JACK FERRARI FIGURES OUT HOW TO MAKE

CLOUDS WITHIN VIDEOGAMES

THE **OFTEN OVERLOOKED**
WHO LOOK OVER US...

LEARNING TO CREATE THESE AMBIGUOUS TITANS IN A VARIETY OF PROGRAMS

PARALLAX SIDE-SCROLLING CLOUDS AND FOG STUDIED FROM PHOTOS RENDERED WITHIN **UNITY**
VOLUMETRIC CLOUDS CREATED AND ANIMATED WITH VOP's WITHIN IN **HOUDINI**
IMPORTED-SETUP-COMPOSITED AND RENDERED USING **UNREAL ENGINE 5**

GAR204 ART RESEARCH PRACTICE:

CLOUDS AND SKYBOXES WITHIN VIDEOGAMES

- JACK FERRARI -

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1. **Research Question**

How do videogames utilise skyboxes and cloud systems to create an atmosphere outside of the main traditional geometry/ interactable content.

2. **Course/Route**

BA(Hons) Game Art - Environment

3. **Project Details and Learning Goals**

Explore professional workflows and systems behind the creation of skyboxes/ cloud systems within the medium of video games. With the goal of creating my own engaging atmospheres outside of the traditional modelled and interactable level content.

Create a collection of engaging pieces/ studies that do not rely upon modelled assets but instead tell a story or convey a mood using atmospheric industry informed techniques.

4. **Rationale**

An often-overlooked element of games is their utilisation of clouds, skyboxes and how the often un-interactable element that is the sky can be used as an incredibly powerful tool when creating a visual identity and mood communication technique. This is one element that has always fascinated me especially within the context of traditional art, photography pieces or even everyday life so applying that interest to videogames will help create more visually unique bodies of work in the future.

Being nearly always onscreen in some capacity within many games, the un-interactable helps push worldbuilding and a sense of scale that exceeds the playable spaces that players inhabit.

To achieve this I will:

- Study the work of traditional artists such as Albert Bierstadt and John Martin and interpret how they handled the sky to convey a feeling within their bodies of work.
- I will explore the use of industry software such as: Houdini, EmberGen, Vue, Unreal Engine and Terragen and discover how these packages can inform my own workflow.
- Seek reference and first-hand research from my own real-life photos and attempt replicative studies to enhance realism, understanding and believability of produced work.
- Research how games/developers such as Destiny (Bungie), Warframe (Digital Extremes), Horizon (Guerilla Games) or even side scrollers such as Mario (Nintendo) have approached the sky through the years of tech progression and hardware divides.

Using all of this to inform my own workflow that can be utilised in future projects.

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GAR204 Art Research Practice:

CLOUDS AND SKYBOXES WITHIN VIDEOGAMES

Clouds. The Sky. An ever-shifting landscape perpetually sprawled above us, continually observable yet forever escaping our grasp.

Throughout this project I intend to look at all aspects of clouds and why as humans we are subconsciously infatuated by the emotive expression of the skies above with it's ability to reflect these feelings down to those below. Through their eventual shift onto our screens where they continue to amaze, albeit in an often-overlooked fashion.

But first a question: What is a cloud? The answer will depend upon who you are asking. To Science a cloud is:

"Clouds are visible accumulations of tiny water droplets or ice crystals in Earth's atmosphere. Clouds differ greatly in size, shape, and color."- NASA [16]

But to more philosophically inclined individuals' clouds are:

An unfathomable expansive domain of the Gods that us mortals can merely dream of reaching. With one such works "The Cloud of Unknowing" comparing Gods unfathomable nature to that of a cloud, in accepting this lack of form one can achieve spiritual realization. "that something else is God, hidden in a cloud of unknowing" [11]

Paramount to all, clouds provide a vital section of the water cycle most notably rain and unsurprisingly this movement of water is essential for all aspects of existence. Thus these harbingers of both life and destruction dramatically floating above can understandably be described as nothing other than godlike.

This fascination with clouds naturally extended through the world of traditional art, their close association with religious iconography has inspired many artists throughout history in an attempt to quantify the world around.

TRADITIONAL ART

- PAINT INK & ALL THINGS PRACTICAL -

"There is no name more illustrious in the annals of art and of science than that of Leonardo da Vinci." [15]
Included in his vast body of works Da Vinci produced studies of clouds, garnering a particular interest in cataclysmic storms towards the end of his life, as a possible expression of his fading mortality. These swirling tempests and foggy shapes sell the shifting/ unfathomable nature of the sky in an almost comedic simplicity when compared to da Vinci's other works.

FIG01: A Deluge: 1518

FIG02: A Study of Clouds: 1518

One period renowned for its utilization of clouds was the renaissance, religious figures often depicted shrouded by clouds, clearly demonstrated in the piece "The Sistine Madonna"

The leftmost clouds seen forming the faces of cherubs. Presenting the idea of purity and motherhood through colour and form providing Raphael with a way of balancing his composition. The figures pushed forward against rest zones, demonstrating an understanding of how clouds can be used to manipulate viewers of his work.

FIG03: Sistine Madonna 1513

Similarly transitioning into the Baroque period Arnold Houbraken's "Pallas Athena Visiting Apollo on Parnassus" is a depiction of the mythological Greek deities, Athena stood atop a fluffy cumulus cloud. A power that is often possessed by such godlike beings, communicating their close ties to the heavens, drawing attention to her entrance.

FIG04: Athena descending: 1703

FIG05: Macbeth: 1820

A stark contrast to the highly dramatic and tempestuous artwork by John Martin, presenting the Shakespearean story of Macbeth. Similar to Da Vinci's cataclysmic obsession, in an apocalyptic weather display, swirling clouds frame the entire scene reinforcing the supernatural nature of this event and the power of these beings in the face of humanity's insignificance.

FIG06: Warframe : 2019 Skybox Reminiscent of Martin's Works

FIG07: Wanderer Above the Sea of Fog: 1818

FIG08: Minecraft's "Wanderer": 2011

A personal favourite piece that uses many forms of clouds to elicit emotions is Friedrich's "Wanderer Above the Sea of Fog". The rising stratus creates a lonely sense of movement and uncertainty, shrouding the landscape below whilst providing deliberate glimpses into the unknown. Combined with the subjects billowing hair you get a emotive sense of the environment being frigid and blustery. Deftly framed by a distant fog and sky above; the character is truly the focal point and invites a great window into the perspective of the subject, alone yet continuing to face the uncertain world beyond…

The Wanderer has found itself represented in Minecraft 2009 [14]. Friedrich's work deftly depicts the intended player experience within the game. A figure stood atop a hill admiring a vista exuding the promise of adventure, with even the fog being reminiscent of render distance within the game itself, often being a tool to mask technical limitations.

FILM & TELEVISION

- SCREEN SOLUTION DEBUTS -

Progressing from traditional art to the screen, film had one unique approach being the “Cloud Tank” a process involving a fish tank and 2 layers of water: denser salt and regular. Injecting paint into the tank would cause cloud-esque plumes to form as it hit the denser saltwater, ultimately creating striking visual effects found in films like “Close Encounters of the Third Kind” [22] “Raiders of the Lost Ark” [23] and “GhostBusters” [19]

FIG09: Raiders of The Lost Ark: Demonstrating Cloud Tank 1981

FIG10: Close Encounters: 1977

FIG 11: Ghostbusters: 1984

These clouds have a dramatic expression, perfectly encapsulating the feeling each of these scenes wish to convey, with powerful otherworldly forces affecting each location. Providing that clear focal point and destination for the characters (be it a portal to another world or telegraphing a UFO's position) Reminiscent of Martin's cataclysmic works, reinforcing the importance of our protagonist's goals in stopping these catastrophes.

FIG12: EldenRing: 2022

FIG 13: LEGOFortnite 2023

Modern video games have similarly utilised these clouds with a boss fight from Elden Ring 2022 [3] (Placidusax) turning into a red tempest, telegraphing a devastating move. The clouds like those in Ghostbusters 1984 [19] can be found in the recent LEGOFortnite 2024 [12] defining the location of the final boss "The Storm King" appropriately located within this eye of the storm. These are however recent titles with over 40 years of clouds within games to observe.

VIDEOGAMES

- FINALLY INTO GAMES -

This communication of directed attention and desired destination has never been more vital than within the medium of video games. A newer creative industry that has decades of techniques to catch-up, however in this time learnt the skies effectiveness on impacting the human psyche.

One of the earliest examples of clouds within games was the 1980 title Polaris [18] featuring pixels that would scroll across the screen (helping differentiate between sky and ocean). Whilst by no means impressive like the works of Houbraken, it demonstrates an understanding of what would become a powerful facet of game design.

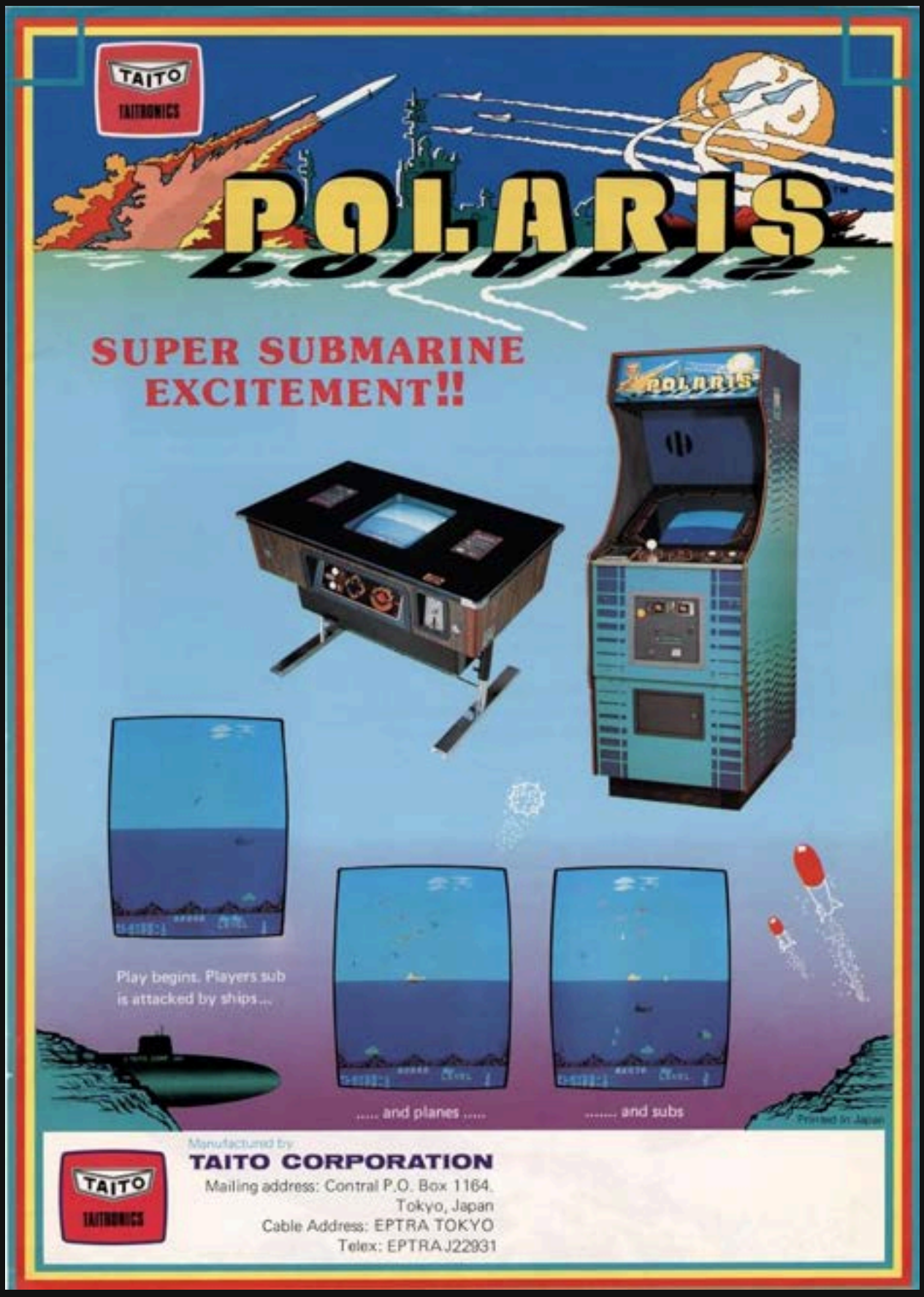

TAITO
TAITRONICS
POLARIS
SUPER SUBMARINE EXCITEMENT!!
POLARIS
Play begins. Players sub is attacked by ships...
..... and planes .....
..... and subs
Manufactured by
TAITO CORPORATION
Mailing address: Contral P.O. Box 1164.
Tokyo, Japan
Cable Address: EPTRA TOKYO
Telex: EPTRA J22931

FIG14: Poster for Polaris (Showing Early Cloud Interpretations)

Super Mario Bros 1985 [24] would refine clouds, one of which being ridden by the character Lakitu, formerly Mario's enemy before using it's apparent divine skills (adjacent to those of Greek mythology) to return racers to the track in Mario-Kart.

FIG15: Cumulus Clouds in MarioBros.

FIG16: Cumulus Riding Lakitu

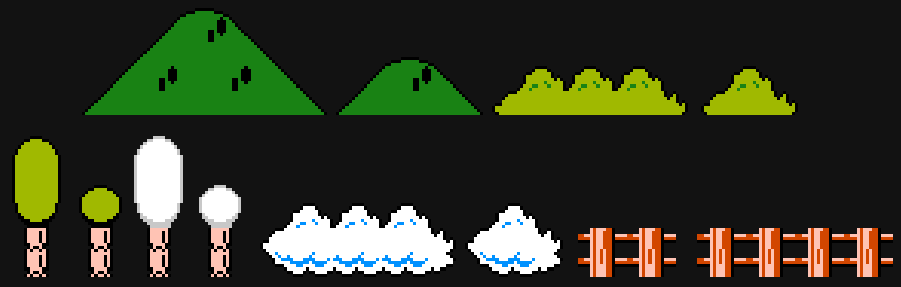


FIG17: MarioBros. Level Sprites

Whilst these cumulus clouds don't particularly convey any specific mood or feeling as one of the first videogames going for an iconic approach these clouds add a surprising amount of depth to the world providing that childish drawing quality to the art style.

This effect is called "Parallax Scrolling", whilst rudimentary, the premise involves having a series of layered images moving by at variable speeds creating the impression of depth and distance.

"Motion parallax refers to the fact that objects moving at a constant speed across the frame will appear to move a greater amount if they are closer to an observer (or camera) than they would if they were at a greater distance."[1]

The foreground consisting of the horizontal ground, warp pipes, blocks and enemy Goomba; serving as interactive elements. The player can walk jump and bash into these as part of the "gameplay" experience. Contrasted to the background, with clouds, bushes and a hill. All entirely uninteractable and serve as a primitive way to produce the effect of depth, expanding the games world without technical strain.

So where better place to start than with one of the most iconic franchises and reproduce this effect.

PARALLAX CLOUDS

- SCROLLING BACKWARDS -

This process started with me observing a selection of reference photos taken in and around Penryn during my weekly walks to and from uni over this project's duration. Whilst also drawing inspiration from my previously observed artists…

FIG18: Weekly Pictures of Clouds Over Penryn Campus

FIG19: Various Cloud Types over Penryn

Through my time spent drawing clouds in Procreate I discovered… Realistic clouds are challenging, easily becoming a mess of hues and shapes, losing any semblance of form or likeness to the stunning titans I've grown to appreciate. Concluding, the best approach was: simplicity, rending the shapes individually, using alpha locking to keep shading to the individual "clumps".

My next stage was to create a completed piece with a defined Fore-Mid and Back grounds.

These initial 4 explored more realistic clouds observed from my photographs, changing only the sky...

Subsequent 4 featuring more fantastical elements: spirals and arcs, being more unique and “Videogamey” however they somewhat lose the read as clouds in the process.

Through this piece I wanted to show how clouds can be used to direct focus, taking inspiration from Freidreich's "Wanderer" using various cloud formations whilst having the central subject be highly visible. This "player character" readability being of paramount importance within videogames.

Once I had the completed piece I exported the defined layers into Unity.

To conclude this exploration I found a video breaking down how to setup a parallax scene within Unity:

Dani: Parallax-Scrolling [2] & Game Code Library: Infinite Parallax-Scrolling [6]

CODE

MOVEMENT: See Game Code Library Reference

PARALLAX: See Game Code Library Reference

Player Movement (Mono Script)

Assembly Information
Filename Assembly-CSharp.dll

```
using UnityEngine;

public class PlayerMovement : MonoBehaviour
{
    float horizontalInput;
    float moveSpeed = 5f;
    Rigidbody2D rb;
    SpriteRenderer spriteRenderer;

    void Start()
    {
        rb = GetComponent<Rigidbody2D>();
        spriteRenderer = GetComponent<SpriteRenderer>();
    }


    private void FixedUpdate()
    {
        horizontalInput = Input.GetAxis("Horizontal");

        spriteRenderer.flipX = horizontalInput > 0;
        rb.velocity = new Vector2(horizontalInput * moveSpeed, rb.velocity.y);
    }
}
```

Background Controller (Mono Script)

Assembly Information
Filename Assembly-CSharp.dll

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class BackgroundController : MonoBehaviour
{
    private float startPos, length;
    public GameObject cam;
    public float parallaxEffect; // The speed at which the background should
move relative to the camera

    void Start()
    {
        startPos = transform.position.x;
        length = GetComponent<SpriteRenderer>().bounds.size.x;
    }

    void FixedUpdate()
    {
        // Calculate distance background move based on cam movement
        float distance = cam.transform.position.x * parallaxEffect; // 0 = move
with cam || 1 = won't move || 0.5 = half
        float movement = cam.transform.position.x * (1 - parallaxEffect);

        transform.position = new Vector3(startPos + distance,
transform.position.y, transform.position.z);

        // if background has reached the end of its length adjust its position for
infinite scrolling
        if (movement > startPos + length)
        {
            startPos += length;
        }
        else if (movement < startPos - length)
        {
            startPos -= length;
        }
    }
}
```

HOW IT WORKS

Once the players view gets near the edge of one of the layers the code will spawn a new version creating an infinite tile effect.

LAYERS

Uses a variety of cloud types to provide a mood. From fog to create atmospheric depth and provide a clearer value structure to the more obvious cloud creature looking at player.

NOTE ON SPRITE CREATION

Ensure your layers correctly Tile! As evident here there are obvious edges, ensure you make these in a program like Photoshop where edges will not get cropped when moved off the workspace.

Overall this exploration wasn't the most successful…

The result only truly works from one location. For an actual game the goal is to create highly reusable assets. Sections like my trees and ground could have mass application, the fog obviously tiles.

To circumvent this I would need to create a set of sprites that could be layered atop one another modularly, increasing efficiency of the project as limiting draw-calls is a key facet of game development.

Where it does succeed is it introduced me to methods of using clouds to frame a subject and particularly within my thumbnail exploration can be used to efficiently produce a variety of moods without having to dramatically change entire lighting setups. In turn increasing efficiency of getting concepts produced.

It also introduced me to Unity, a game engine I have little previous experience with. Having the ability to now mockup quick 2D side-scrolling game concepts is a bonus!

VOLUMETRIC CLOUDS

- MODERN SOLUTIONS HAVE VOLUME -

FIG20: MarioBros,Wonder: Petal Isles

FIG21: Kelvin-Helmholtz Clouds

Much like the sky, the ever shifting landscape that is gaming, where technology and systems are constantly evolving; aspects like clouds can be approached in a variety of ways. This progressions particularly evident with the recent title: Super Mario Bros. Wonder [25], a stark contrast to the original 1985 humble pixel cumulus, instead being fantastical volumetric creations.

Through my research into cloud formations I discovered whilst the left may seem like a stylistic choice, simply enhancing the feeling of a whimsical beach these clouds are near perfect examples of Kelvin-Helmholtz clouds.

“An extremely rare phenomenon, where a cloud produces a billowing wave pattern. They occur when there is a strong vertical shear between two air streams, causing winds to blow faster at the upper level than at the lower levels.” [13]

Or in the case of Mario have been created using a program like Houdini to transform the main wave-like “Hill” asset into an editable VDB, giving it cloud like properties in a wonderfully effective demonstration of recontextualising premade assets; saving both development time and money.

To mirror this shift in the world of gaming I have been learning how to produce volumetric clouds in the aforementioned Houdini.

Being a program I have absolutely no previous experience with, Houdini presented a lot of questions, most notable of which... What does it offer?

Houdini is a procedural node based program primarily used in the creation of simulated VFX, from fire and destruction to liquid sims, finding its use predominantly within film and television. Mostly through the use of “Volumes”... but what actually is that?

“Volumes allow you to store values for “voxels” (three dimensional pixels) in a space. This allows you to represent phenomena such as clouds, smoke, fire, as well as store simulation metadata” [21]

Basically a volume creates a 3D grid that dictates the position of a voxel (A 3D pixel or cube) as shown adjacent.

I will be using these Volumes to create clouds…

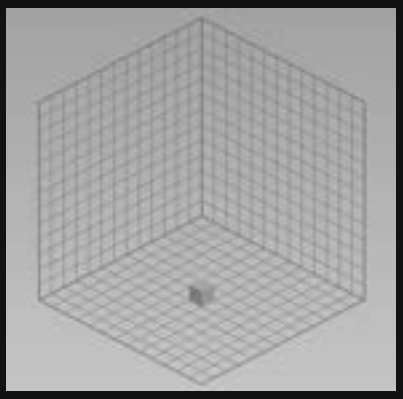
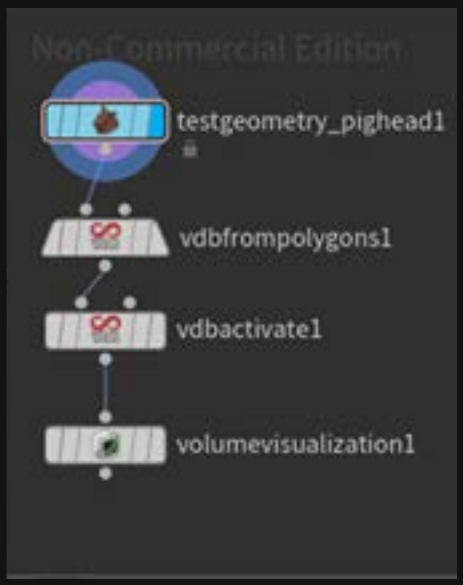


FIG22: Voxel Depiction

Fortunately or not Houdini introduced a new method of cloud creation as of 2024 making many tutorials online now obsolete. Despite this my processes went as follows:



STEP: 01

Using **CloudShapeGenerate** to create a basic form that looks like a cloud.

This can be any shape you desire and can be created from an existing sculpt/ model.

STEP: 02

CloudShapeFromIntersection will place more geometry where 2 shapes overlap.

This will create a more interesting fluffy cloud form. (**WARNING: EXPENSIVE**)

STEP: 03

Add some more noise like "Mountain"

Using a **VDBFromParticles** will turn the geometry into a Volume. (Higher Resolution = Less obvious Voxels)

STEP: 04

Houdini's **NEW** Cloud Nodes come with a variety of noises.

Add some **BillowyNoise** **WispyNoise**, these all have changeable parameters to get the result you want.

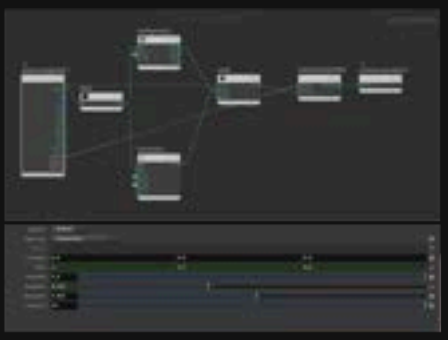
STEP: 05

Creating some more extreme areas of noise particularly around the base makes the cloud more realistic.

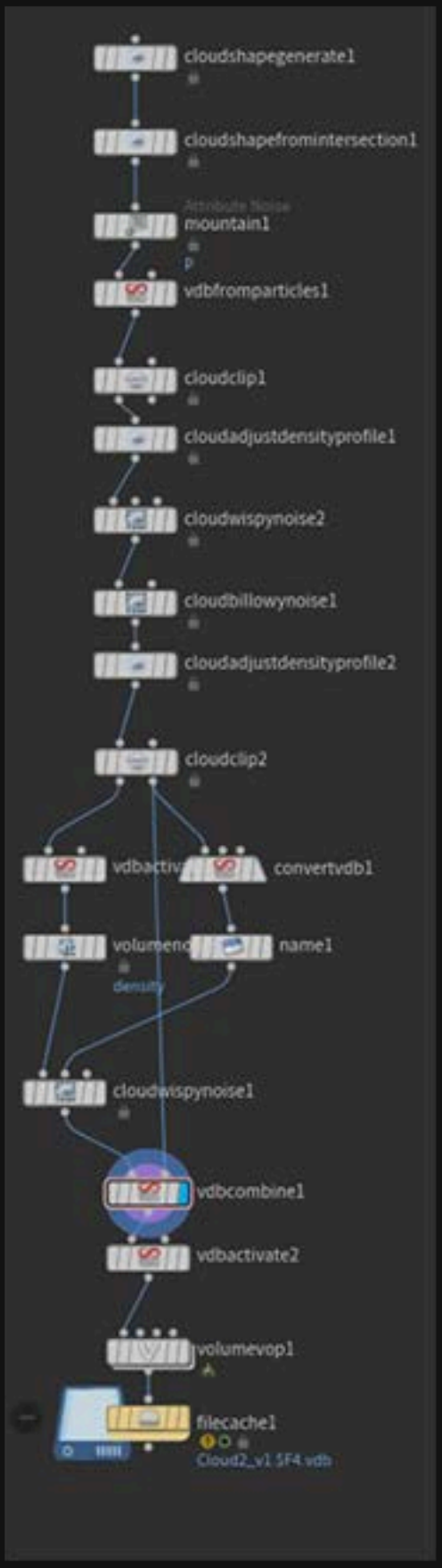
VDBCombine will merge these 2 sections back together.

STEP: 06

Animating the clouds uses a **VolumeVop**. This setup > causes a noise (Worley) to scroll through the Volume Giving the illusion of the clouds moving whilst actually remaining static.



EXPORTING: ENSURE AS **VBD**



For a portion of this process I followed the premise set out by: Project Pegasus: [20] A great series discussing the cloud tools in Houdini. Amongst other videos [4] [6] setting out how to import these VDBs into Unreal scenes using HeterogeneousVolumes [5]

Through these I did create a personalised workflow combining the information setout in each. Learning:

- Houdini Node Order
- AnimatedVOP process
- Base UE5Volume material setup

Cloud Exploration UE5

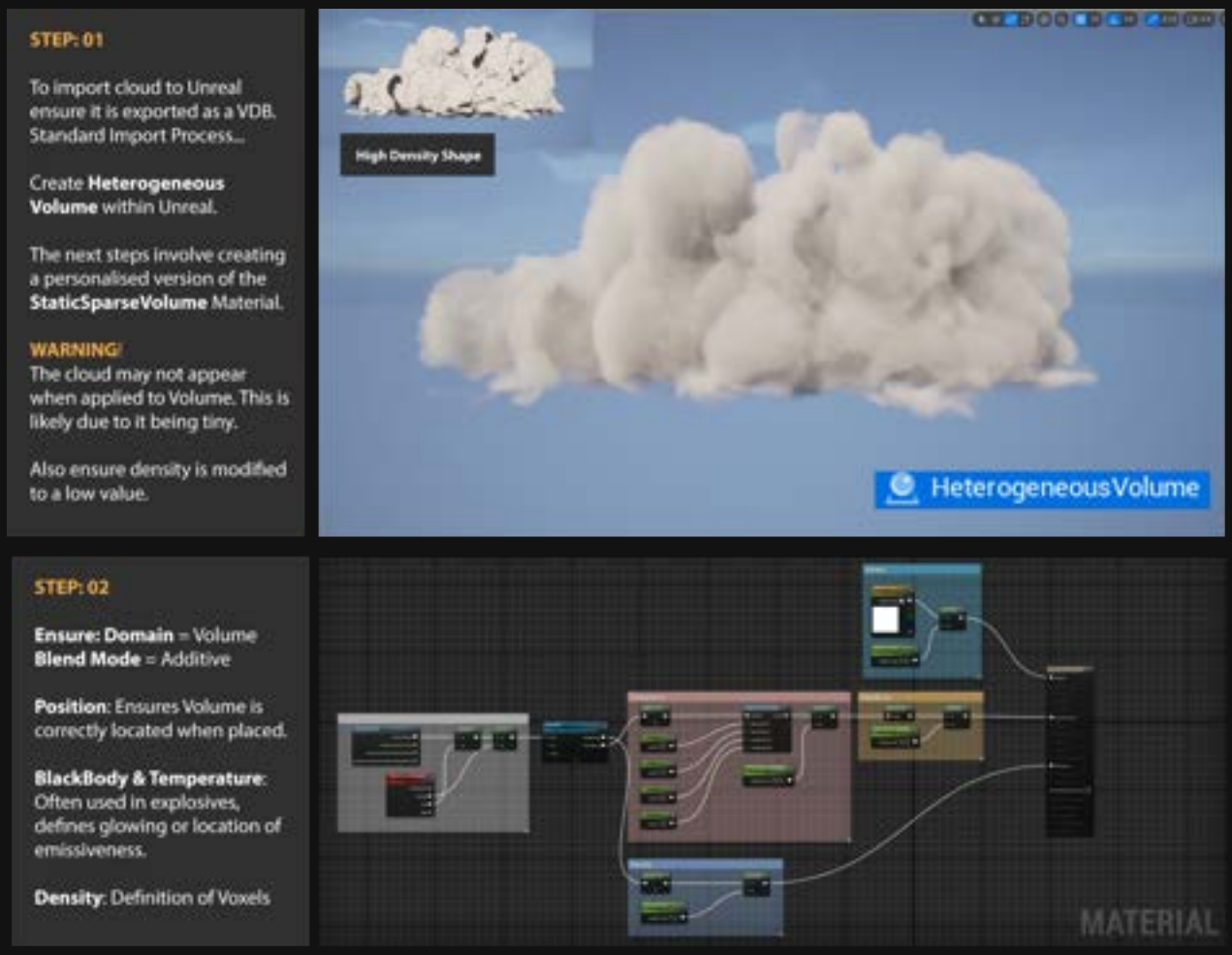


FIG23: HorizonForbiddenWest: 2022

For a prime example of using volumetrics look no further than Horizon Forbidden West[11]. Guerrilla Games providing a GDC document discussing their process [8]. Where I sourced the idea of scrolling a noise through the Volume to produce movement, implemented with the help of O.Song's VDB export video. [17]

SKYBOXES

- ALL ENCOMPASSING -

Following this progression of 2D into 3D, skyboxes began showing up, creating artificial details outside of the player's reach that exponentially expands the game world. Much the same as Mario's Parallax systems.

Originally a large inverted textured cube, placed around the entire level like a cloche, rendering a vast space efficiently. Developers would otherwise have to create an entire realised world that would never be touched by the player. This being faked saves time, money and ultimately sanity.

Focussing effort on a playable level with our easily trick minds being manipulated to fill in the rest with basically a painted mural alluding to the awe-inspiring vastness of real-life.

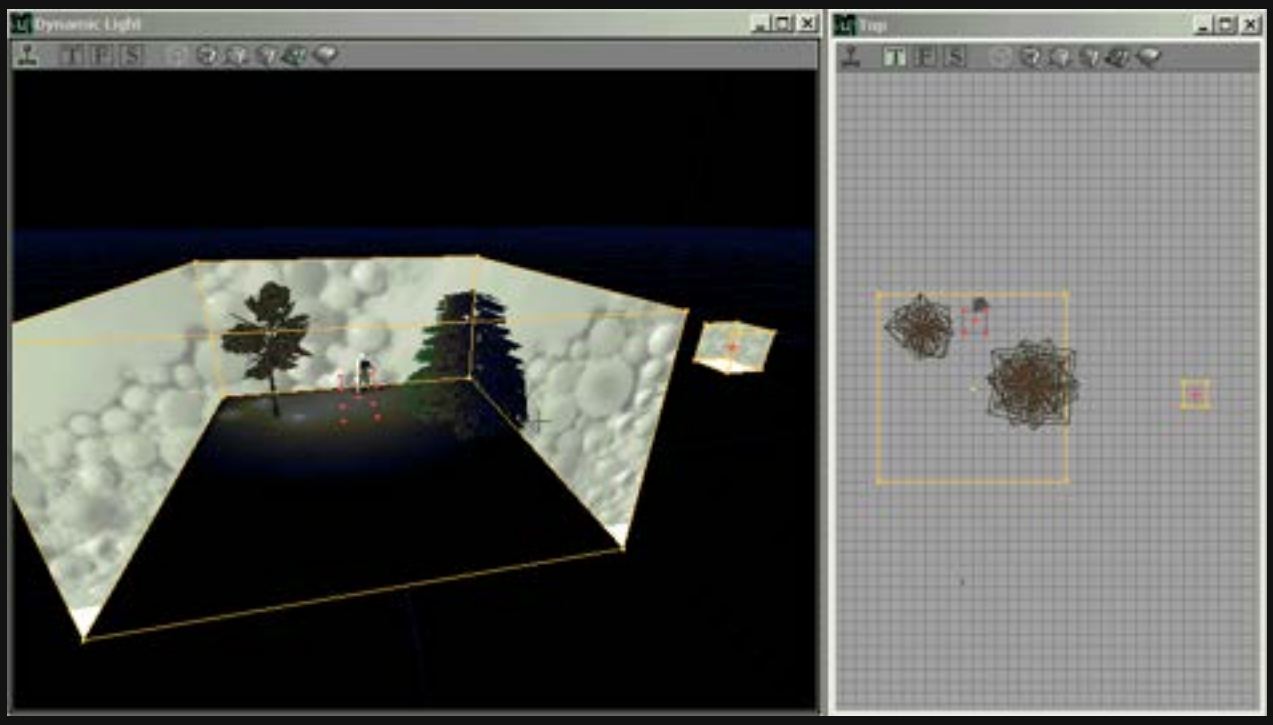
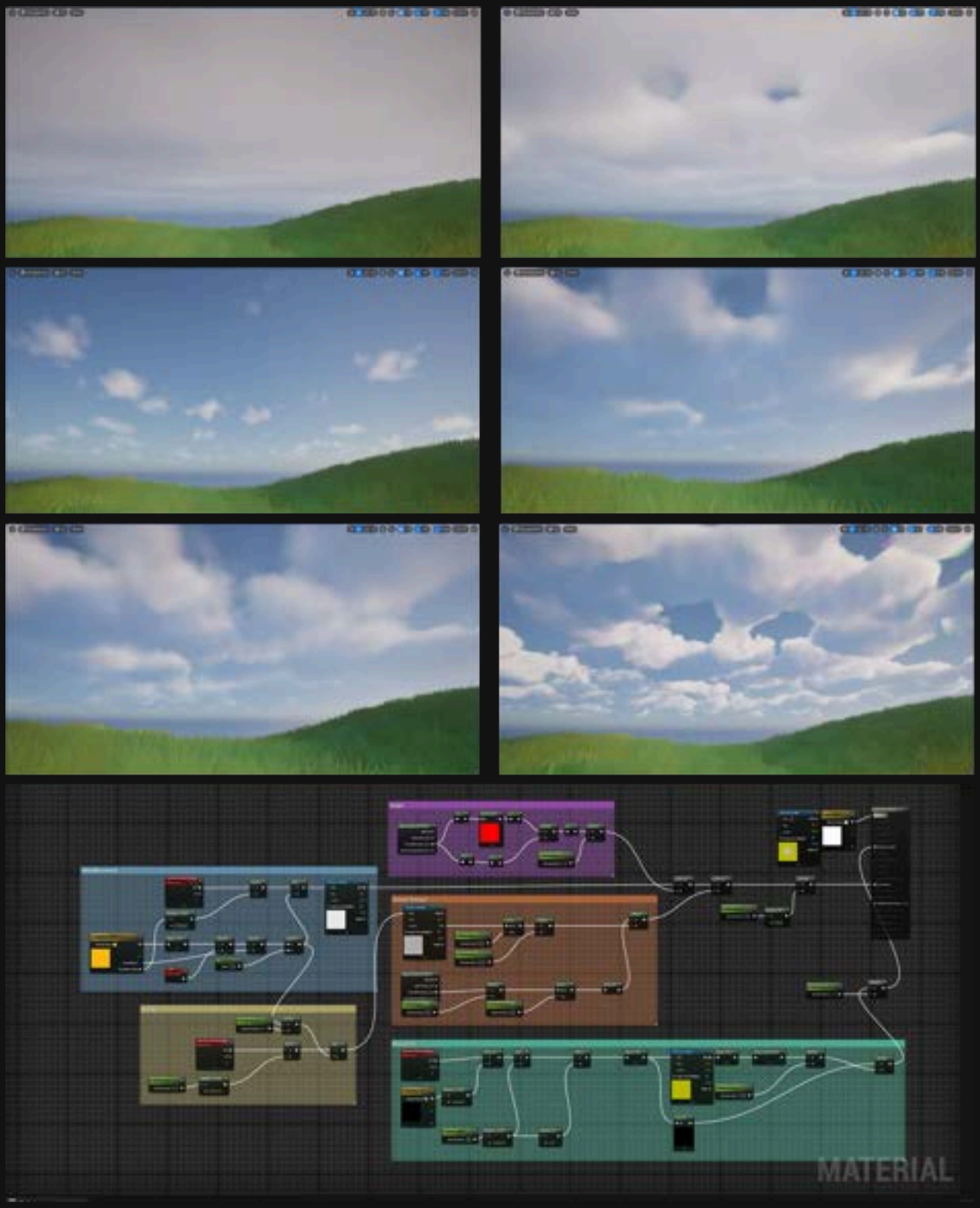


FIG24: 2001 Skybox Example

Opposing this approach, developers can set an oppressive mood, never more evident than with the setting of SilentHill[23], the fog is as much a character as Harry Mason, reinforcing the unsettling locale he finds himself trapped within. A close field of rendering or “Tiny Cloche” skybox simultaneously masks technical limitations under the guise of what became a USP in a beautiful piece of ludo narrative harmony, projecting Silent Hill into gaming infamy.

FIG25: SilentHill

FIG26: SilentHill



Custom SKybox/ Cloud Volumes
Workflow of a custom animated Skybox. Similar to previous cloud production methods uses a pair of scrolling volumetric noises in opposite directions to produce moving clouds.

Erosion: Cloud Sparsity **Wind**: Mass Cloud Movement **Movement**: Individual Movement **Height**: How High up in skybox

In Unreal I made an environment, with grass that blows in the wind. [28] and a custom skybox [17].

For my final exploration into clouds I want to create a simplistic scene that uses all the work and information I have gained thus far…

TEST COMPOSITES
Featuring a bank of fog, prime for a creature to emerge from.

TEST COMPOSITES
Lrge background cloud draws focus away = unbalanced comp.

Combining my VDB volumetric clouds imported from Houdini, both animated and static alongside my modified skybox I made a selection of compositions. Utilizing the age old Pathetic Fallacy

FINAL 3 COMPOSITES

Combination of all of my work thus far. All rendered within Unreal and depict slightly varying moods yet the same cloud assets.

Left- Has a nice value structure however the diagonal stratus cloud creates a bit of an unsual break to the visual flow.

Central- Probably the most balanced and lends itself nicely to my poster (ample room for text both above and below the focal points)

Right- Painterly feel like my studied traditional artists and overall a serene dramatic feel. (My personal favourite)

CONCLUSION

- BROADENING HORIZONS -

FIG 27: HorizonForbiddenWest 2022

FIG 28: HorizonForbiddenWest 2022

Anyone familiar with playing games will have encountered unreachable vistas and imagined what could possibly be out in the distant mountains of Skyrim[23] or cities within FinalFantasy[7]. Their unreachable nature forces us to formulate our own conclusions, often proving more exciting than reality. Much like those of the past who viewed the clouds above as the domain of the gods.

However the modern trajectory of clouds and skies is towards using these volumetrics, culminating in fully realised simulated systems, like those displayed beautifully in Horizon Forbidden West[10]

What sets this title apart is it bridges the gap between the playable and uninteractable, the PS5's power enables Aloy to physically fly through these clouds that will react and move around the Sunwing she sits atop. Where the sky and land have often been definitive, separate entities for optimisation reasons this is the current situation of the medium where everything is truly interactable and fully realised.

There are certainly further refinements I intend to bring into my own workflow most notably around the base cloud creation and optimisation. But the ability to create all manner of weird and wonderful cloud shapes has many possible applications and I have merely scratched the surface.

Ultimately having now attained an understanding of Animated Volumetrics a world of possibilities has been opened for future projects. Not only the obvious dynamic clouds, fog and smoke but even fluid and destruction sims. When combined with Unreal you have an immensely powerful toolset that I cannot wait to continue learning.

GAR204 Art Research Practice:

DRAWING FOR GAMES

GAR204 Art Research Practice:

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