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Abstract

Procedurally generated weather based on a number of conditions, such as climate and season, makes up this tool that allows for immersive world building through its dynamic nature.

TECHNICAL DESIGN DOCUMENT

Climate-Based Dynamic Weather System

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# Glossary

GPU – Graphics Processing Unit

CPU – Computer Processing Unit

PCG – Procedural Content Generation

EUW – Editor Utility Widget

# Introduction

The weather tool will create a weather system for the game on which it is used. It will create realistic weather by selecting features based on a number of settings that the layer can choose – most notably, climate, but also season and time of day.

# List of Features

* Wind movement
  + I will have a parameter for wind speed that will be generated by my algorithm, and a master material for the foliage used throughout the level. The parameter will be used in the master material with grass wind speed, which will affect the movement of the leaves and simulate wind
  + A maximum and minimum wind speed can be set in the editor
* Day/night cycle
  + Can be enabled/disabled in the editor
  + Will transition from a bright scene with a clear sky to a dark scene with a starry sky over time. The length of the cycle can be adjusted in the editor
  + The weather that is generated will be different depending on whether it is day or night
* Climates
  + The main factor of the PCG. There will be six climate presets, all with different kinds of weather that can be generated
* Clouds
  + Clouds of different shapes and colours will appear in the sky and move over time

# A notebook with writing on it AI-generated content may be incorrect.Planning

# Engine Requirements

The tool will be developed in Unreal Engine 5.4 but should be compatible with older versions of Unreal Engine 5.

# Logic and AI Requirements

To generate the weather

# Audio and Visual Requirements

Niagara systems will be used to create weather features, such as rain and snow. These will have parameters that can be affected by my program.

# User Setup Guide

How to setup the game engine to accommodate the tool process. All sections are a user setup guide and how to use them.

# Minimum System Requirements

Give this some thought! This is for the engine!

# UI

The UI of the tool needs to be simple as to what each setting is, and it needs to be easy for the user to be able to select the value they want. For the user’s inputs, the UI will include combo boxes (drop-down menus), spin boxes (sliders with type-in capability for choosing a value within a range), and checkboxes. In order to keep to the weather theme, it will be designed similarly to a televised weather broadcast, with a landscape picture showing a cloudy sky as the background. The button to press to generate the weather will be large and obvious, so that there is no confusion as to what has to be done in order to get the system working.

# Platform Specifications

The tool requires relatively high processing power and graphical capabilities, so is more aimed at being used on projects being created for PC games or powerful home consoles.

# Asset Pipeline

How to bring in assets and where to they go.

# Material Pipeline

Shader systems, etc.

* Tool System engine user manual considerations.
* Potential upgrades/Future developments.

# Inspiration

As a fan of open-world games, I have always been interested in the small aspects that help tp make a world feel immersive. In a previous project, I began developing a game in an open-world style, and, while I was able to create quite an involved scene through landscaping and decorating, I realised that something that would have made it feel much more “alive” would have been weather that changes throughout runtime. Games in franchises such as *The Sims* and *Animal Crossing* include wide landscapes with changing weather, and although it is not a core feature of the gameplay, it creates a more natural atmosphere, and subconsciously keeps the player’s interest and prevents the game from becoming stale.

# Research

#### Games

In addition to the previously mentioned games of *Animal Crossing and The Sims*, I also looked at the weather present in *SimCity*. As the day goes on, rain can be seen forming across the map, alongside wind, and there is a day/night cycle, with the two stages of equal duration. *SimCity* was my main inspiration for my tool, as its weather does not have any impact on gameplay, whereas there are small elements within *Animal Crossing* and *The Sims* that work differently depending on the current weather. I wanted what I produced for this project to be completely for aesthetic purposes: to help with the game’s environment, but not impact the actual gameplay that design teams separate from myself would be implementing alongside it.

#### Weather

I hoped to make my tool align with the weather of the real-world. To ensure this would be the case, I looked at multiple data sources studying the weather tendencies in five world climate types: arid, mediterranean, polar, temperate and tropical. I collated a large amount of information and created a spreadsheet to keep track of the intensity of different weather features for each climate and for each season.

# Purpose of Use

The weather tool is something that can be used by designers to speed up development time. If they want a weather system in their game in order to add more detail to their scenes, they can add the tool to their project, select what kind of weather they will need, and, once placing a weather volume in their scene, it will work and be present instantly. If the weather is not an integral part of gameplay, developing a system would most likely be of lowest priority, and could be potentially overlooked or left behind if there turned out to not be enough time or resources to work on it. Instances like this are where my tool would be perfect, as it would take a very short amount of time to add and setup the tool compared to starting developing a system from scratch.

# Diagrams

A diagram of a computer program

AI-generated content may be incorrect.

A diagram of a flowchart

AI-generated content may be incorrect.

A diagram of a flowchart

AI-generated content may be incorrect.A diagram of a graph

AI-generated content may be incorrect.

A diagram of a process

AI-generated content may be incorrect.

A diagram of a process

AI-generated content may be incorrect.

A diagram of a weather forecast

AI-generated content may be incorrect.

# Horizontal Prototype

Time and date of post.

Link to post.

**On the post:**

It is ideal to have this as a single but very detailed post on the forum.

Include:

* Have the title “Horizontal Prototype”.
* Visual inspiration
* Technical inspiration
* UI inspiration
* Output inspiration
* Anything else you feel is beneficial to the way the system should look and its outputs.
* Images
* Videos

# Vertical Prototype

Time and date of post.

Link to post.

**On the post:**

It is ideal to have this as a single but very detailed post on the forum.

Include:

* Have the title “Vertical Prototype”.
* System summary
* Identify core system output/function achieved in the Vertical Prototype
* Show iterations of the system within the vertical prototype phase (if any. May only be one)
* Show the output at this stage.
* Images
* Video(s)
* Test plan in the primitive format (incomplete or partially complete)

# Polished System

Time and date of post.

Link to post.

(Submit zip file separate)

**On the post:**

It is ideal to have this as a single but very detailed post on the forum.

Include:

* Have the title “Polished System”
* System User Manual
* Show system output to a polished level.
* Show iterations of system output to a polished level.
* Show the system requirements for your Tool system.
* State the usage of the system and how it fits into the development cycle.
* Complete test plan.
* Images
* Videos

# Test Plan

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test Number** | **Climate + Season** | **Test** | **Expected Behaviour** | **Actual Behaviour** | **Time** | **Success?** | **Fix** |
| 1 | Temperate, Winter | In weather types with both snow and rain possible, the two should not occur simultaneously | If rain is present, snow should not be present, and vice versa | No weather spawned | 14/02/2025 13:41 | No | Fix in code with new conditions based on its data table information |
| 2 | Temperate, Winter | Weather spawning | Weather should spawn based on moderate-high rain and snow, and moderate-low wind | Wind too high, unable to determine | 14/02/2025 13:53 | Indeterminate |  |
| 3 | Temperate, Autumn | Wind should generate with intensity based on data table | Low rain should be affected by low wind | Low rain, low wind | 14/02/2025 14:17 | Yes |  |
| 4 | Polar, Winter | Transitioning between weather states, including random no rain | It should stop raining rarely | Transitions, but very abruptly | 14/02/2025 14:22 | Somewhat |  |
| 5 | Tropical, Spring | Wind should generate with intensity based on data table | High rain should be affected by high wind | No wind change | 14/02/2025 14:34 | No | Setting wrong data in struct; changed variable in code |
| 6 | Tropical, Spring | Wind should generate with intensity based on data table | High rain should be affected by high wind | High, rain, high wind | 14/02/2025 14:35 | Yes |  |
| 7 | Temperate, Winter | Wind should generate with intensity based on data table | Moderate-high rain should be affected by moderate-low wind | Wind far too high | 14/02/2025 14:52 | No | Significantly decreased multiplier in wind calculations |
| 8 | Temperate, Winter | Wind should generate with intensity based on data table | Moderate-high rain should be affected by moderate-low wind | M-H rain, M-L wind | 14/02/2025 15:02 | Yes |  |
| 9 | Temperate, Winter | In weather types with both snow and rain possible, the two should not occur simultaneously | If rain is present, snow should not be present, and vice versa | Snow never spawns | 14/02/2025 15:06 | Somewhat | Rewrite snow calculations |
| 10 | Temperate, Winter | In weather types with both snow and rain possible, the two should not occur simultaneously | If rain is present, snow should not be present, and vice versa | Snow and rain both spawn | 14/02/2025 15:11 | No | Adjust bool checks |
| 11 | Temperate, Winter | In weather types with both snow and rain possible, the two should not occur simultaneously | If rain is present, snow should not be present, and vice versa | Snow and rain do not spawn simultaneously | 14/02/2025 17:17 | Yes |  |
| 12 | Tropical, Spring | Scale weather amount with volume size | Rain spawn rate should be higher for large volume and lower for small | Particle count maxed out | 14/02/2025 17:50 | No | Adjust scaling calculation |
| 13 | Tropical, Spring | Scale weather amount with volume size | Rain spawn rate should be higher for large volume and lower for small | Particle count maxed out | 14/02/2025 17:52 | No | Adjust scaling calculation |
| 14 | Tropical, Spring | Scale weather amount with volume size | Rain spawn rate should be higher for large volume and lower for small | Not enough particles spawning | 14/02/2025 17:54 | No | Adjust scaling calculation |
| 15 | Tropical, Spring | Scale weather amount with volume size | Rain spawn rate should be higher for large volume and lower for small | Working, but more adjustment needed. Needs to scale better with very large volumes | 14/02/2025 18:00 | Somewhat | Adjust scaling calculation |
| 16 | Tropical, Spring | Scale weather amount with volume size | Rain spawn rate should be higher for large volume and lower for small | Working, but more adjustment needed. Needs to scale better with very large volumes | 15/02/2025 18:53 | Somewhat | Adjust scaling calculation with cube root |
| 17 | Tropical, Spring | Softening of transitions between weather states | Rain should become closer to the next value before actually transitioning | Transitions more softly, but now it will never reach zero | 15/02/2025 12:32 | Somewhat | Debug while loop; it isn't actually looping |
| 18 | Tropical, Spring | Softening of transitions between weather states | Rain should become closer to the next value before actually transitioning | Transitions more softly, but now it will never reach zero | 15/02/2025 12:43 | Somewhat | Try using tick |
| 19 | Tropical, Spring | Softening of transitions between weather states | Rain should become closer to the next value before actually transitioning | Transitions more softly, but now it will never reach zero | 15/02/2025 13:00 | Somewhat | Make function for calling timer |
| 20 | Tropical, Spring | Softening of transitions between weather states | Rain should become closer to the next value before actually transitioning | Transitions more softly and can still reach zero | 15/02/2025 13:13 | Yes |  |
| 21 | Temperate, Winter | Erraticism factor should affect rate of transition | Higher erraticism values should have faster transitions, lower should have slower | Transitioning too fast for both high values and low values | 15/02/2025 13:48 | No | Wasn't setting erraticism in struct from user input |
| 22 | Temperate, Winter | Erraticism factor should affect rate of transition | Higher erraticism values should have faster transitions, lower should have slower | Lower values are transitioning faster, higher are slower | 15/02/2025 13:57 | No | Change timer calculations |
| 23 | Temperate, Winter | Erraticism factor should affect rate of transition | Higher erraticism values should have faster transitions, lower should have slower | High values have fast transitions and low have slow, but softening time is too long | 15/02/2025 14:03 | Somewhat | Change timer calculations |
| 24 | Temperate, Winter | Softening of transitions between weather states | Softening time should be proportional to erraticism factor | Inverse of softening rate is being applied | 15/02/2025 14:16 | No | Change timer calculations |
| 25 | Temperate, Winter | Softening of transitions between weather states | Softening time should be proportional to erraticism factor | Softening is being called too soon because it is within the transition timer | 15/02/2025 15:25 | No | Create a timer manager |
| 26 | Temperate, Winter | Softening of transitions between weather states | Softening time should be proportional to erraticism factor | Program failed to build because of recursion causing stack overflow | 15/02/2025 14:37 | No | Create a softening manager |
| 27 | Temperate, Winter | Softening of transitions between weather states | Softening time should be proportional to erraticism factor | Program failed to build because of recursion causing stack overflow | 15/02/2025 14:51 | No | Create a delay |
| 28 | Temperate, Winter | Softening of transitions between weather states | Softening time should be proportional to erraticism factor | Transitions, but correct softening is inconsistent | 15/02/2025 15:17 | Somewhat | Soften calculation is getting incorrect elements from queue |
| 29 | Temperate, Winter | Softening of transitions between weather states | Spawn rate should soften to midpoint of current and next weather | Transitions, but correct softening is inconsistent | 15/02/2025 15:32 | Somewhat | Incrementing head of queue |
| 30 | Temperate, Winter | Softening of transitions between weather states | Spawn rate should soften to midpoint of current and next weather | Softening to midpoint with rate proportional to erraticism | 15/02/2025 15:41 | Yes |  |
| 31 | Mediterranean, Winter | Weather spawning | Low rain | Extremely high rain | 15/02/2025 15:44 | No | Weather is scaling inversely |
| 32 | Tropical, Spring | Scale weather amount with volume size | Climate|Seasons with low rain should have low rain, and high should have high, rather than doing the opposite and scaling inversely | Low rain Climate|Season has low rain, high rain has high rain | 15/02/2025 16:50 | Yes |  |
| 33 | Tropical, Spring | Scale weather amount with volume size | Should have high rainfall no matter the size of the volume | High rainfall no matter the size of the volume | 15/02/2025 16:51 | Yes |  |
| 34 | Mediterranean, Winter | Scale weather amount with volume size | Should have low rainfall no matter the size of the volume | Low rainfall no matter the size of the volume | 15/02/2025 16:52 | Yes |  |
| 35 | Polar, Winter | Weather spawning | High snow spawn rate | High snow spawn rate | 15/02/2025 17:52 | Yes |  |
| 36 | Tropical, Spring | Wind changes should be more drastic | Wind should remain high, but change precipitation angles more drastically | Difference not very noticable | 15/02/2025 17:55 | No | Adjust range of values in data table |
| 37 | Tropical, Spring | Wind changes should be more drastic | Wind should remain high, but change precipitation angles more drastically | Angle change is drastic | 15/02/2025 18:04 | Yes |  |
| 38 | Polar, Winter | Weather spawning | High snow and high, drastically changing wind | Spawn rate and wind angle being set to 0 | 15/02/2025 18:17 | No | Properly defined snow data in struct |
| 39 | Polar, Winter | Weather spawning | High snow and high, drastically changing wind | UE\_LOG is showing correct values but weather isn't changing | 15/02/2025 18:38 | No | User parameter wasn't set to change the gravity in Niagara system |
| 40 | Polar, Winter | Weather spawning | High snow and high, drastically changing wind | Values are definitely correct but are too small to be visible | 15/02/2025 18:46 | Somewhat | Change data in table |
| 41 | Polar, Winter | Weather spawning | High snow and high, drastically changing wind | High snow and changing wind | 15/02/2025 18:49 | Yes |  |

# System User Manual

Add your user manual here, simply continue writing this document in the format of a user manual beyond this point.

Include:

* System brief
* System output
* Development Cycle Application
* System requirements
* Team the system would be suitable for.
* If UI explain it and how to work it.
* Identify future updates (1-2 no more)

# Add more headers as appropriate. This is basically how to use the game engine. Take inspiration from UE5.2.1 Docs.

# Additional Supportive Documentation

Any additional documentation that is relevant to the project.

# Bibliography

Harvard Referencing examples:

**Website**:

**Bibliography format:**

BBC News (2008) Factory Gloom worst since 1980 [Online]. Available from: http://news.bbc.co.uk/1/hi/business/7681569.stm [Accessed: 21 October 2008]

**In-text example:**

(BBC News 2008)  
…as reported on BBC News (2008)

**Book (1 Author)**:

**Bibliography format:**

Neville, C. (2007). The Complete Guide to Referencing and Avoiding Plagiarism. Maidenhead: Open University Press

**In-text example:**

(Neville, 2007)  
Neville (2007) commented that…  
“Direct quotations are placed in double quotations marks” (Author’s Surname, Year of Publication, p. – followed by page number – in brackets)

**Journal**:

**Bibliography format:**

Trefts, K. & Blaksee, S. (2000). Did you hear the one about Boolean operators? Incorporating comedy into library instruction. Reference Services Review. 28 (4) p. 369-378.

**In-text example:**

(Trefts & Blaksee 2000)

This supports Trefts & Blaksee’s (2000) evidence that……  
“direct quotations are placed in double quotations marks” (Author’s Surname, Year of Publication, p. – followed by page number – in brackets)