

‘How has Technological Advancements effected the usage of Pixel Art within Video Games’

Final Viva

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Summary of Project

My project had the title of 'How has Technological Advancements effected the usage of Pixel Art within Video Games.'

My dissertation covered the history of Pixel Art, analysing how it has evolved alongside technological advancements.

My practical was an asset pack created in a pixel art style. I made use of the research from my dissertation to inform the creation of the asset pack.

Aims and Objectives

The following are my aims and objectives for this project taken from my project proposal.

- The main aim of this study will be to critically analyse the effectiveness of pixel art as an artform to determine the best use cases of it and the limits of using it and to use this analysis to help inform the creation of an asset pack creation using the medium of pixel art.
- To achieve this aim, a few goals will be given to help reach the main aim of this study.
- Firstly, early games will be analysed to determine why pixel art was such a prevalent art style that most would make use of.
- Secondly, modern games will be analysed to determine why they would make use of pixel art over other art styles.
- Finally, to add more depth to the research beyond, general opinions on pixel art as an art style will be gathered from a wide variety of people.

Gantt Chart

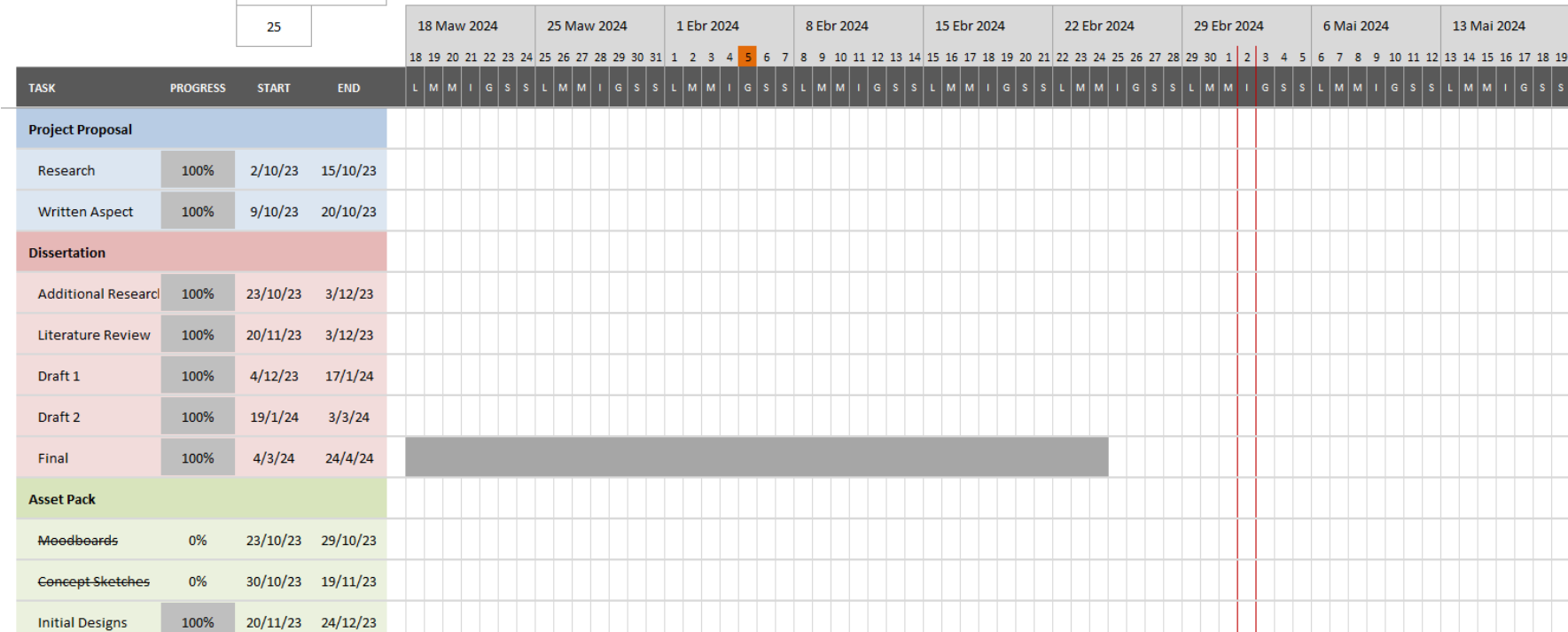
Below is the gantt chart created for this project:

Independent Project

Luke Rees

Llun, 02/10/2023

25



Research

Both sections of my research focused heavily on finding many different examples of pixel art within media. This means that my research pretty much entirely consists of video games that I've looked at and analysed for how they use pixel art. I have included some other references in my bibliography, such as films, books and websites, but the nature of my project meant that the bulk of my research was on existing video games.

[14] 'NES Zapper', Wikipedia, Jan. 7, 2024 (Last Edited), [Online], Available: https://en.wikipedia.org/wiki/NES_Zapper, [Accessed: Apr. 9, 2024].

[15] Duck Hunt. [SOFTWARE], Kyoto: Nintendo, 1984.

[16] Hogan's Alley. [SOFTWARE], Kyoto: Nintendo, 1984.

[17] Super Mario Bros. [SOFTWARE], Kyoto: Nintendo, 1985.

[18] The Legend of Zelda. [SOFTWARE], Kyoto: Nintendo, 1986.

[19] Metroid. [SOFTWARE], Kyoto: Nintendo, 1986.

[20] Castlevania. [SOFTWARE], Ginza: Konami, 1986.

[21] Sonic the Hedgehog. [SOFTWARE], Shinagawa: Sega, 1991.

[22] 'Sega Genesis', Wikipedia, Mar. 18, 2024 (Last Edited), [Online], Available: https://en.wikipedia.org/wiki/Sega_Genesis, [Accessed: Apr. 13, 2024].

[23] Super Mario World. [SOFTWARE], Kyoto: Nintendo, 1990.

[24] Mortal Kombat. [SOFTWARE], Chicago: Midway, 1992.

[25] Maze War. [SOFTWARE], Moffet Field: NASA, 1973.

[26] Spasim. [SOFTWARE], Champaign-Urbana metropolitan area: Jim Bowery, 1974.

[27] Battlezone. [SOFTWARE], Sunnyvale: Atari, 1980.

[28] Super Mario 64. [SOFTWARE], Kyoto: Nintendo, 1996.

[29] Quake. [SOFTWARE], New York City: GT Interactive, 1996.

[30] Earthbound. [SOFTWARE], Kyoto: Nintendo, 1994.

[31] Chrono Trigger. [SOFTWARE], Meguro: Square, 1995.

[32] Harvest Moon. [SOFTWARE], Burlingame: Natsume Inc., 1996.

[33] Doom. [SOFTWARE], Shreveport: id Software, 1993.

[34] Wolfenstein 3D. [SOFTWARE], Aalborg: Apogee Software, 1992.

Bibliography

Below is a zoomed-out section of my bibliography. This section is for video games, I also have sections for films, tv shows, websites and journals:

Title of Game	City (or country) of publication	Publisher or developer	Year of publication	IEEE Reference	Main System	Point about Games use of Pixel Art
Tennis for Two	Upton	William Higinbotham	1958	Tennis for Two. [SOFTWARE] Upton: William Higinbotham, 1958.	Analog Computer	One of the earliest forms of a video game. It makes use of very simple graphics due to being on a very early computer that couldn't produce anything more complicated than what you could see on a computer screen. Similar to Tennis for Two
Computer Space	Cambridge	Steve Russell	1966	Spacewar!. [SOFTWARE] Cambridge: Steve Russell, 1966.		
Mountain View	Nutting Associates	Nutting Associates	1971	Computer Space. [SOFTWARE] Mountain View: Nutting Associates, 1971.	Arcade Machine	
Pong	Sunnyvale	Atari	1972	Pong. [SOFTWARE] Sunnyvale: Atari, 1972.		
Maze War	Moffet Field	NASA	1973	Maze War. [SOFTWARE] Moffet Field: NASA, 1973.		This game has a very similar feel to Tennis for Two with very simple pixel art graphics with monochrome colours however this game was made for Arcade Machines to be used by the public. Released in arcades first until 1975 when it would become a home console release showcasing the improvement in the 3 years between those releases.
Spasim	Champaign-Urbana metropolitan area	Jim Bowerly	1974	Spasim. [SOFTWARE] Champaign-Urbana metropolitan area: Jim Bowerly, 1974.		
Wimbledon	Mountain View	Nutting Associates	1974	Wimbledon. [SOFTWARE] Mountain View: Nutting Associates, 1974.		
Space Invaders	Shinjuku	Taito	1978	Space Invaders. [SOFTWARE] Shinjuku: Taito, 1978.	Arcade Machine	
Asteroids	Sunnyvale	Atari	1979	Asteroids. [SOFTWARE] Sunnyvale: Atari, 1979.		One of the earliest pixel art character to become highly recognisable by the public. This showcases how effective pixel art can create a good character despite limitations.
Galaxian	Ôta	Namco	1979	Galaxian. [SOFTWARE] Ôta: Namco, 1979.		
Pac-Man	Ôta	Namco	1980	Pac-Man. [SOFTWARE] Ôta: Namco, 1980.	Arcade Machine	
Space Invaders	Shinjuku	Taito	1980	Space Invaders. [SOFTWARE] Shinjuku: Taito, 1980.	Atari 2600	
Battlezone	Sunnyvale	Atari	1980	Battlezone. [SOFTWARE] Sunnyvale: Atari, 1980.		An early arcade machine that helped video games become popular, good examples of how effective simple sprites can be
Adventure	Sunnyvale	Atari	1980	Adventure. [SOFTWARE] Sunnyvale: Atari, 1980.		
Donkey Kong	Kyoto	Nintendo	1981	Donkey Kong. [SOFTWARE] Kyoto: Nintendo, 1981.	Arcade Machine	
E.T.	Sunnyvale	Atari	1982	E.T. [SOFTWARE] Sunnyvale: Atari, 1982.		
Pac-Man	Sunnyvale	Atari	1982	Pac-Man. [SOFTWARE] Sunnyvale: Atari, 1982.		8-bit, cartridge had limited storage so some sprites were duplicated e.g. cloud and bush are the same sprite
Duck Hunt	Kyoto	Nintendo	1984	Duck Hunt. [SOFTWARE] Kyoto: Nintendo, 1984.		
Hogan's Alley	Kyoto	Nintendo	1984	Hogan's Alley. [SOFTWARE] Kyoto: Nintendo, 1984.	NES	
Super Mario Bros	Kyoto	Nintendo	1985	Super Mario Bros. [SOFTWARE] Kyoto: Nintendo, 1985.	NES	
The Legend of Zelda	Kyoto	Nintendo	1986	The Legend of Zelda. [SOFTWARE] Kyoto: Nintendo, 1986.	NES	One of the first open world games as it uses multiple screens to create a massive map. Each screen has to be loaded sperately so the map is explored in chunks
Metroid	Kyoto	Nintendo	1986	Metroid. [SOFTWARE] Kyoto: Nintendo, 1986.	NES	
Castlevania	Ginza	Konami	1986	Castlevania. [SOFTWARE] Ginza: Konami, 1986.		
Mega Man	Osaka	Capcom	1987	Mega Man. [SOFTWARE] Osaka: Capcom, 1987.	NES	
Duck Tales	Osaka	Capcom	1989	Duck Tales. [SOFTWARE] Osaka: Capcom, 1989.		Side scroller that uses changeable weapons for the combat
Super Mario World	Kyoto	Nintendo	1990	Super Mario World. [SOFTWARE] Kyoto: Nintendo, 1990.		
Final Fantasy IV	Meguro	Square	1991	Final Fantasy IV. [SOFTWARE] Meguro: Square, 1991.		
Sonic the Hedgehog	Shinagawa	Sega	1991	Sonic the Hedgehog. [SOFTWARE] Shinagawa: Sega, 1991.		
Street Fighter 2	Osaka	Capcom	1991	Street Fighter 2. [SOFTWARE] Osaka: Capcom, 1991.		Sprites used in a 3D environment. One of the first shooter games
Battletoads	Coriscana	Tradewest	1991	Battletoads. [SOFTWARE] Coriscana: Tradewest, 1991.		
Mortal Kombat	Chicago	Midway	1992	Mortal Kombat. [SOFTWARE] Chicago: Midway, 1992.	PC	
Vollenstein 3D	Aalborg	Apogee Software	1992	Vollenstein 3D. [SOFTWARE] Aalborg: Apogee Software, 1992.		
Doom	Shreveport	id Software	1993	Doom. [SOFTWARE] Shreveport: id Software, 1993.		Monochrome colours due to the gameboy being incapable of a colour palette.
Earthbound	Kyoto	Nintendo	1994	Earthbound. [SOFTWARE] Kyoto: Nintendo, 1994.	Game Boy	
Chrono Trigger	Meguro	Square	1995	Chrono Trigger. [SOFTWARE] Meguro: Square, 1995.	Nintendo 64	
Pokémon Red and Blue	Kyoto	Nintendo	1996	Pokémon Red and Blue. [SOFTWARE] Kyoto: Nintendo, 1996.		
Super Mario 64	Kyoto	Nintendo	1996	Super Mario 64. [SOFTWARE] Kyoto: Nintendo, 1996.		Doesn't use pixel art games but marks a point where games became capable of using 3d models and environments
Quake	New York City	GT Interactive	1996	Quake. [SOFTWARE] New York City: GT Interactive, 1996.		
Harvest Moon	Burlington	Natsume Inc.	1996	Harvest Moon. [SOFTWARE] Burlington: Natsume Inc., 1996.		
Advanced Wars	Kyoto	Nintendo	2001	Advanced Wars. [SOFTWARE] Kyoto: Nintendo, 2001.		
Pokémon FireRed/LeafGreen	Kyoto	Nintendo	2004	Pokémon FireRed/LeafGreen. [SOFTWARE] Kyoto: Nintendo, 2004.	Gameboy Advance	Remake of Red and Blue so it can take advantage of the upgrades to the software. Better colour palette, more detailed sprites, better animations on the player.
Super Mario 64 DS	Kyoto	Nintendo	2004	Super Mario 64 DS. [SOFTWARE] Kyoto: Nintendo, 2004.		
Pokémon Diamond and Pearl	Kyoto	Nintendo	2006	Pokémon Diamond and Pearl. [SOFTWARE] Kyoto: Nintendo, 2006.		
Grand Theft: Auto Vice City Stories	New York City	Rockstar Games	2006	Grand Theft: Auto Vice City Stories. [SOFTWARE] New York City: Rockstar Games, 2006.		
Plants vs Zombies DS	Seattle	PopCap Games	2009	Plants vs Zombies DS. [SOFTWARE] Seattle: PopCap Games, 2009.	DS	A version of a pc ported to the DS. this version made use of a distinct pixel art style not used in other version
Pokémon Black and White	Kyoto	Nintendo	2010	Pokémon Black and White. [SOFTWARE] Kyoto: Nintendo, 2010.	DS	
Scott Pilgrim vs. the World: The Game	Saint-Mandé	Ubisoft	2010	Scott Pilgrim vs. the World: The Game. [SOFTWARE] Saint-Mandé: Ubisoft, 2010.		
Terraria	Re-Logic	Re-Logic	2011	Terraria. [SOFTWARE] Re-Logic: Re-Logic, 2011.	PC	
Minecraft	Stockholm	Mojang	2011	Minecraft. [SOFTWARE] Stockholm: Mojang, 2011.	PC	Uses sprites to create a 3D space
Pokémon Black 2 and White 2	Kyoto	Nintendo	2012	Pokémon Black 2 and White 2. [SOFTWARE] Kyoto: Nintendo, 2012.	DS	
Pokémon X and Y	Kyoto	Nintendo	2013	Pokémon X and Y. [SOFTWARE] Kyoto: Nintendo, 2013.	3DS	
Plants vs Zombies 2	Redwood City	Electronic Arts	2013	Plants vs Zombies 2. [SOFTWARE] Redwood City: Electronic Arts, 2013.	Mobile	

Dissertation - Plan

I started my dissertation by creating a bullet point plan of what I would cover.

Introduction

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Early Games

- Tennis for Two (1958)
 - o One of the first games.
 - o Makes use of simple graphics due to the technology.
 - o Most games would follow this design philosophy for the next few decades.
- Computer Space (1971)
 - o Similar feel to Tennis for Two.
 - o Made for arcade machines.
 - o An early commercial game that was made available to the public.
- Pong (1972)
 - o First released in arcades but then released as a home console.
 - o Represents how the technology has advanced since 1958.
- Asteroids, Pac-Man, Donkey Kong (1979-81)
 - o Some early examples of highly recognisable characters.
 - o Showcases how effective pixel art can be despite limitations.

Post Industry Crash

- Mario (1985)
 - o Popular game after the games crash.
 - o 8-bit cartridge with limited storage.
 - o Good showcase of tricks used by early games to save on space.
 - o E.g. Sprites being reused in different places such as clouds and bushes.
- The Legend of Zelda (1986)
 - o One of the earliest examples of an open world game.
 - o Travel from screen to screen due to not being able to run a full world all the time.
- Metroid, Castlevania (1986)
 - o Started the Metroidvania genre of games.
- Mortal Kombat (1992)
 - o A controversial 'violent' game.
 - o Despite the violence being pixelated it still resulted in legal action.
 - o One of the reasons games have a rating system in place.
- Doom (1993)

- o Improvements since then are obvious in this game.
- o Has a larger colour palette.
- Plants vs Zombies DS (2009)
 - o Port of a PC game.
 - o Has a unique style that makes use of pixel art.

Modern

- Terraria (2011)
 - o Massive sandbox game.
- Minecraft (2011)
 - o Uses pixel art sprites to create a 3D environment.
- Pokémon Black 2 and White 2 (2012)
 - o Uses a mix of sprites and 3D models to create an interesting style.
- Shovel Knight, Undertale, Stardew Valley, Celeste, Octopath Traveller (2014-18)
 - o All examples of games that try to evoke the feeling of playing an older game.
 - o Put self-imposed limitations on their style to mimic the limitations of older games.
- Enter the Gungeon, Core Keeper (2017-22)
 - o Makes use of sprites as the main art style but within a 3D environment to allow for other dynamic effects to be used.
 - o Core Keeper, for example, has dynamic lighting.

Other Media

- Examples of other media that includes pixel art in some form.
- Mostly done for stylistic reasons.
- Scott Pilgrim vs. the World, Scott Pilgrim Takes Off (2010-23)
 - o Makes use of pixel art to evoke imagery of old games.
 - o Main example would be fighting games.
- Wreck-It Ralph (2012)
 - o Film is takes place within arcade machines.
 - o Creates a fake game that is reminiscent of older games like Donkey Kong.
 - o One segment shows some characters as pixelated sprites.
- Pixels (2015)
 - o Takes old game sprites and turns them into 3D cuboid models.

Conclusion

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Dissertation

My completed dissertation covered a brief history of games from the 1950s to modern day. This history focused on pixel art games to answer the question I produced. I was also able to take techniques that some games used and apply them to my practical project.

readily available to the public for some time. This technology was limited to labs and universities for the first few decades of game history while it developed and improved.



Figure 2 Pong [4]

Computer Space [3] and Pong [4] would follow on from Tennis for Two [1] in the early 1970s, marking the beginning of true pixel art in comparison to older games which used the equivalent of a military radar. By this point technology has advanced enough to allow for games to be released in arcades on arcade cabinets and, following a few years later, on dedicated video game consoles. Graphically, the depictions shown consist of a very early and limited pixel art style, being limited by the number of pixels able to be displayed as well as a lack of colour outside of the default colour of the monitor. Some games from this era made use of screen overlays to enhance the visuals. These overlays would be put over the screen to add extra details outside of the graphics displayed on the screen. This was done in an effort to assist the very limited pixel art of the time and to add some more colour to the game being played.



still hasn't advanced enough to allow for more detail, however, colour now allows for the sprites created to be easier to recognize despite the simplicity required.

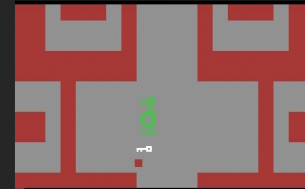


Figure 4 Adventure [10]

The early 1980s saw Atari as the most notable developer at the time. This era saw a very unique style in comparison to other eras. Atari games used a pixel art style that made use of sprites composed of more rectangular shapes as opposed to the basic squares traditionally used in other pixel art styles. This was seemingly done to take advantage of the CRT televisions of the time as the stretched pixels would display better on those monitors as opposed to modern TVs. Similarly, Atari employed other techniques that would only work on a CRT or an emulated CRT monitor such as with Pac-Man [11] the ghosts would flicker to create a see-through effect that was only noticeable on the CRT TVs of the time. Colour was also seeing more frequent use with coloured backgrounds becoming increasingly common during this era.

Post Industry Crash



Dissertation - Summarised

Half-way through writing my dissertation I began running out of ideas on what to include as I had given a brief history of games like I intended. To produce new ideas, I read through my dissertation and created a new list of bullet points to see where I was lacking.

Early Games

- First game Tennis for Two.
- Made in Brookhaven to showcase computer's ability to simulate physics.
- Visuals consist of simple graphic of tennis game.
- Not pixel art but does showcases the principles.
- Technology was only accessible to people working within science institutions so style couldn't be developed.
- Computer Space and Pong came next.
- Marks the beginning of true pixel art rather than military radar.
- Games could now be released within arcades and home consoles thanks to technological advancements.
- Depictions consist of very early pixel art style.
- Limited onscreen pixels and no colours.
- Screen overlays for enhanced visuals and one colour.
- Asteroids, Pac-Man and Donkey Kong next.
- More detail and colour.
- Wimbledon first game with basic colour then Galaxian first game with full colour sprites.
- Some of the most recognizable game characters came from this generation despite limited pixel art.
- General techniques not changed much.
- Still required to follow early principles due to limits.
- However, colour could now assist and make sprites more easily recognizable.
- Early 1980s.
- Atari consoles and games
- Coloured backgrounds became more common in this era.
- This era had a unique style with sprites seemingly stretched into more rectangular shapes.
- Artists also were able to take advantage of the CRT TVs used at the time to create interesting visuals with pixel art.

Post Industry Crash

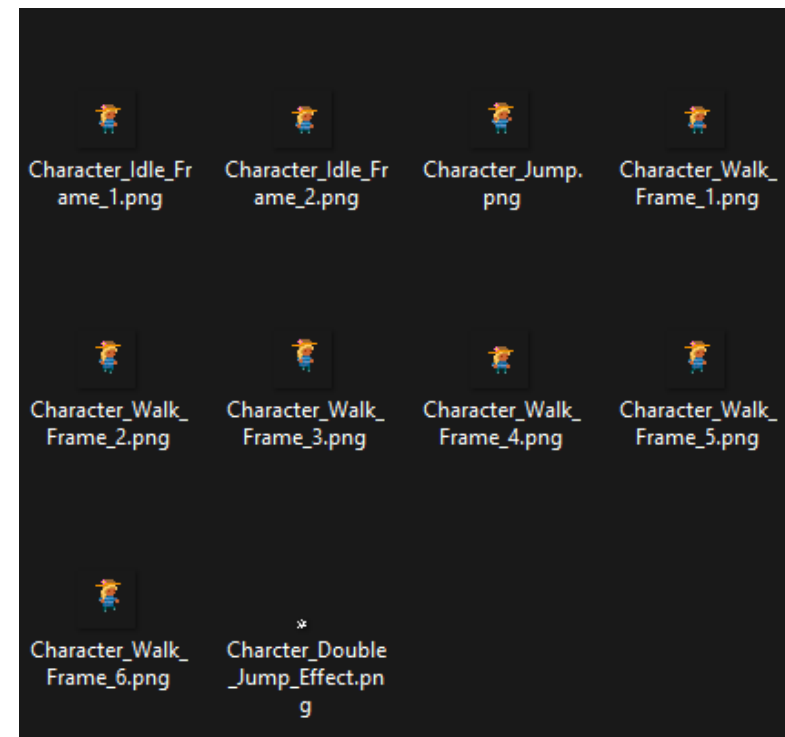
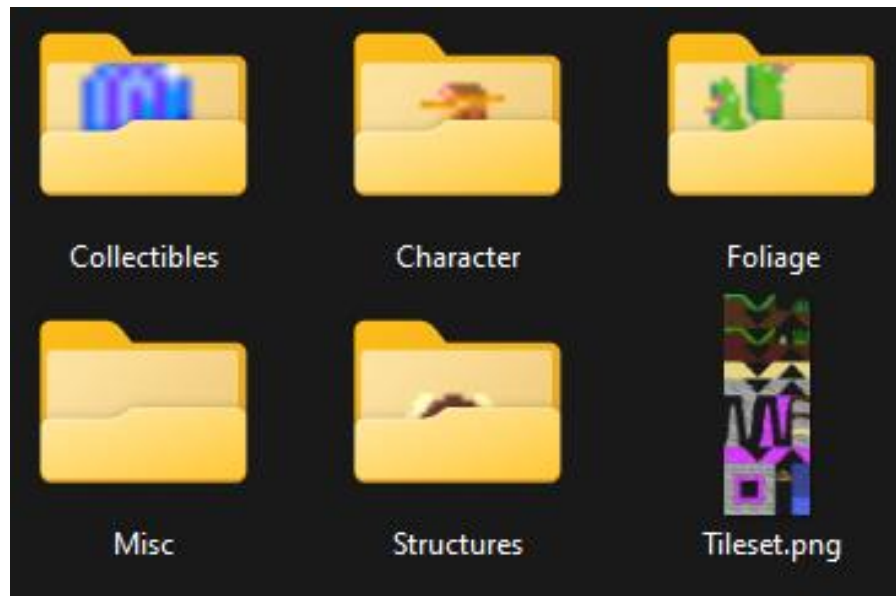
- R.O.B and NES Zapper are good examples.
- These games still made use of pixel art.
- Mario, Zelda, Metroid good showcases of the art style at the time.
- Still limited by 8-bit graphics cards used which would describe the art style.
- Limited cartridge space led to techniques being developed.
- Like recolouring sprites for use in different places.
- Next decade graphical advancement would come in the amount of detail and colour being showed on screen.
- As well as cartridge size.
- 16-bit followed with Sonic and the Genesis.
- Showcased further increase in pixels and colours.
- However, once 32- and 64-bit arrived 3D graphics began taking over as mainstream art style.

The Start of 3D

- 1990s saw 3D become easier to create and sell.
- Number of 3D games increased dramatically.
- Not true start of 3D, Maze War, Spasim and Battlezone first examples.
- Not true 3D however, instead used tricks to create 3D illusion with pixel art.
- True 3D was possible and easy by the 1990s.
- Pixel art no longer a necessity.
- Did still see usage though.
- Just meant that no limits were left on home console pixel art.

Practical – Asset Pack

My practical for this project was an asset pack for a 2D pixel art style game.



Asset List

Below is the asset list created for this project. It does not cover all the assets created, however:

Forest	Tiles	Grass	Dirt	Stone		
	Decorations	Tree	Campfire	Forget Me N	Cherry Bloss	Green Gems
Cave	Tiles	Crystal	Stalagmite	Stalagtites		
	Decorations	Crystal Clust	Purple Gems			
Jungle	Tiles	Long Grass	Mud			
	Decorations	Ferns	Tall Trees	Shrubs		
Beach	Tiles	Sand	Water			
	Decorations	Beach Grass	Blue Gems	Boat		
Desert	Tiles					
	Decorations	Cactus	Dead Bush	Yellow Gem	Well	

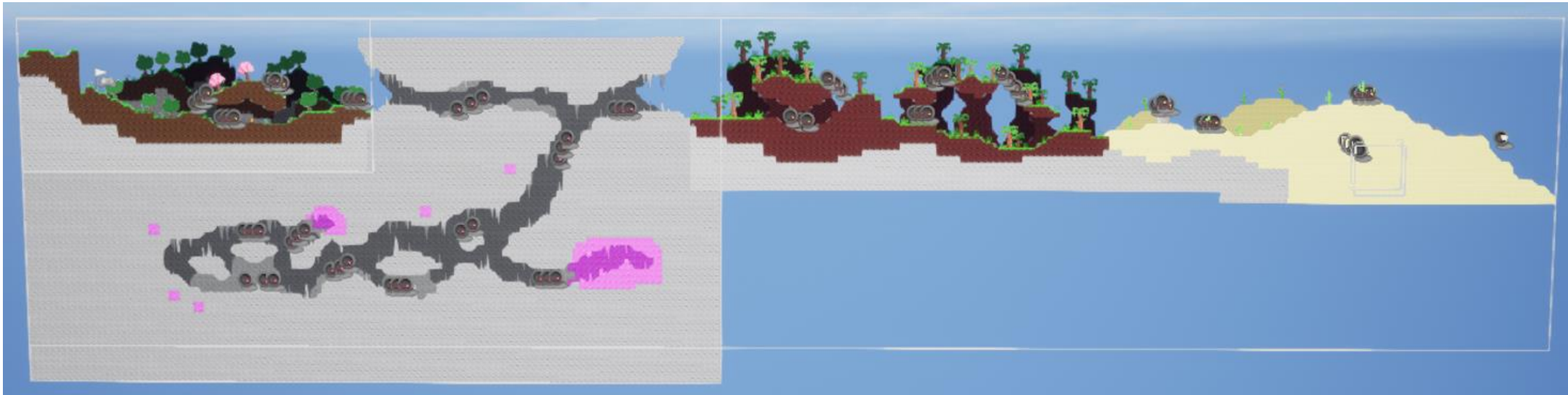
Unreal Engine Showcase



Before Last Presentation

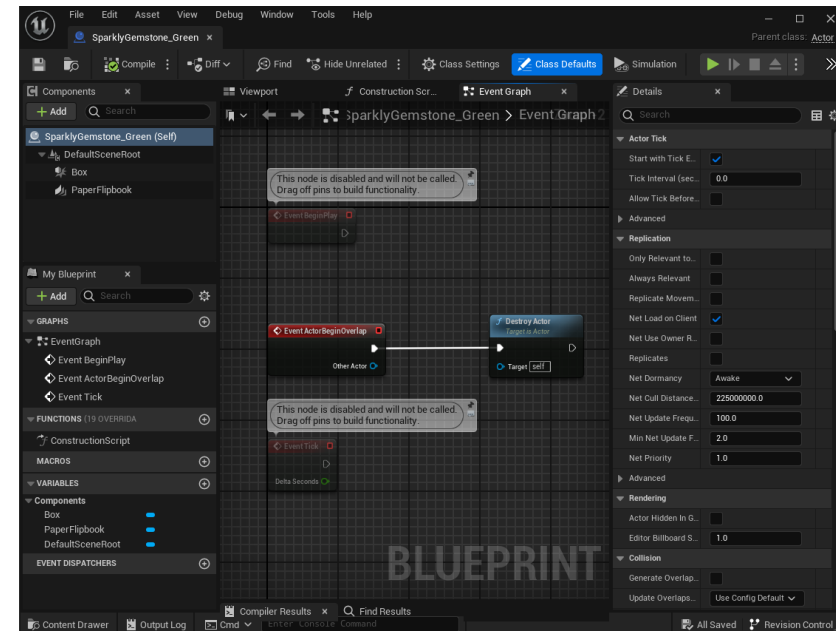
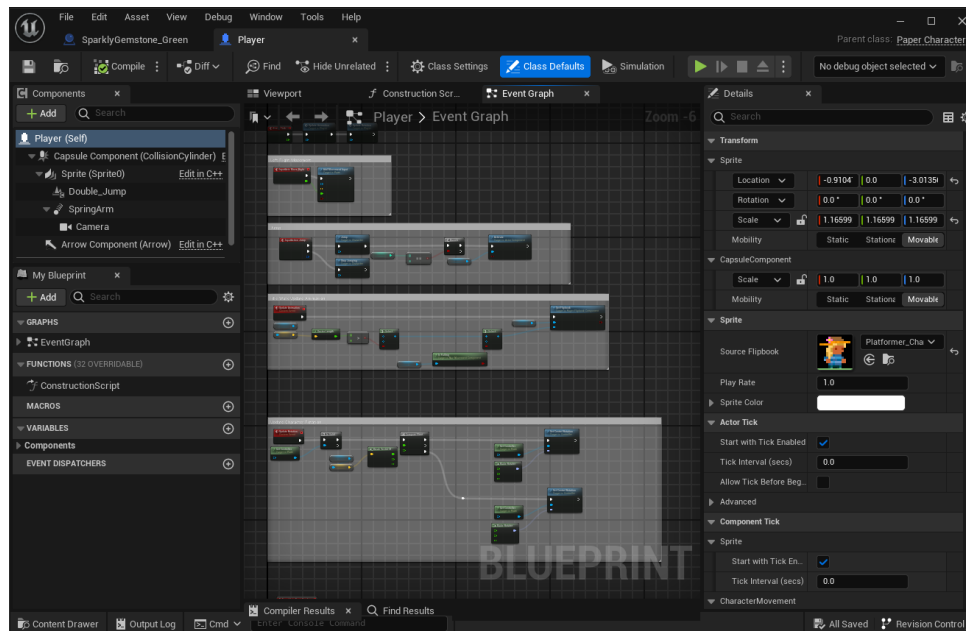


After Last Presentation



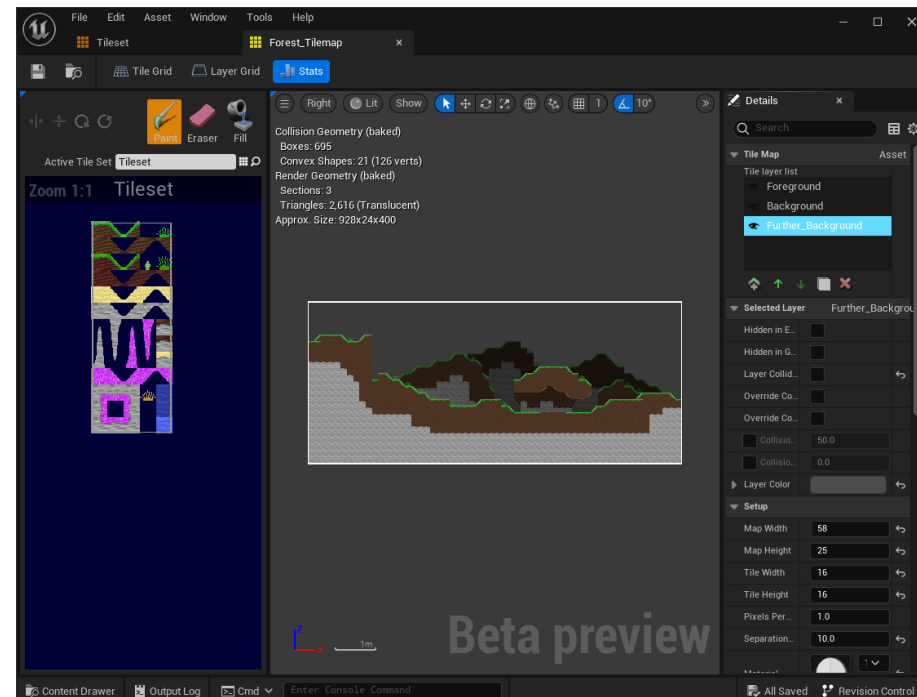
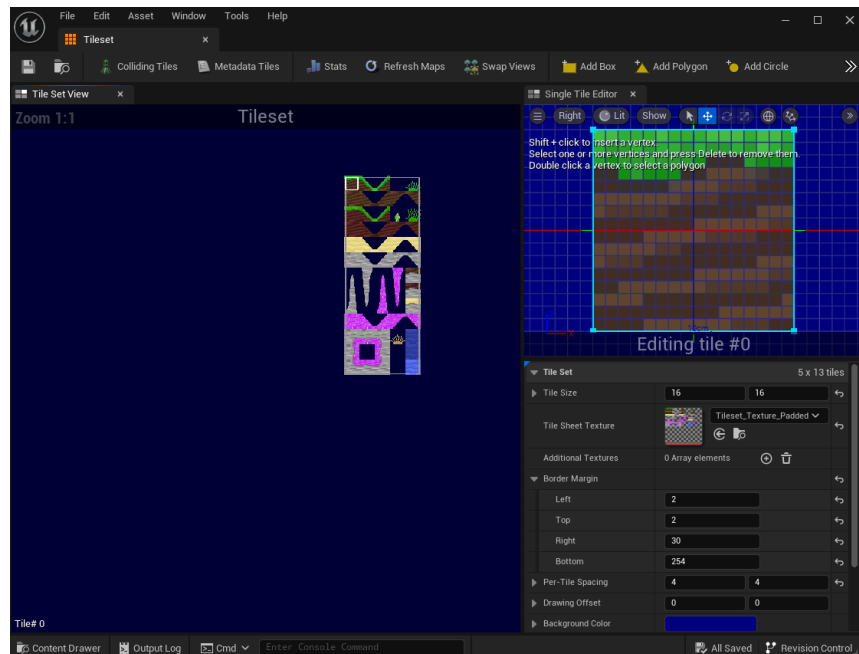
Blueprints

I was able to make use of Unreal's Blueprint system to create some basic gameplay for the project as well as moving and interactable elements such as the gems and the water.



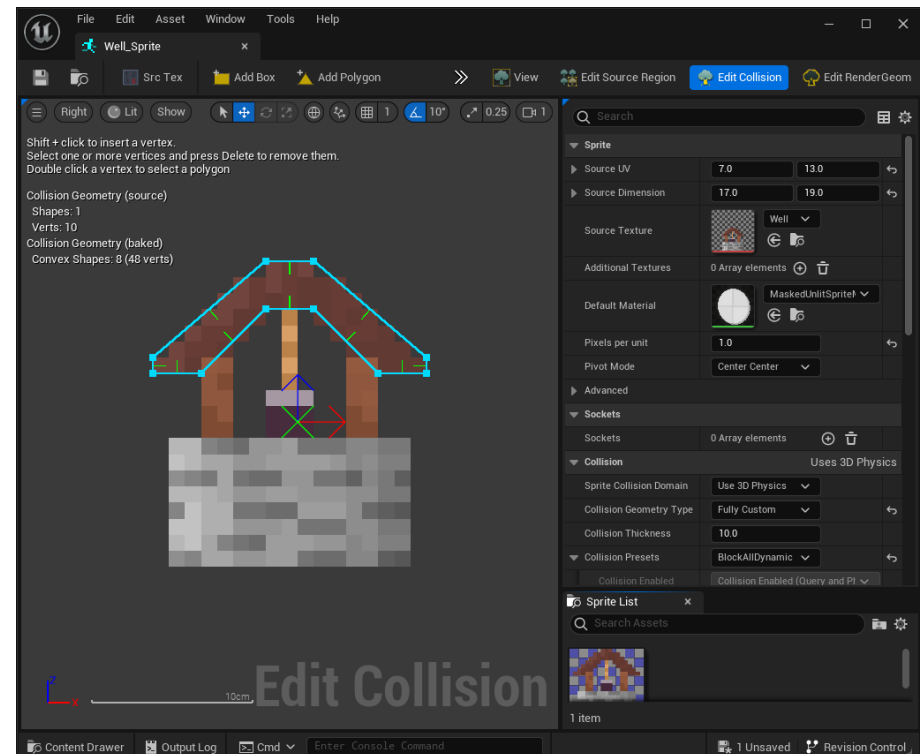
Tile sets and Tile maps

Unreal has a dedicated tile set system that I made heavy use of in this project. You create a tile set and then apply that tile set to a tile map that gets placed into the world.



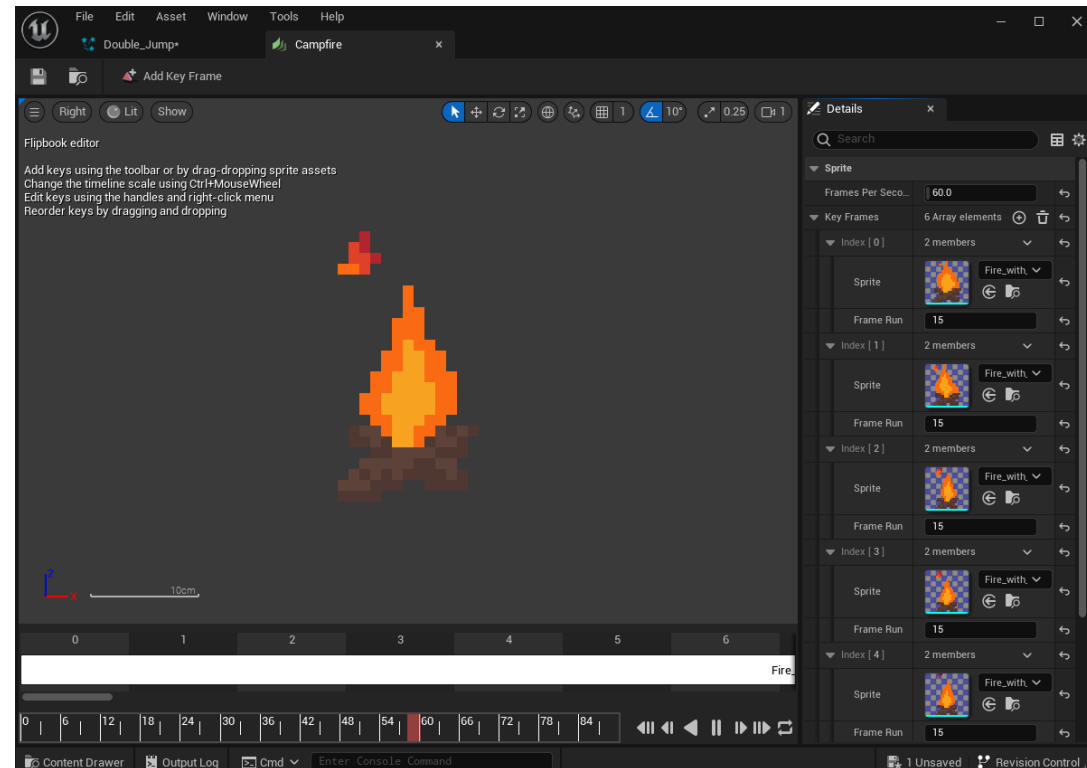
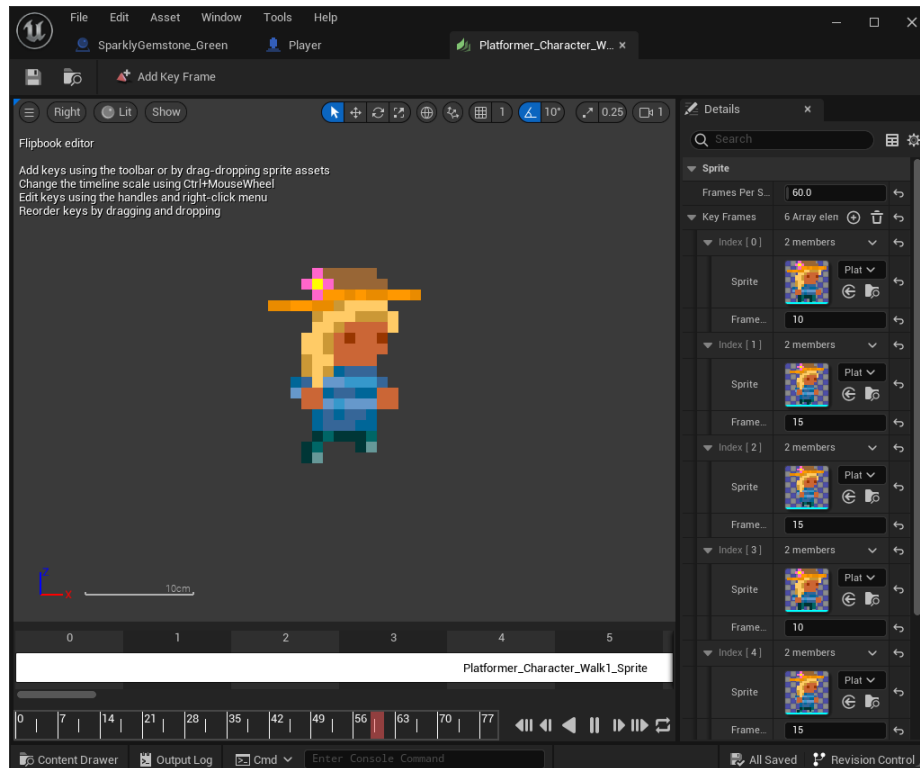
Sprites

Since I am working entirely with sprites for this project, I had to make use of Unreal's sprite system. This would allow me to place them within the project as a flat plane.



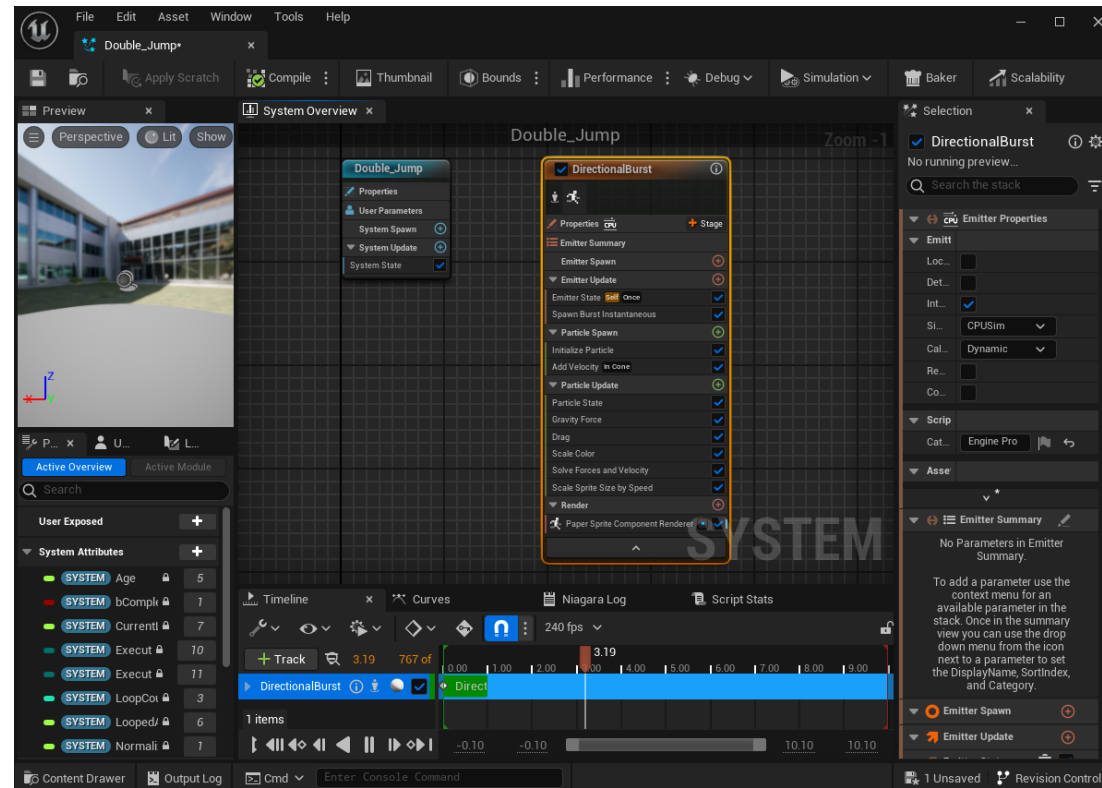
Flipbook

The animated sprites make use of flipbooks that were then either placed into the world or used within blueprints.



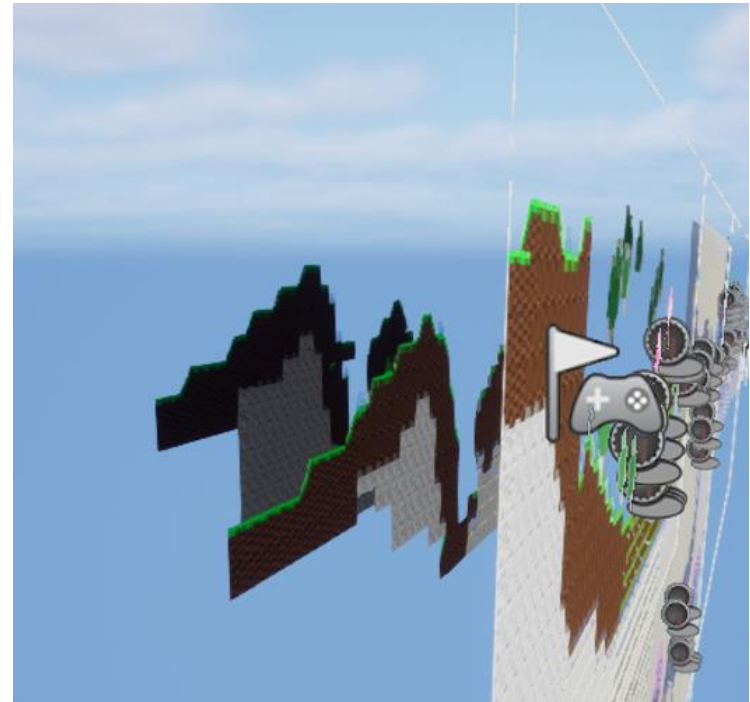
Particle System

For this project I made use of Unreal's built in particle system to create an effect for the double jump. This was my first time using this system.



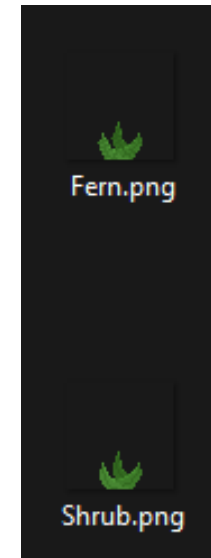
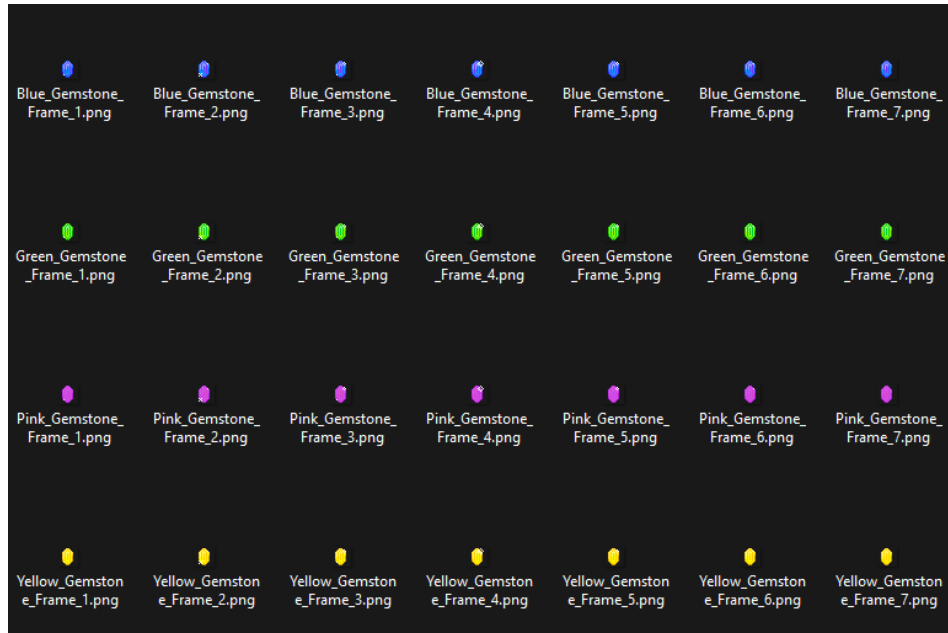
Perspective

By making my project within Unreal Engine rather than a dedicated 2D engine, I was able to create a sense of perspective by layering objects in the 3D.



Sprite Reuse

I reused some sprites to create new unique ones. For example, all the gemstones share the same 7 sprites but are recoloured depending on the area they are found in.



A solid green vertical bar is positioned on the far left side of the slide.

Thanks for listening

Any questions?