbines. These questions are provided by the commissioner. | * The participants who play the game these days can answer 70% of these questions easily. And the average performance of the participants who have only watched the MOOC videos is worse than the average performance of the participants who have not only watched the MOOC videos but also experienced the game. |
| Game should be open-ended. | * - | * This online game is accessible to all participants every time. |
| Game should be physics based. | * Some of the participants are chosen from the commissioners. They will give an analysis after this test, which reflects this point. | * All participated commissioners think this game is physics based. |
| Game should give useful hints to help players to know the learning objectives better. | * Questionnaires about the hints will be given to participants. | * Most participants think hints are useful. Few think hints are annoying. |

## Testing Schedule

|  |  |
| --- | --- |
| Test Activity | Time Period |
| Preparation for the First Test | 25.11 - 30.11 |
| First Major Test | 1.12 - 4.12 |
| Collect the Useful Information of the First Test | 4.12 |
| Analysis of the First Feedback | 4.12 - 5.12 |
| Preparation for the Second Test | 6.12 - 9.12 |
| Second Major Test | 15.12 - 20.12 |
| Collect the Useful Information of the Second Test | 20.12 |
| Analysis of the Second Feedback | 20.12 - 25.12 |
| Preparation for the third Test | 25.12 - 5.1 |
| Final Major Test | 9.1 - 14.1 |

## Weekly Short Tests

#### Week 1- Week 3

#### Test Plan

|  |  |  |  |
| --- | --- | --- | --- |
| Test Goals | Test Objects | Methods | Expected Results |
| The game is addicting. | Game design. | Build a questionnaire which contains the description of the mechanism of our current idea of the game with some abstract sketches about what the game will. Then send this questionnaire to some target players and let them answer questions about how they think about this idea. | Most participants think this kind of game will be interesting and they will be willing to play this game. |

#### Analysis

**% Analysis will be done after we get the feedback from previous test.**