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Contents

Introduction to Project

This project was based on the gorgeous concept art by Max Suleimanov found at this link: https://www.artstation.com/artwork/18qvbe

The project aimed to recreate the environment from the concept art into a 3D game-ready realistic environment that is playable on the university's PCs at a minimum of 30 FPS. It should be a playable environment and therefore consider gameplay elements in the environment such as creating affordance for paths the player could take. The environment should feel alive and focus on the life and community surrounding the harbour rather than being focused on defensive capabilities and violence. This aims to pull away from the often-dangerous forts found in games which encourage violence to focus more on how life functions with the protection in a positive way. This aims to showcase an understanding in creating game levels which incorporate storytelling and world building.

Other deliverables included realistic foliage and set dressing, use of decals, optimised for gameplay to an industry standard using techniques such as RGB Masks, detail normals and trimsheets, the environment should be modular and focus on being accurate to the concept art.

'The Harbor' – Max Suleimanov (2021)

Aims and influences

Developing a coastal fortified city that prioritizes the life and story of the people living there over defensive capabilities and violence.

- To achieve this, I will be following the concept art by Max Suleimanov and recreate the harbour in 3D with the focus being the market in comparison to the walls with cannons. I will be taking out the cannons, having them implied that they are hidden behind the walls and in the dark windows to create a feeling of peace and safety for the players without being overlooked by weapons.

My main influences were the *Assassin's Creed* games with how they have NPCs living harmoniously beside large forts on guard to be attacked by the players whilst also including lots of set dressing assets that world build the kind of community they have and how the life functions in the world.

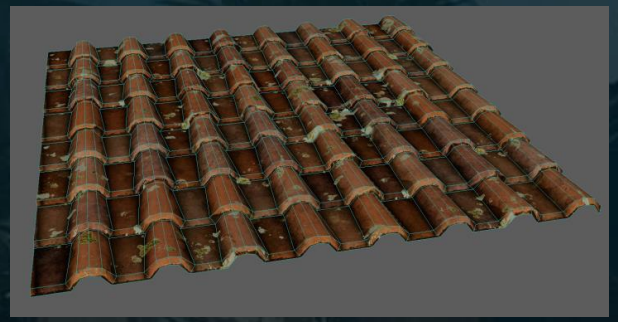
'Assassin's Creed Mirage - Baghdad Residential District' - Corentin Marquet (2024)

'Assassin's Creed Odyssey - Fortifications Texturing.' – Pierre Fleau (2019)

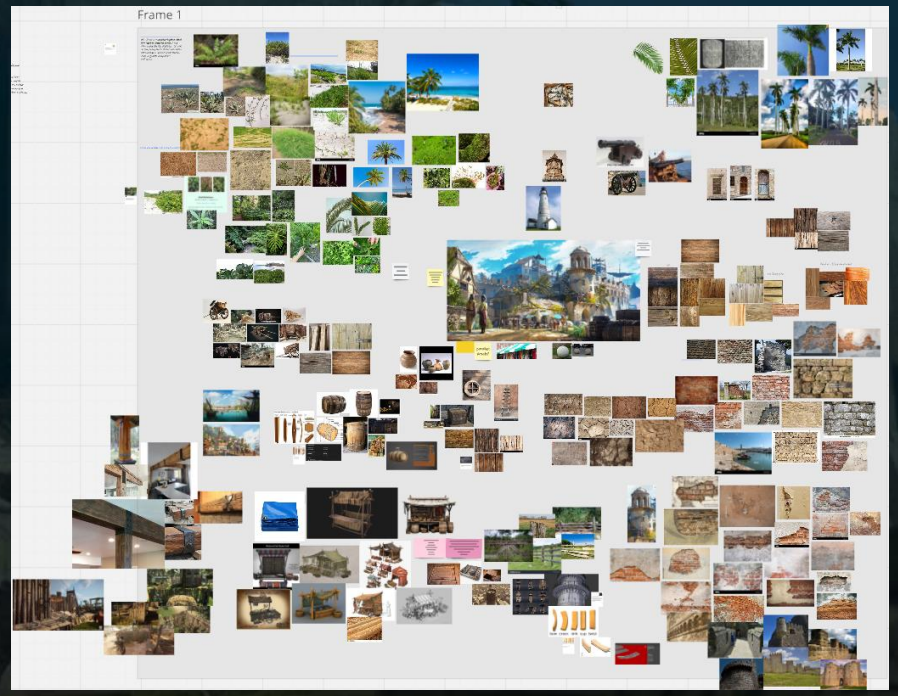
Influences and References

When setting up a project, reference gathering is very important so that was done very early on and added to throughout the project. Using Miro, I gathered many references for materials, assets and influences.

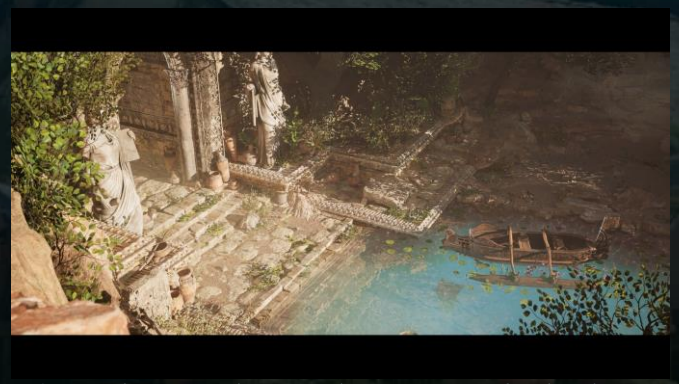
I looked for references regarding art style, to set the quality I wanted to achieve, as well as regarding optimisation and industry techniques that could be incorporated into the environment such as tileable materials repeating across many assets with RGB masks to add variation, detail normals and trimsheets.



'Attikan Farmlands' – Nathan Rose (2022)



'Technical breakdown: Assassin's Creed II' – Froyok (2013)

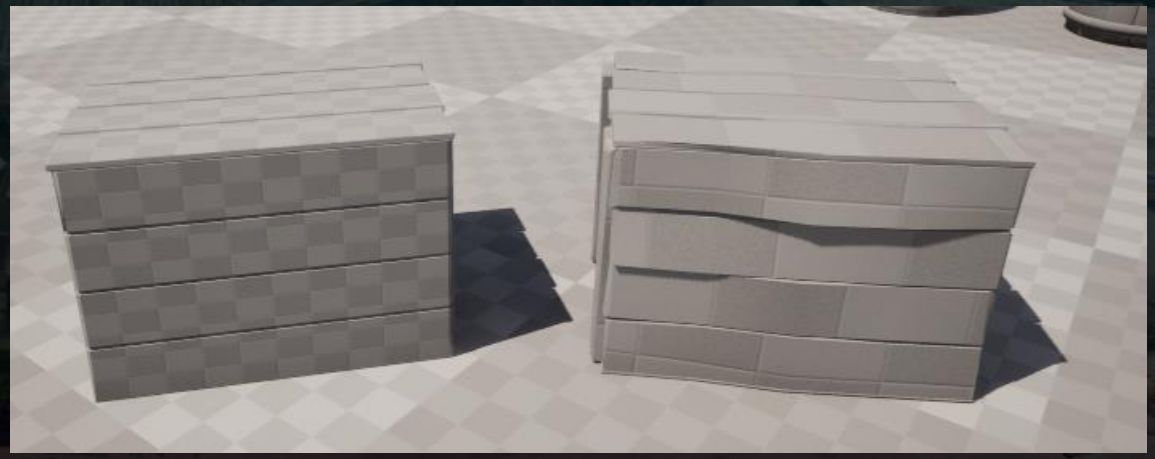


'Artstation Learning - Environment Production in UE5' – Dekogon Studios (2022)

Project Research

- The main goal of this project was to improve skills in PBR texturing for realism, creating a game-ready optimised environment and improving set dressing and story telling to add depth to the game environment. Other learning goals include:
  - PCG experimentation to set dress the ground in a more naturally occurring way
  - Creating photogrammetry and scanning assets and materials for games
  - Creating master materials to use tileable materials and trimsheets efficiently.
  - Realistic foliage creation

I wanted to achieve a realistic art style and so to begin the project I completed a two-week challenge alongside my research to create a realistic tileable wood texture, crate and barrel to set the quality bar for my project. I made two variations of barrel to match the concept with one having a rope tied around from being shipped around.
I ended up going back and revising the shape and sculpt after feedback from my supervisor on how to make it look less uniform. I adjusted the silhouette and removed a lot of the straight lines to add a more organic and worn appearance.



Before After

Before After

Modular Asset Planning and Block-outs

As part of the required deliverables, the environment must be modular. Modularity is helpful especially for fleshing out the areas the concept doesn't show allowing for quick iteration, and it helps towards optimisation through the reusability of assets.
I began by planning out what areas of the concept would need modular pieces and blocked out the scene from there focusing on the modular pieces for scale, grid modelling for simplistic engine implementation.

Modular paint-over plan

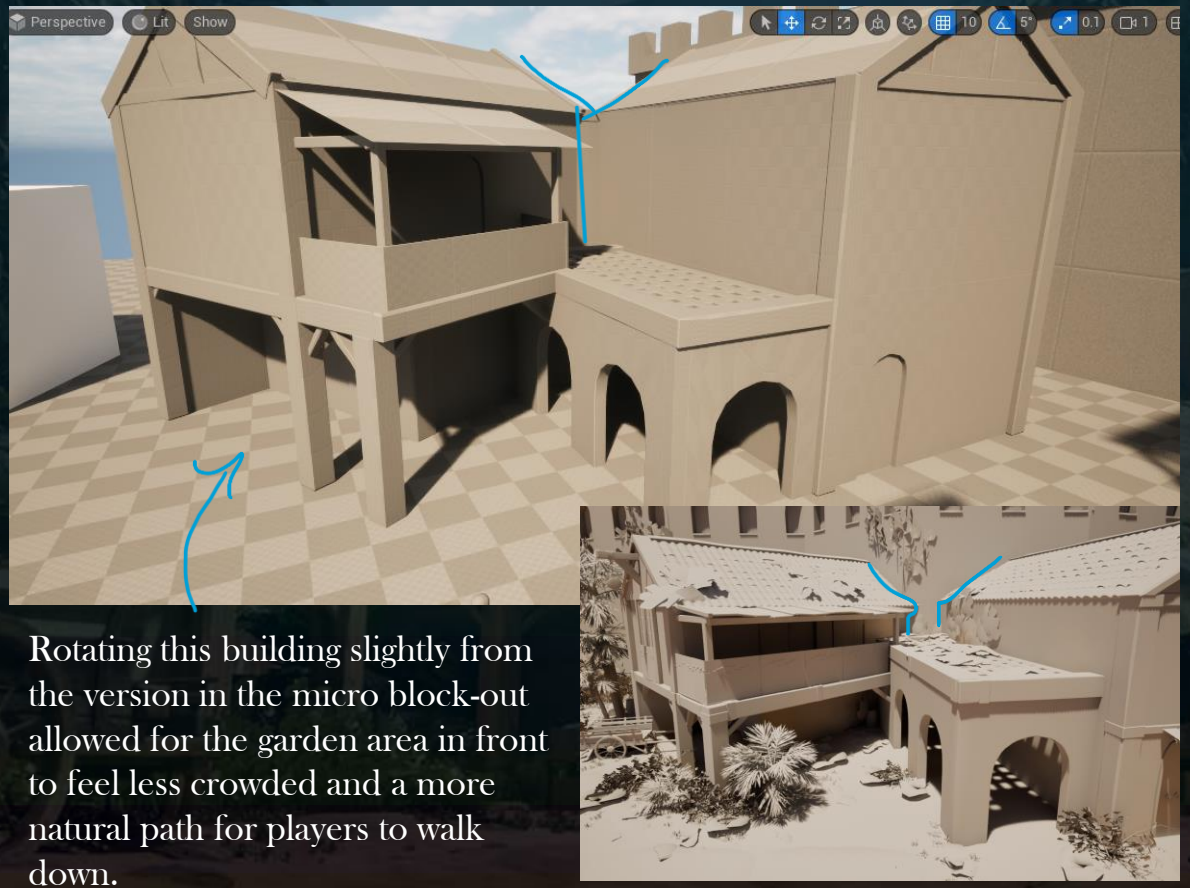
Macro block out

Micro block out

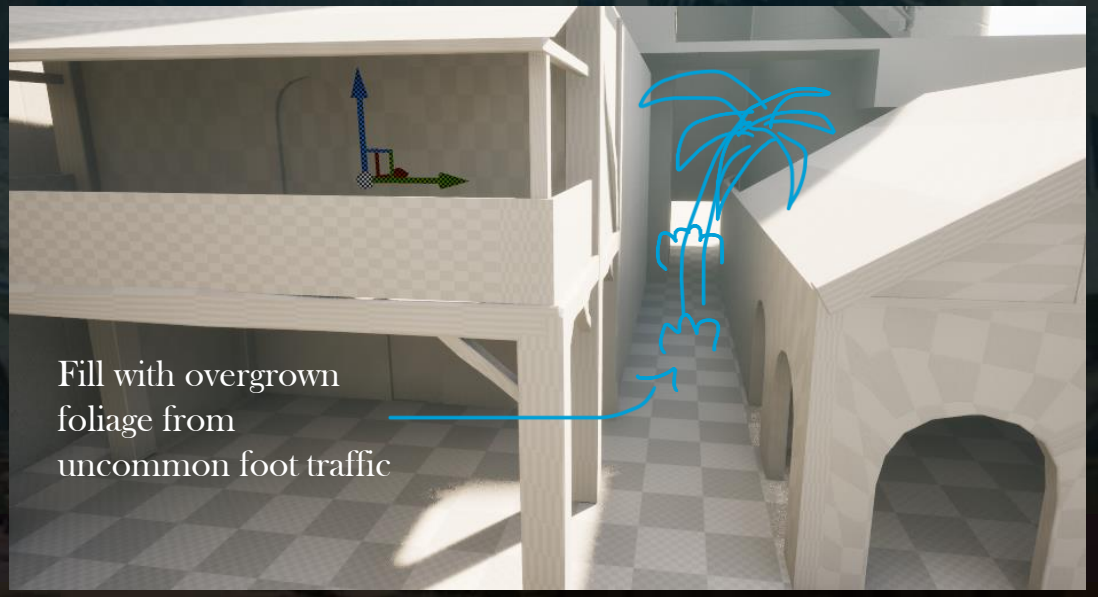
Level Planning

Once the initial scale and micro block-out was established, then came the planning and iteration for the areas of the level not shown within the concept, reusing modular assets to put the scene together whilst requiring very little extra asset creation for time saving and consistency as if the same group of people were building the town together.

Mood board references for level set dressing



Rotating this building slightly from the version in the micro block-out allowed for the garden area in front to feel less crowded and a more natural path for players to walk down.



Fill with overgrown foliage from uncommon foot traffic

Comparing to Concept

Translating the 2D concept art into 3D was challenging due to the perspective differences so the scale had to be adjusted to make sense for gameplay.
Using this article: *UE4: Guide to Player Scale and World/Architecture Dimensions* by AlexG (2015) helped inform the scaling for players interacting with the environment for assets such as doorways which need to be slightly exaggerated in third person games for players to naturally pass through.

Adjusting camera lenses and other various settings as well as scaling and rotations of assets helped moved towards more accurately fitting the concepts visual language whilst also focusing on playability.

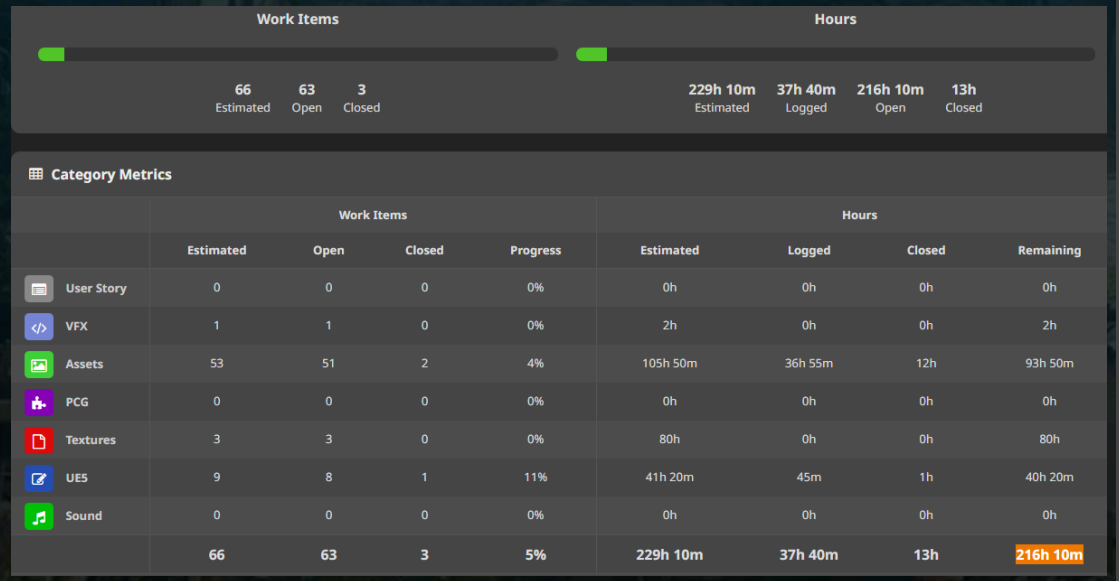
Concept overlaid 50%

Before adjustments

After adjustments

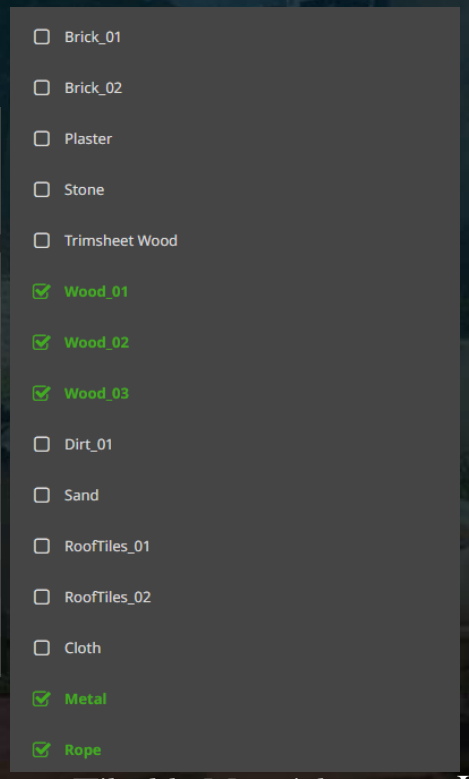
Asset List

- Using HacknPlan to plan assets this also creates an estimated time for completion set for each asset aswell as the overall project. These assets shown are the most important assets needing priority for completion.
- To add to this is a materials list which contains the tileable materials needed for this scene as well as a list for the unique materials.
  - The level will focus on using tileable materials alongside RGB Masks for variation and more control within engine and normal bakes with detail normals for added detail to optimise the scene and aim to reduce draw calls using material instances from master materials.

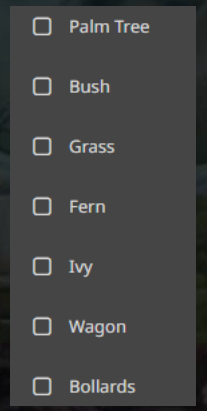


	Work Items				Hours			
	Estimated	Open	Closed	Progress	Estimated	Logged	Closed	Remaining
User Story	0	0	0	0%	0h	0h	0h	0h
VFX	1	1	0	0%	2h	0h	0h	2h
Assets	53	51	2	4%	105h 50m	36h 55m	12h	93h 50m
PCG	0	0	0	0%	0h	0h	0h	0h
Textures	3	3	0	0%	80h	0h	0h	80h
UE5	9	8	1	11%	41h 20m	45m	1h	40h 20m
Sound	0	0	0	0%	0h	0h	0h	0h
	66	63	3	5%	229h 10m	37h 40m	13h	216h 10m

Estimated total time for completion



Tileable Materials



Unique Materials

Main Priority Assets

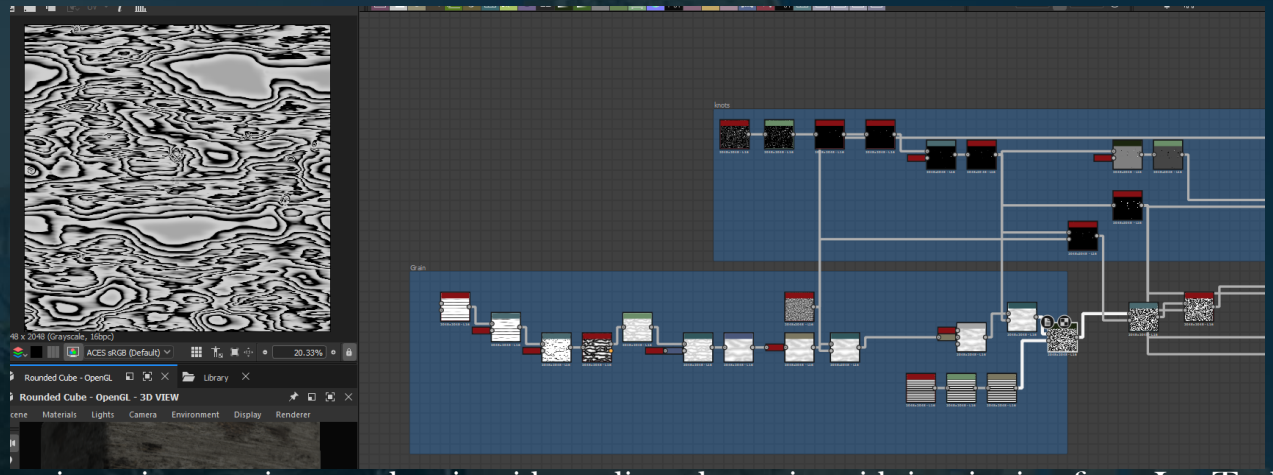
Hybrid Block-out

Here is the hybrid block-out first pass.

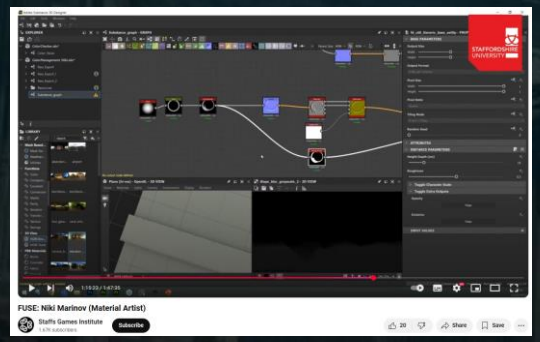
- The visual language and composition matches the concept. The blue markets draw the attention to the centre of the image. The lighting matches that of the concept art although the front of the market is in the shade the brightness of the roof keeps your attention in the centre with leading lines created from the wagon and supporting buildings and castle walls as well as the barrels and crates framing the image closer to the camera.

Wood Tileable Material Creation

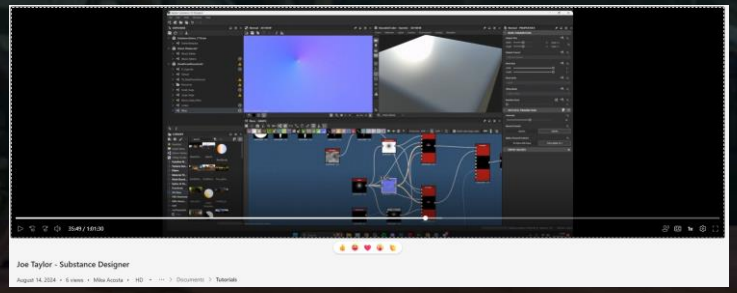
Lots of research went into creating realistic tileable materials in Designer. Main sources of research came from *Niki Marinov's talk in the FUSE conference* as well as a university *industry talk by Joe Taylor*. Niki Marinov (2024) spoke about different techniques such as using the RGBA Split and Merge nodes for different uses such as vector map inputs to have shapes follow a shape created or splitting the red and green channels from a normal map to specifically add detail on one area.
Joe Taylor's talk (2024) was especially helpful for creating knots as he spoke through his process using gradient dynamics to simply create a base for wood grain and warping the knots in.



Experimenting creating wood grain with gradient dynamics with inspiration from Joe Taylor.



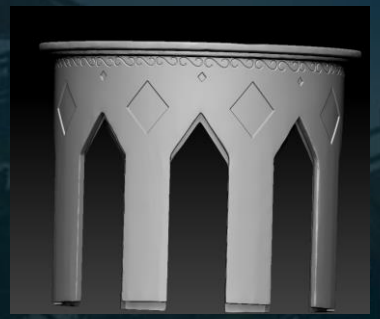
'FUSE: Niki Marinov (Material Artist)' – Niki Marinov/Staffs Games Institute (2024)



'Joe Taylor – Substance Designer' – Joe Taylor (2024)

Created tileable wood variations based on research

Hero Prop Production



Before sculpting any wood, I researched into realistic sculpting techniques to create a realistic sculpt. I mainly followed a video by *Polygon Academy (2019)* which includes:

1. Carving out chunks
2. Layering up noise onto mesh with clay tubes
3. Flattening with Trim dynamic
4. DamStandard for extra detail

Following these steps and ensuring to include primary, secondary and tertiary detail on each sculpt helped to achieve much more realistic results.

Using alphas that I drew using Photoshop to add detail into the mesh, I also made use of the layers in Zbrush to adjust the intensity after engraving them into the mesh for a less destructive workflow.

Before adjustment

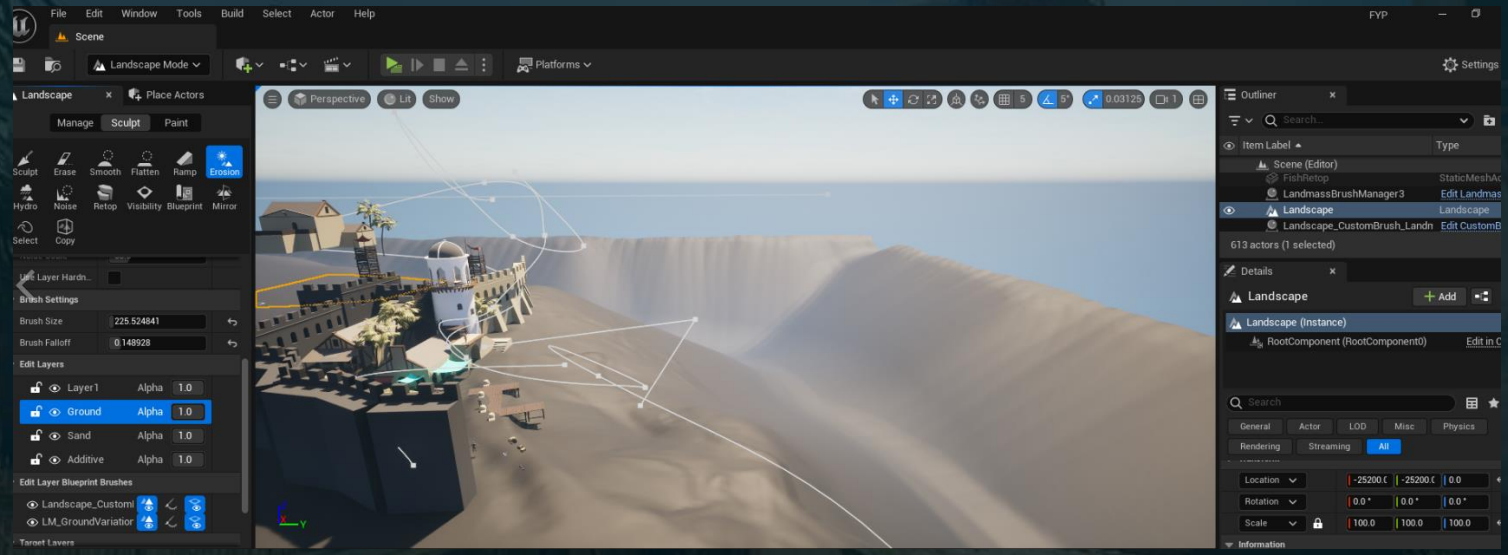
After adjustment

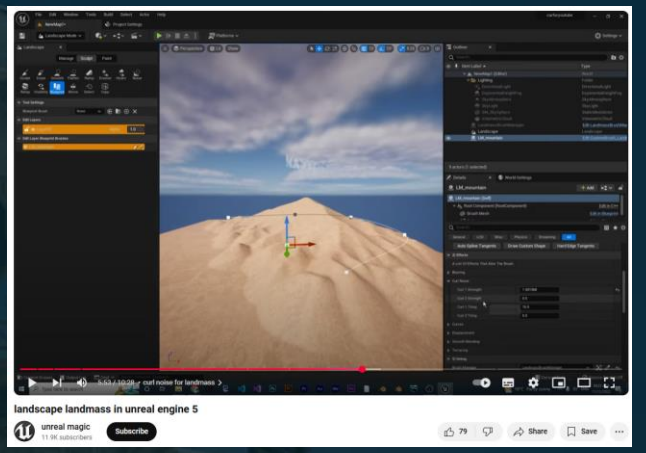
The tower had a few iterations along the way to achieve the best quality. Originally it was sculpted with wood going into the centre with the top section of the tower resting on some unrealistically large wood pieces. After feedback from my supervisor, I went back and reworked the design by finding industry reference on similar towers and how they were constructed focusing on the supports and where the tower connects.

'WATCHTOWER PLATFORM MEDIEVAL SLAVIC TOWER VILLAGE COLLECTION AAA' - Deliverables (2022)

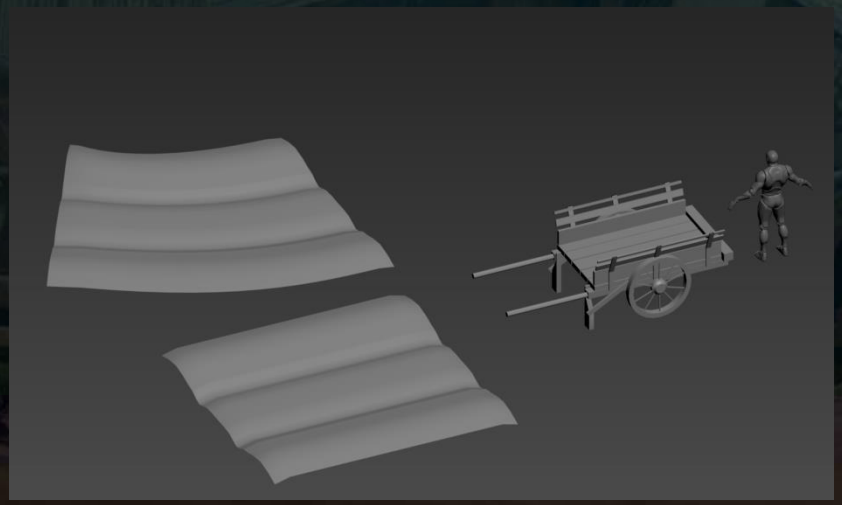
Landscape Production

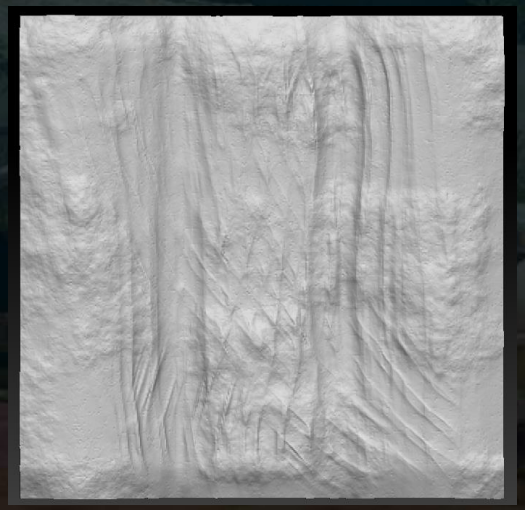
Added subtle noise to the landscape and carved out the ocean area using the Landmass Plugin. Then created a modular path that was sculpted to have wagon trail marks in and overlaid within the landscape to add a more detailed pathway.





'landscape landmass in unreal engine 5' – unreal magic (2023)



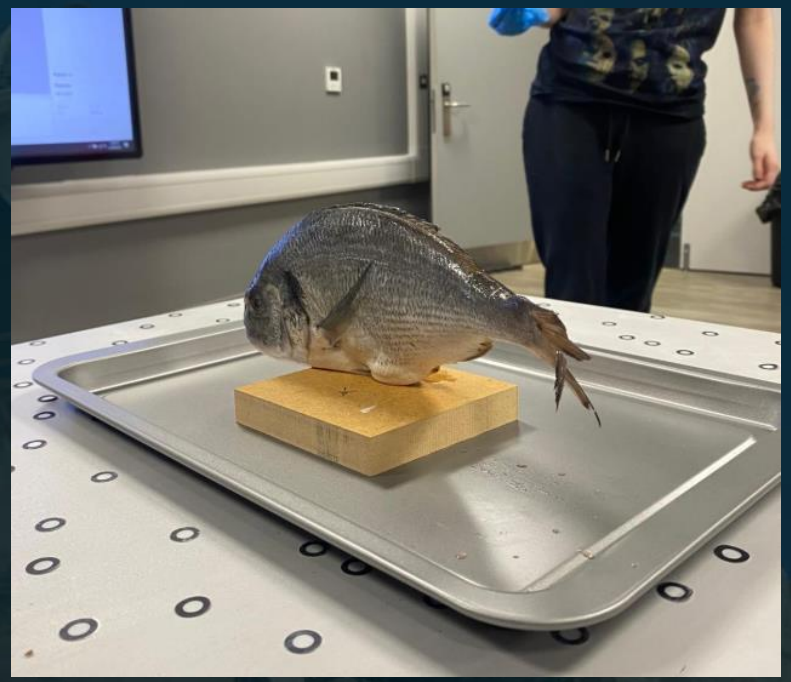


Scanning

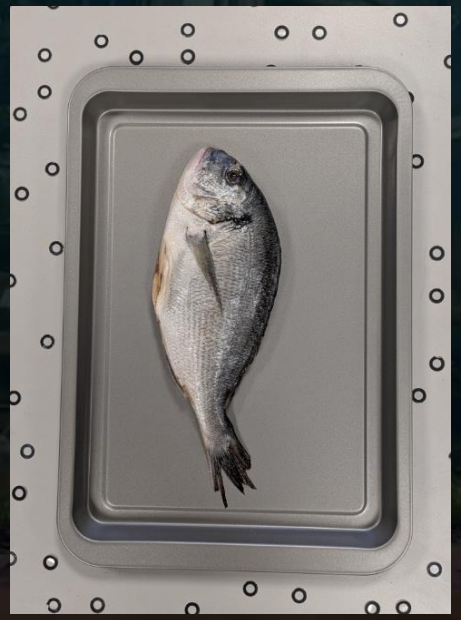
Fruit, veg and fish for scanning

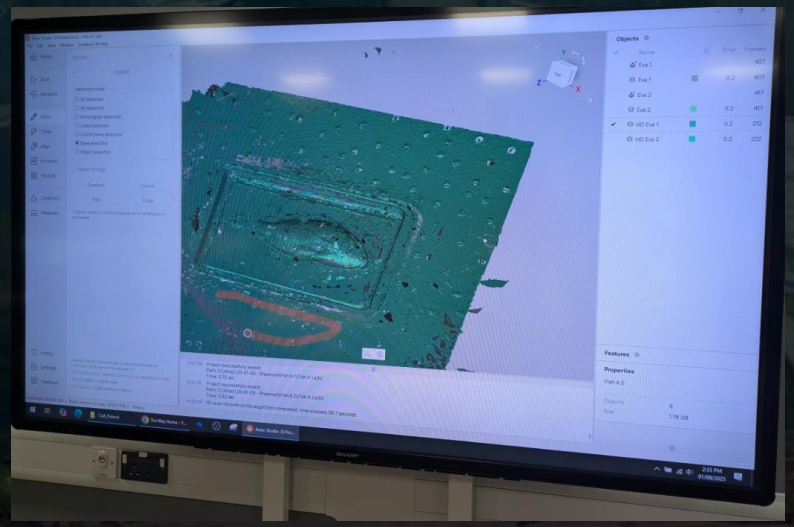
Laser scanning and photo scanning captured different amounts of detail. Laser scanning captured high quality normal detail whereas photo scanning was able to capture the textures as well as lower quality (in comparison) normals.

Scanning the fish flat created problems when aligning the two sides together due to the floppiness so by creating a stand to scan it upright allowed for a much better result.

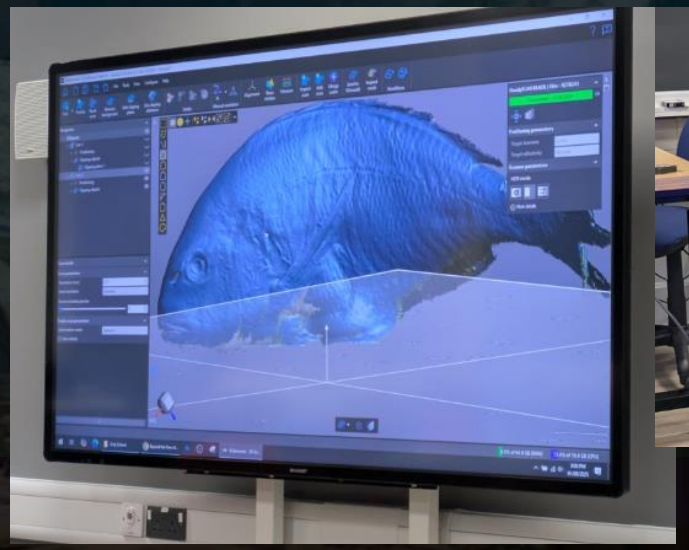


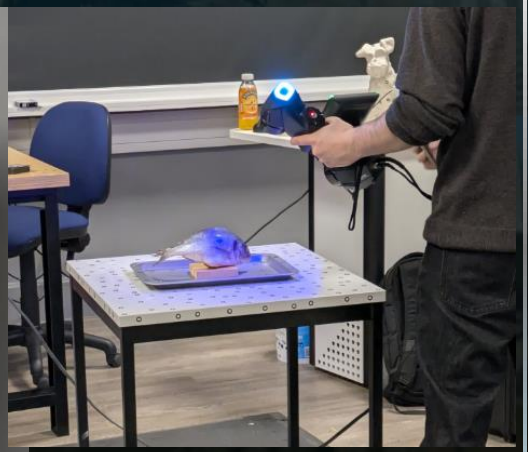
Standing Scan





Flat Scan

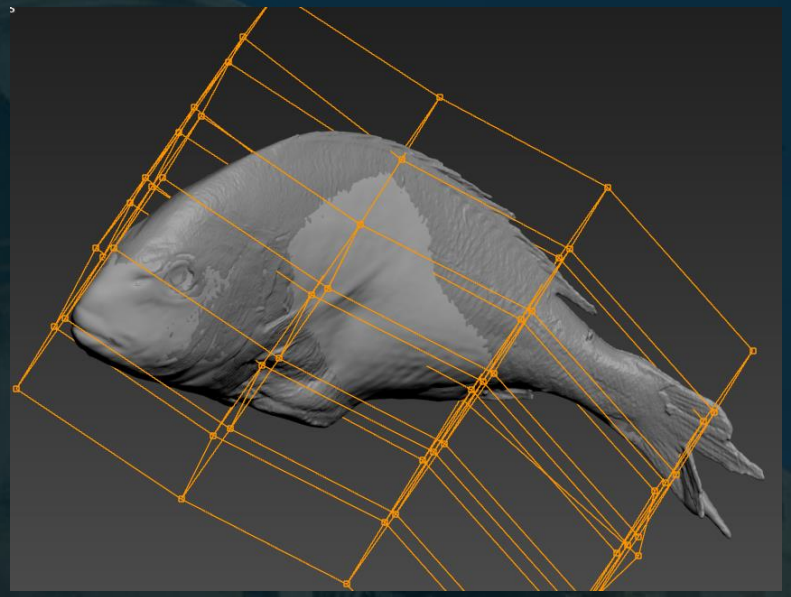


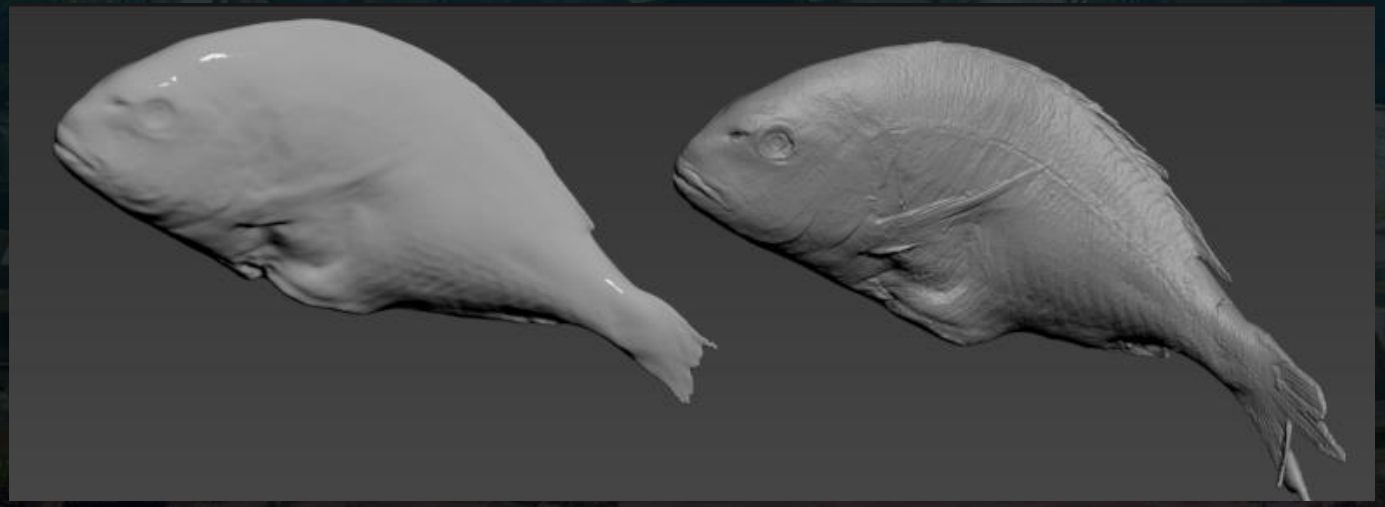


Scanning

Captured both laser and photo scans of the fish to capture different kinds of detail. Between scans as time went on the fish became warmer and floppier to work with meaning that it began to fall to the side and the shape captured from each was different. Using an FFD modifier I could mould the photo scan in line with the laser scan to allow the transfer of detail from both meshes.

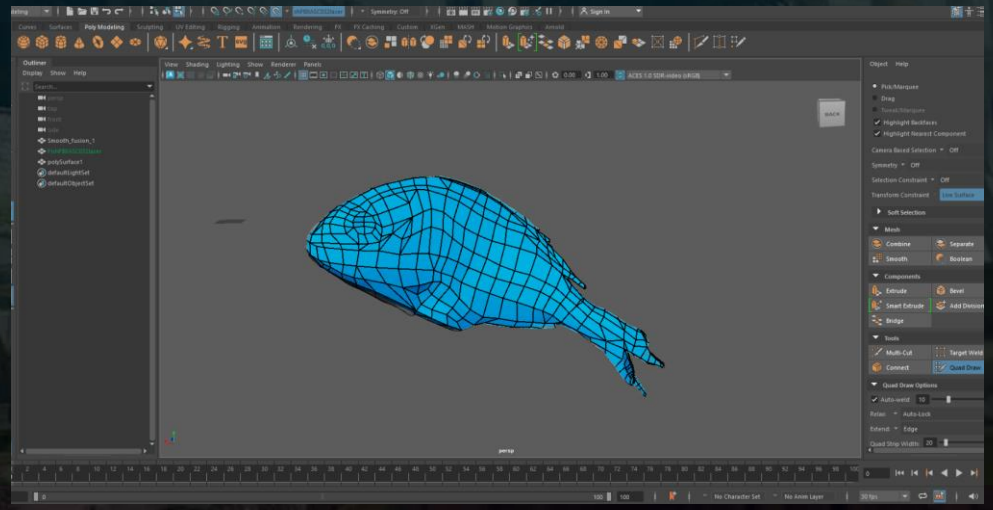
Below is an example of the detail difference captured between laser and photo scans.





Photo

Laser



Quad drawing in Maya was a useful tool for simple retopology.

Scanning

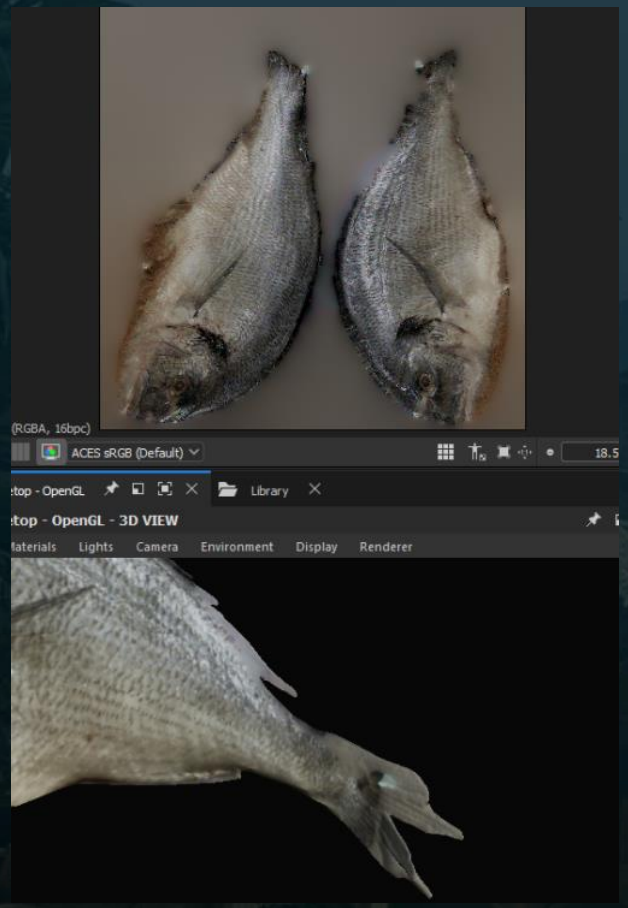
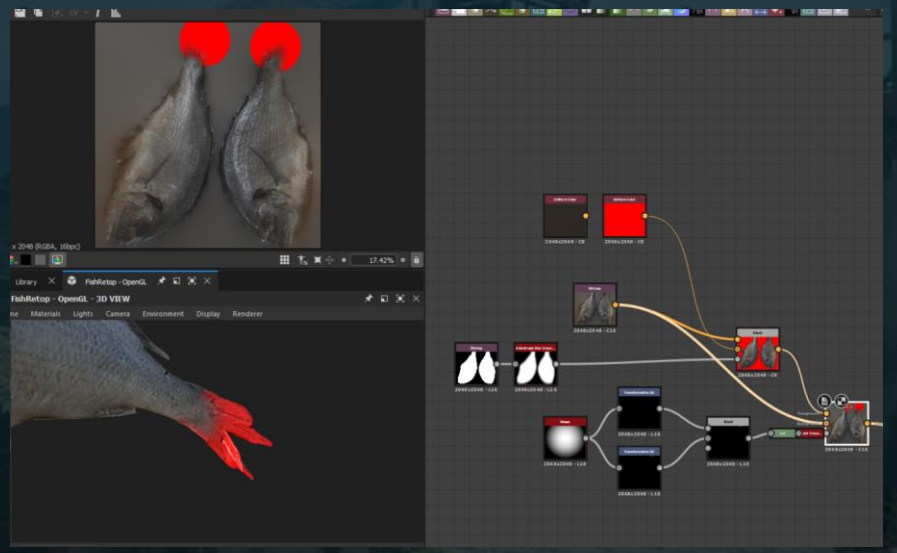
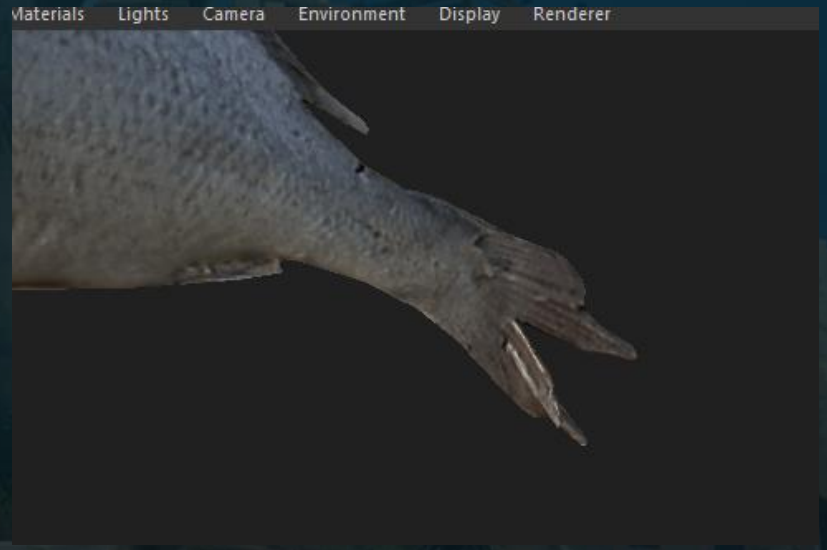
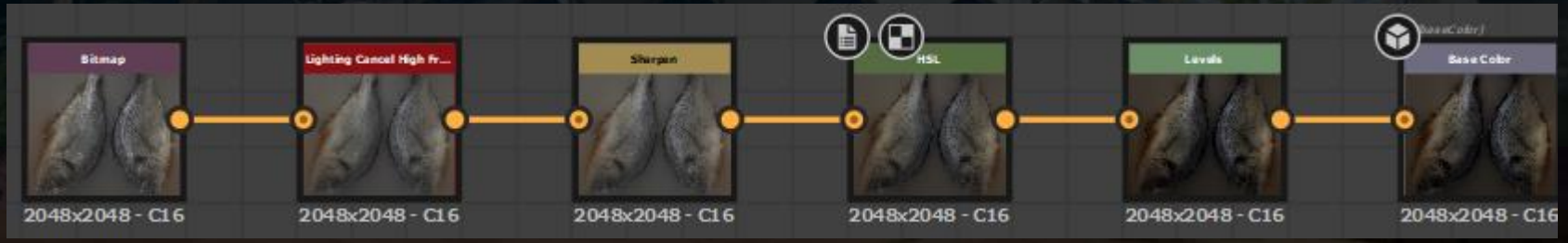


Photo scanners struggle to pick up information from thin areas, so the end of the tail missed some data so to fix it, I masked out the end and colour matched to the rest of the fin.





The photo scanner also captured the reflections from the flash. Using a Lighting Cancel High Frequency node it removes any light flashes on scanned materials.



Scanning

Bake with laser scan normals

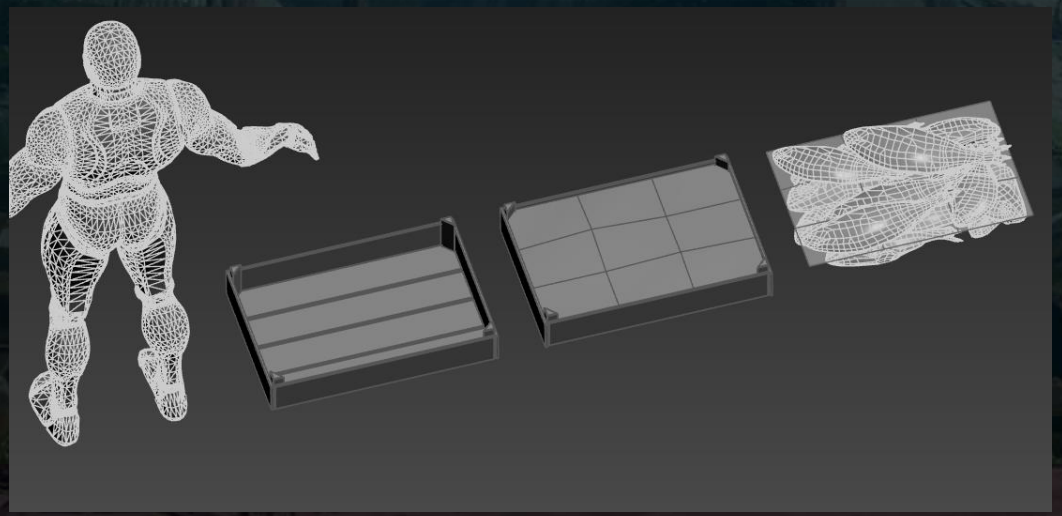
Scanned asset in Unreal Engine 5.4

Scanning

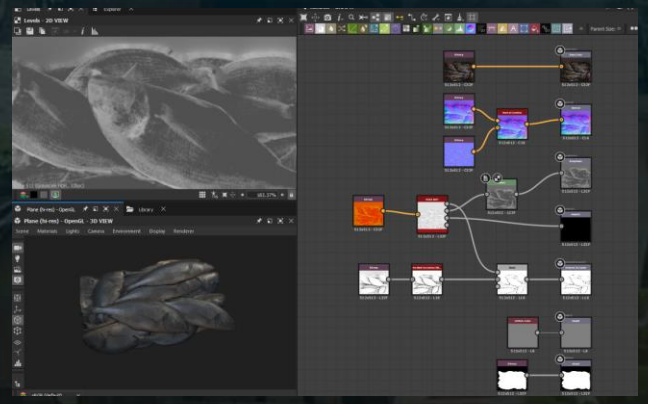
Baked crates shown in Unreal Engine with 2-3 actual meshes on top for added depth.

- To fill the crates in a way that is optimised, I looked at how Harrison Snatt (2023) baked down fish onto a flat plane to create the illusion of a full crate without needing all the hidden geometry to stack actual fish meshes.

- Baking in Designer to allows you to bake transferred textures from the photo scans onto the fish being stacked.



Empty crate – Low poly full crate – Full crate high poly to be baked

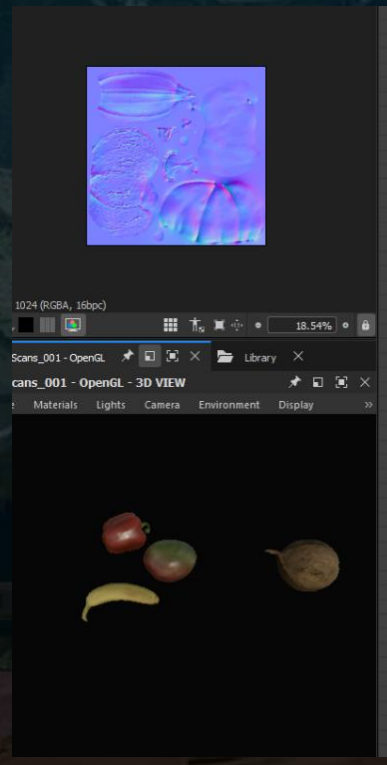


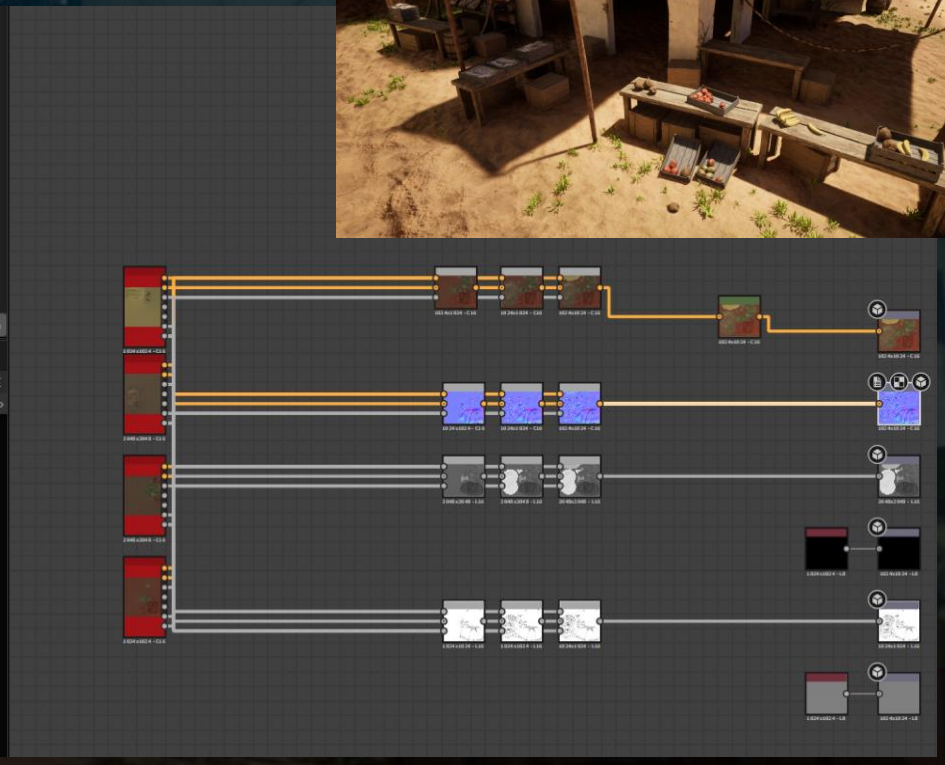
Transferred textures (normals and colour) baked in Designer

'Fishmonger's Stall' – Harrison Snatt (2023)

Scanning

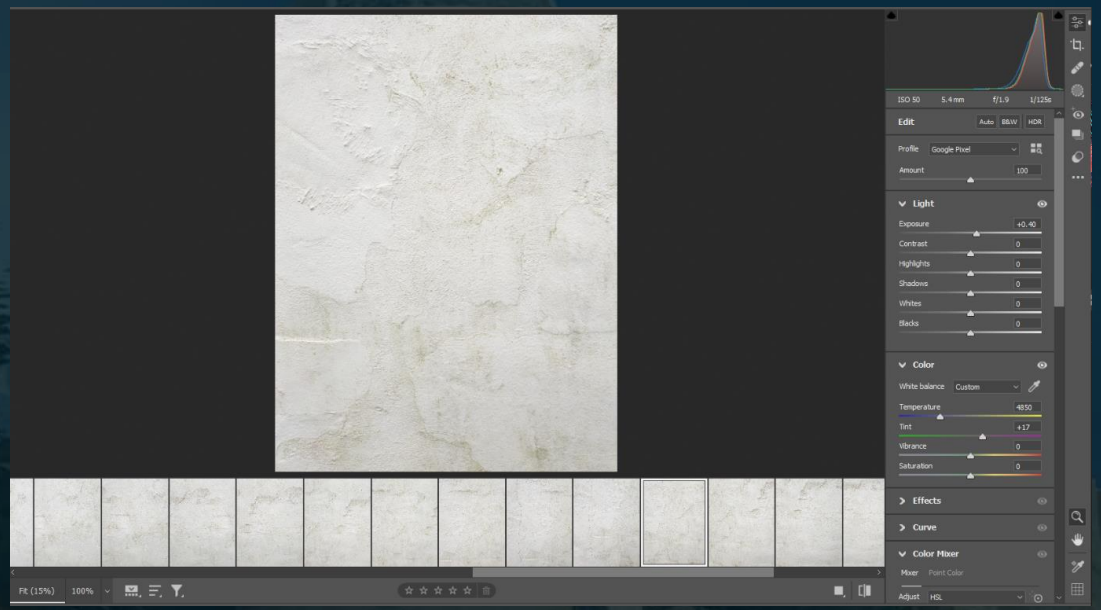
- The rest of the food scanned assets were simple to Quad draw and bake excluding the pineapple.
- The pineapple scan had collapsing areas due to the number of thin sections which couldn't be aligned and picked up by the scanners so I chose to not use the scan as the clean up would be too time consuming and would require me to resculpt the mesh and texture myself.
- The remaining food assets were baked on the same texture sheet to optimise their textures as they will always be rendered together in the market.



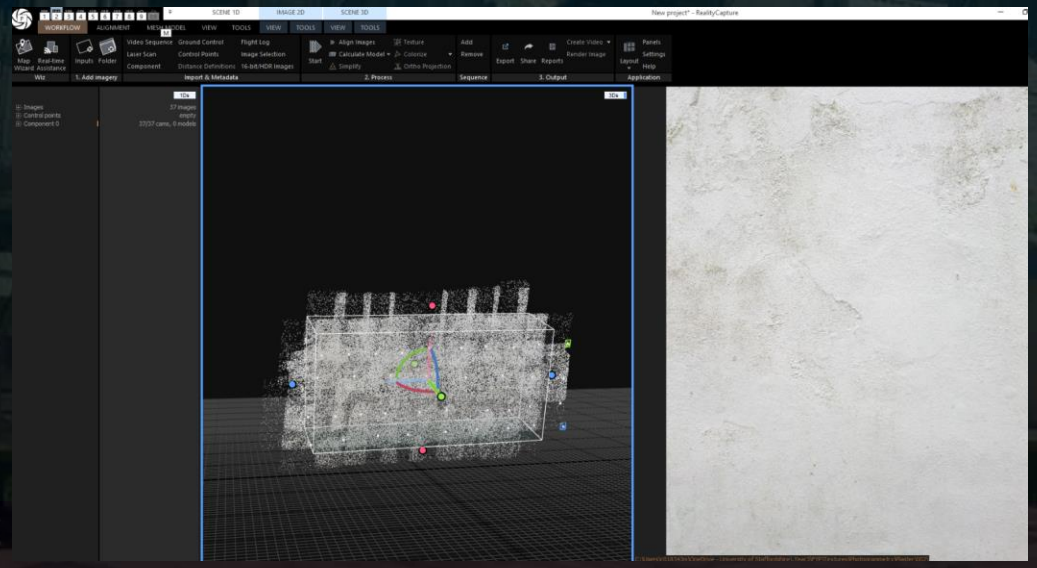


Photogrammetry

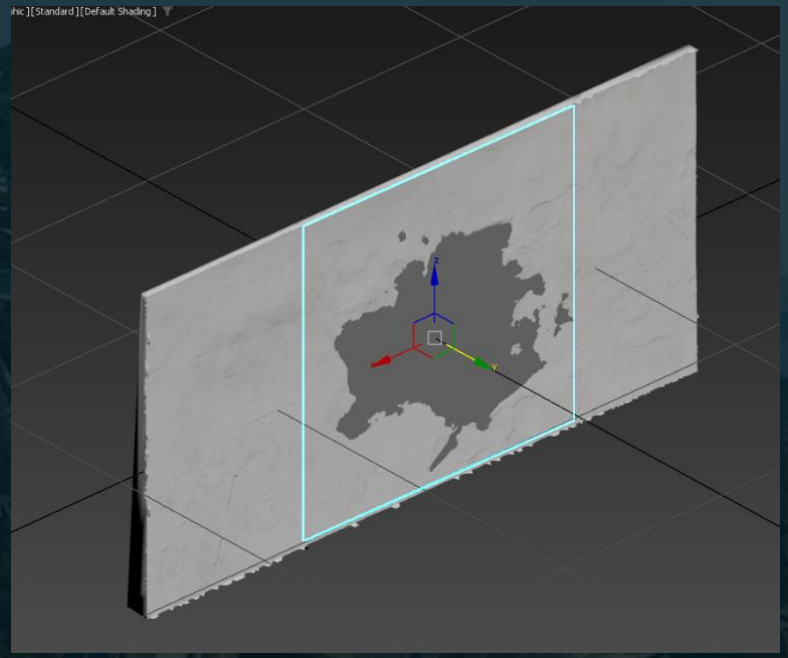
- Using a DSLR Nikon D3400 to take RAW photos captured lots of detail in textures and by putting the RAW images through Photoshop's Camera RAW image processors to colour balance the images keeping consistency but also ensuring to stay accurate to real colours by colour picking pure white in the image to balance.



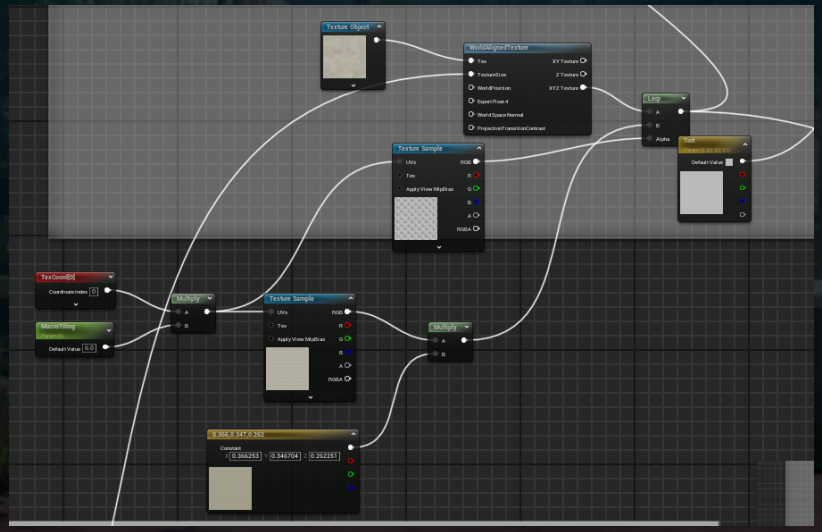
- Then using Reality Capture to process the images into meshes to be baked into tileable materials.



Photogrammetry



- Overlapping a plane with the high poly mesh allows you to bake the detail onto a square image plane and bake transferred textures to transfer the colour information.



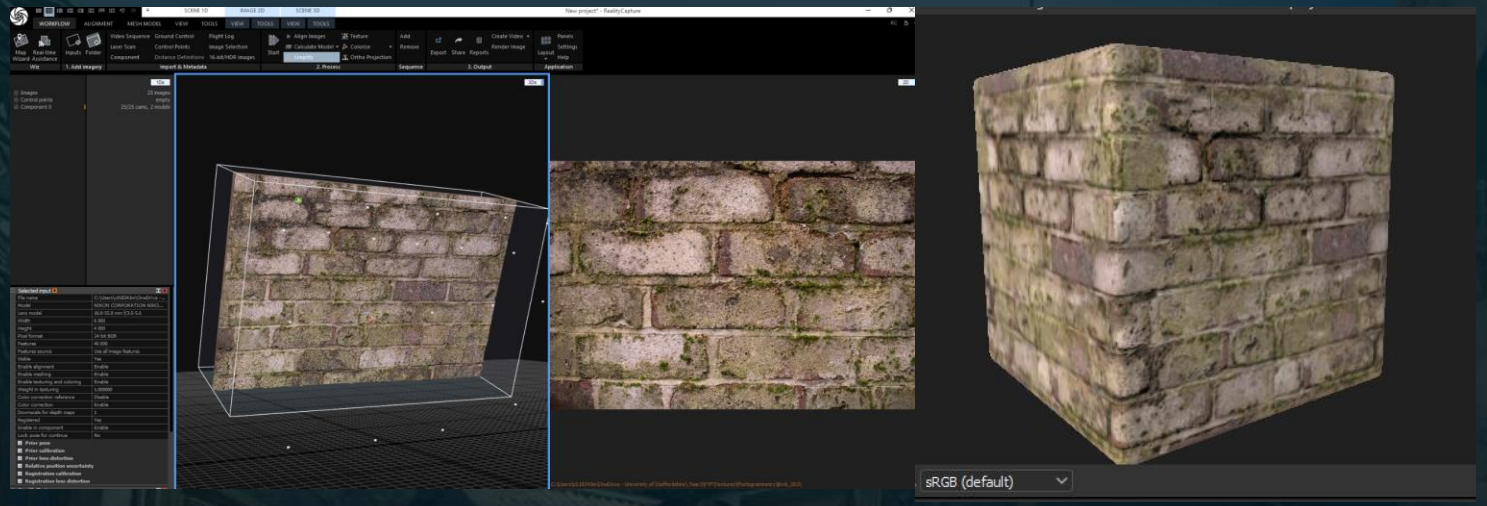
- When adding this tileable plaster material into engine it tiled repetitively. To break up the tiling the base colour with a tint was overlaid at a different, larger, scale to the main material adding more variation.

Without variation

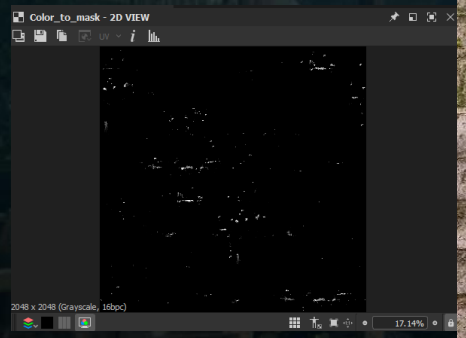
With variation

Photogrammetry

- More materials that were created using photogrammetry include bricks and the palm trees.



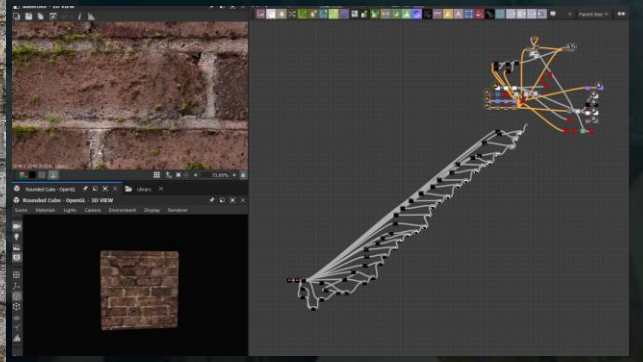
- These bricks had lots of interesting detail and old wear on however, were not the colour needed for the environment.



Colour to Mask mask

Photogrammetry colour

Colour adjusted using moss mask



Colour adjusted bricks after grout masked out.

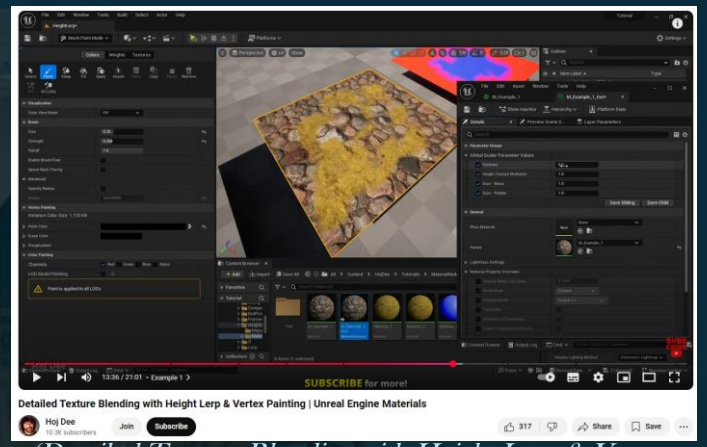
Palm tree bark photogrammetry materials

- To adjust the colour without affecting the colour of the moss a Colour To Mask node was helpful in isolating it. Each brick had to be masked individually to avoid affecting the grout however due to the lack of depth in these bricks making it almost impossible to mask out only the grout.

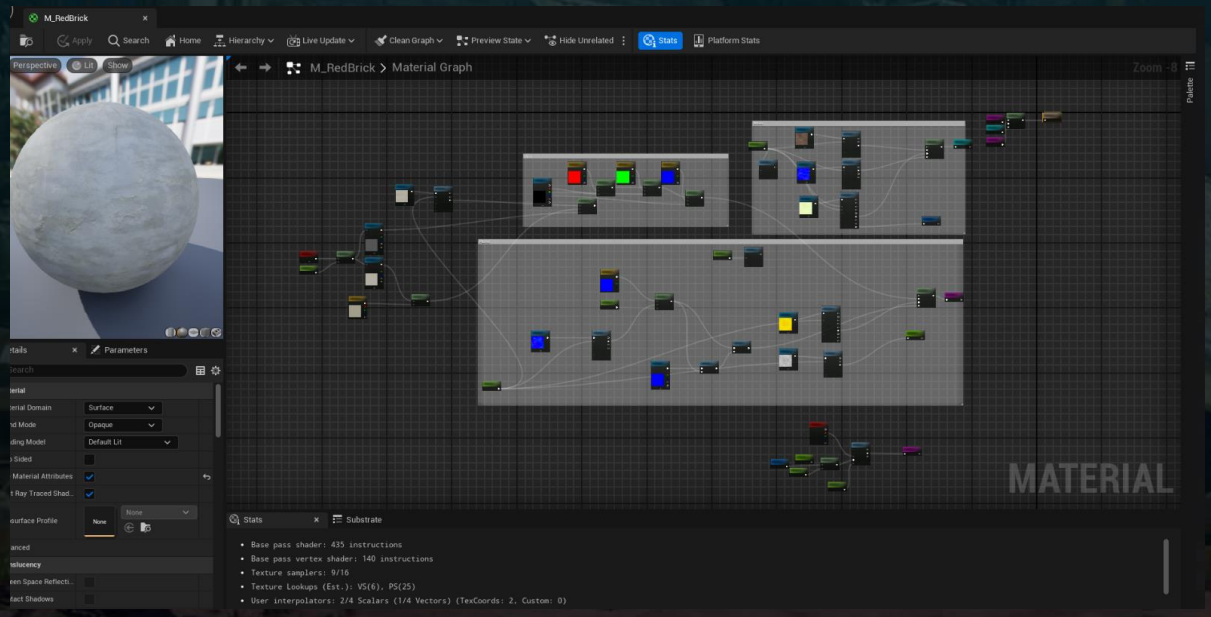
Vertex Painting

- Using a video by Hoj Dee on Detailed Texture Blending with Height Lerp & Vertex Painting | Unreal Engine Materials I learnt how to setup vertex painting in a way that also gives me control on the contrast and height values.

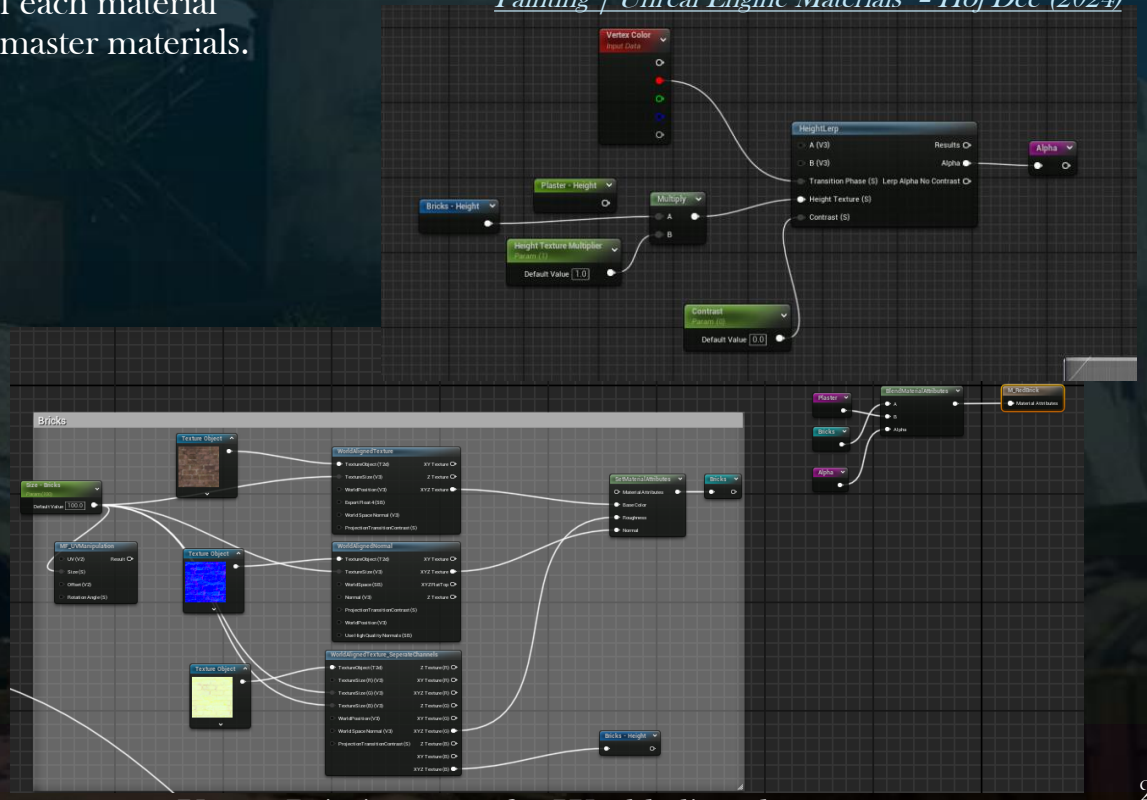
- I then incorporated this into my master material that utilises the overlaid macro detail for variation, RGB masks and detail normals as well as created a version for world aligned textures as well. Working in this way allows me to reduce shader permutations by having specific master materials per tileable material needed and/or per need of each material therefore reducing the need for static switches by using more simplified master materials.



'Detailed Texture Blending with Height Lerp & Vertex Painting | Unreal Engine Materials' – Hoj Dee (2024)



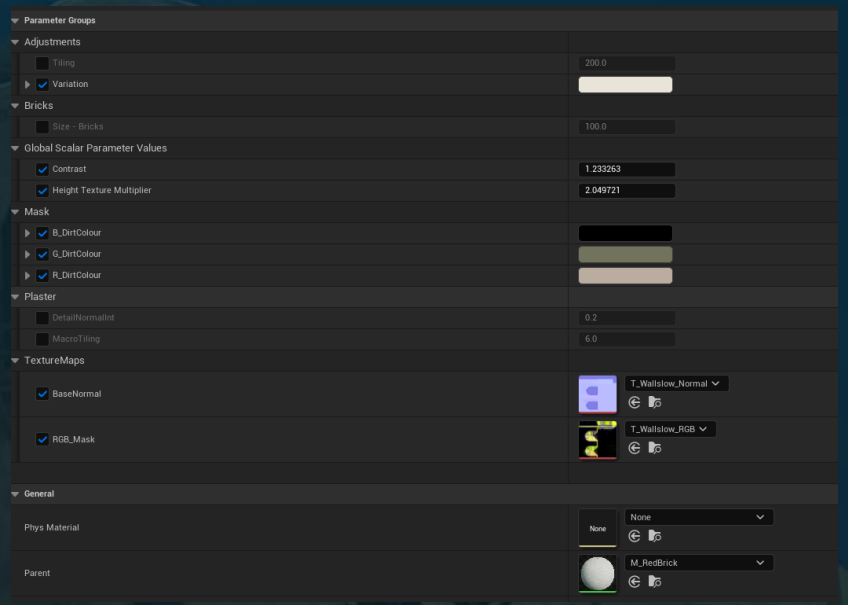
Vertex painting master material graph overview



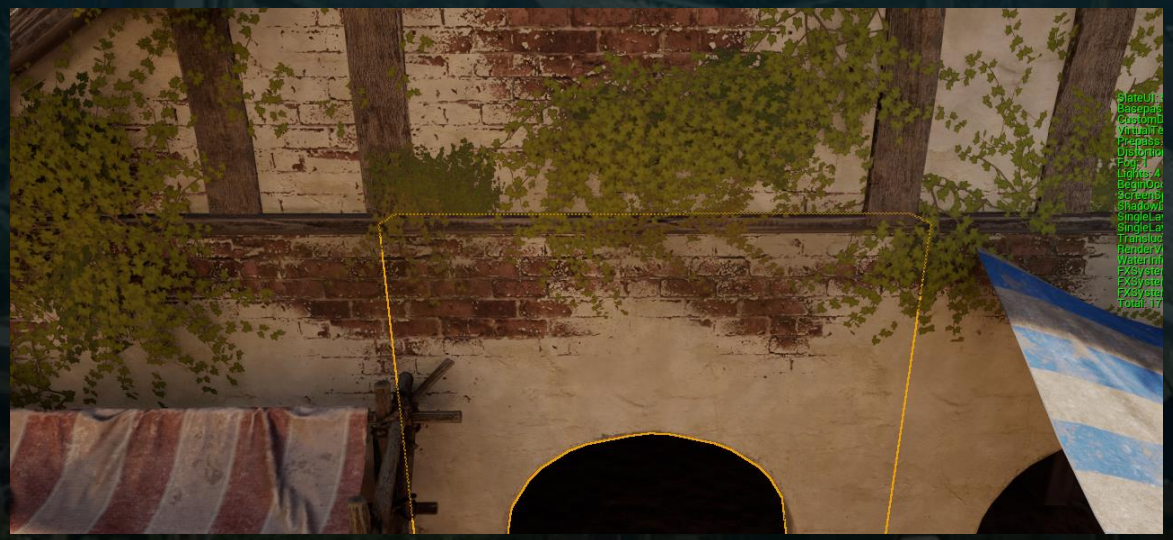
Vertex Painting setup for World aligned

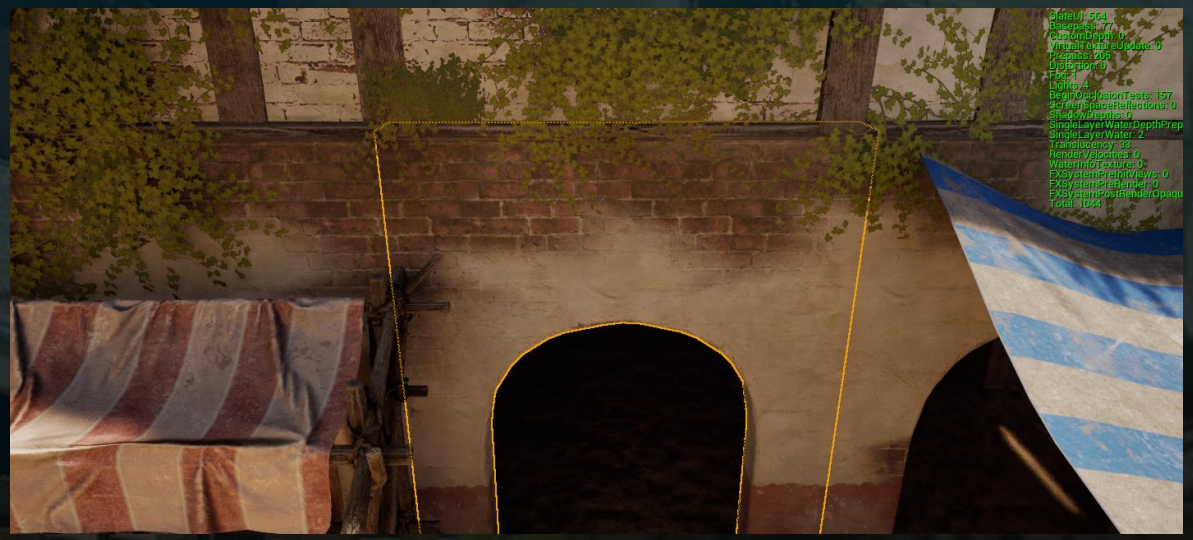
Vertex Painting

Here shows how the parameters can be adjusted for the vertex painting to achieve different affects.



High contrast and high height texture multiplier

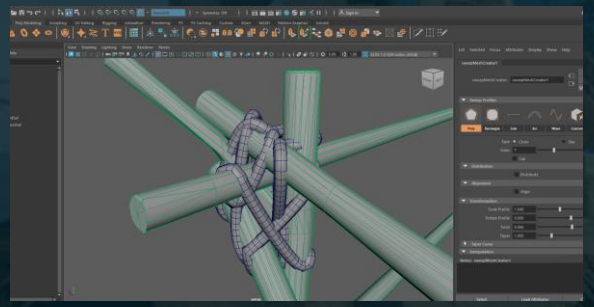




Low contrast and low height texture multiplier

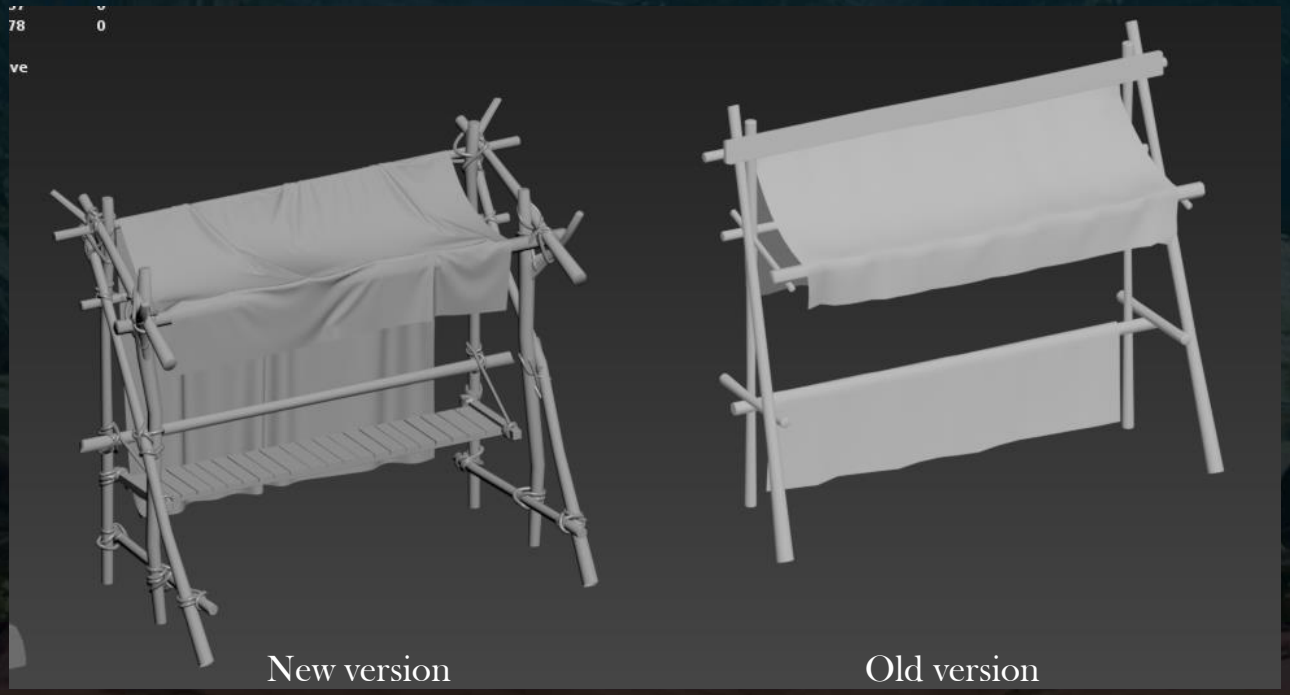
Market Production

After receiving feedback from my supervisor about the market stall I reworked it to be a lot more believable and realistic by taking the cloth into Marvelous Designer for more realistic physics simulation as well as restructuring the market making it stand stronger and tying the joints with rope using Curves on the market structure as a live object and adding a Sweep Mesh in Maya for geometry.



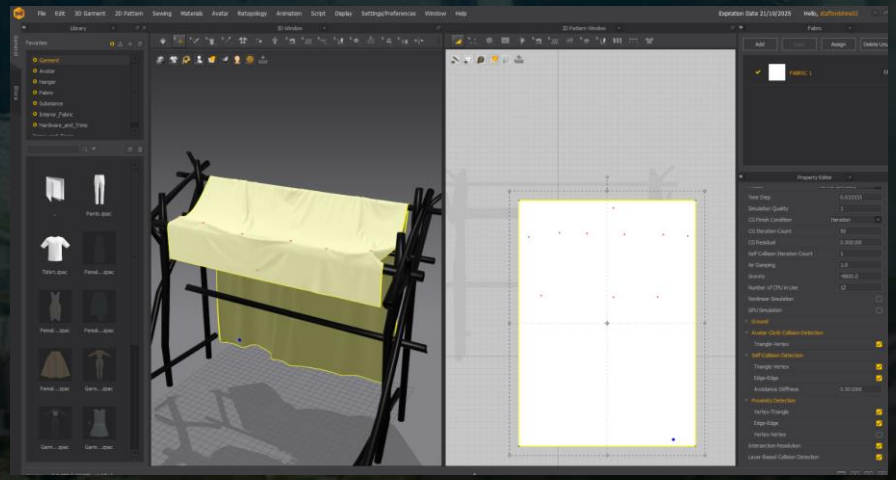
Curves in Maya

Reworked structure



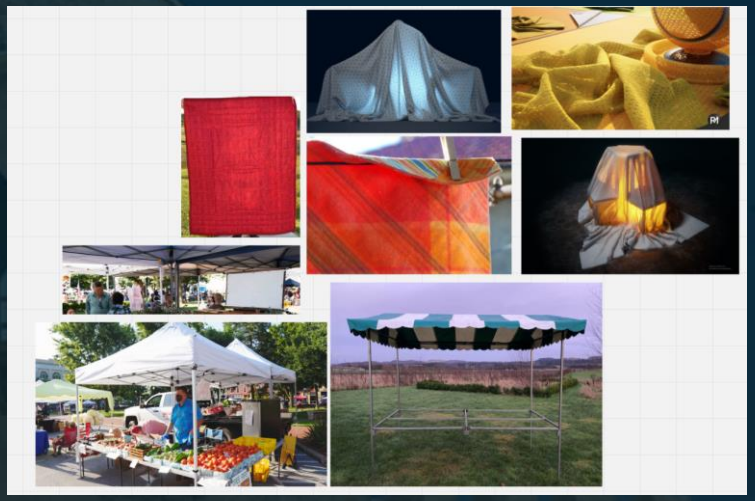
New version

Old version



Marvelous Designer cloth simulation

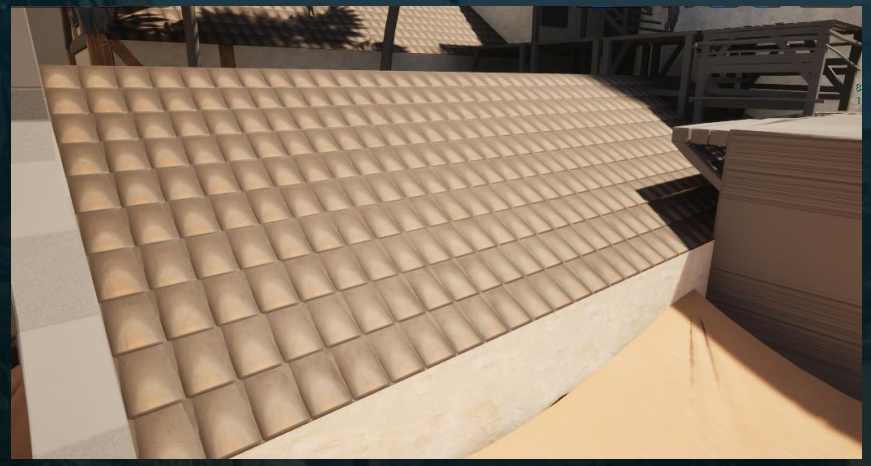
Market Production

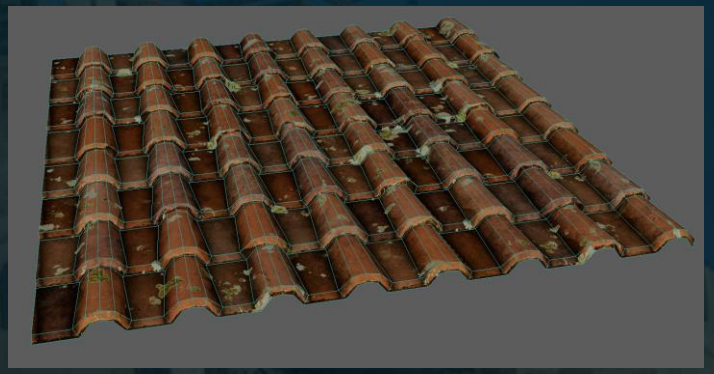


Adding Subsurface colour to the material of the cloth allowed light to pass through the mesh more realistically helping to portray a realistic depth

Asset Production

- To add more depth, I experimented with Parallax Occlusion however, the goal of this project is to have a playable environment level and with Parallax still being experimental it impacted performance heavily. Instead, I looked at Nathan Rose's Attikan Farmlands (2022) Article where he talks about his process on creating realistic roof tiles and created geometry based on the tileable material for the tiles.

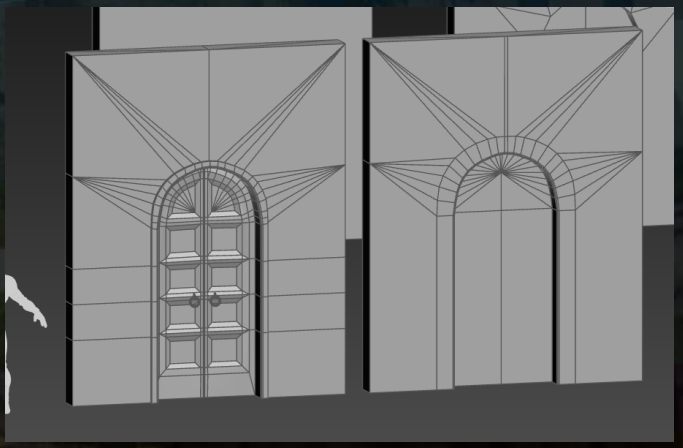




'Attikan Farmlands' – Nathan Rose (2022)

- Added extra metal supports to beams to support the structures more realistically.

- Modelled the door, baking majority of the detail in.

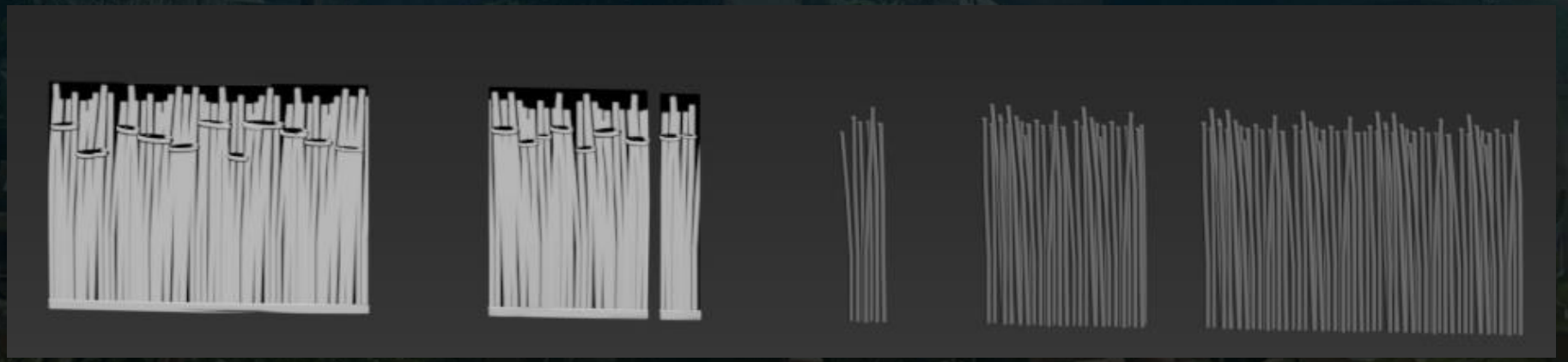


Asset Production

Assassin's Creed Black Flag (2013)

Assassin's Creed Origins (2017)

- For the fence creation I used influences from Assassin's creed for ways to assemble the fences and optimise them. In Origins (2017) the fence is made using straw and sticks and baked onto planes with certain elements of geometry floating for depth.



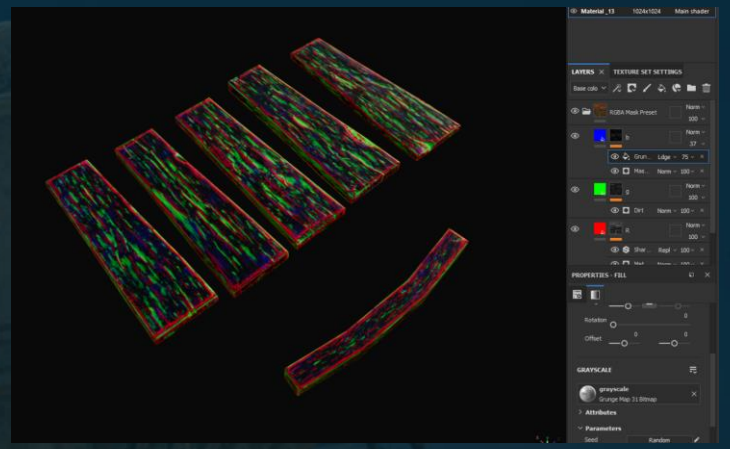
Low

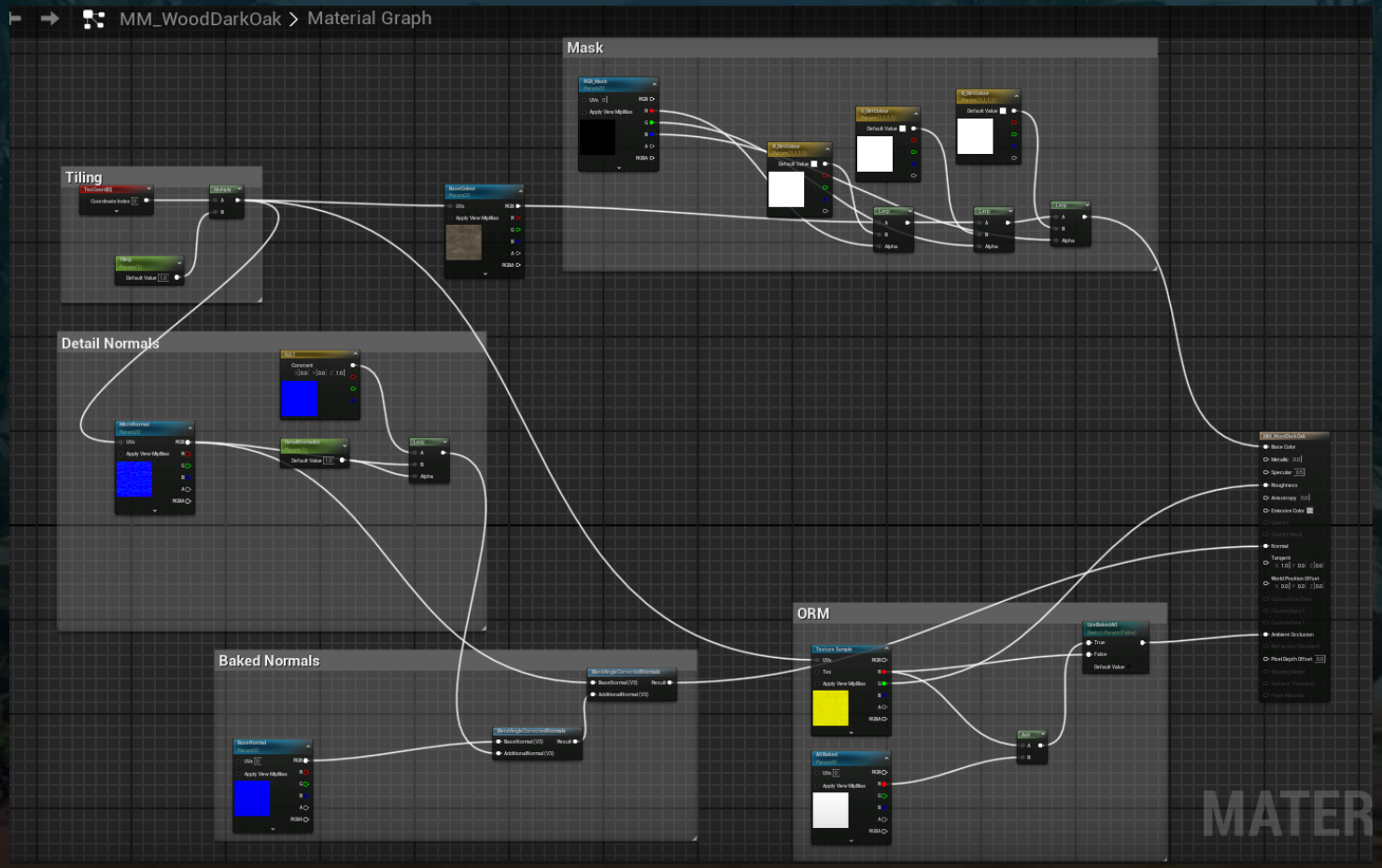
High

- Using floating geometry for the supporting planks and rope tying together it added some extra realism and depth without needing to have every stick with its own geometry.

Material Setup

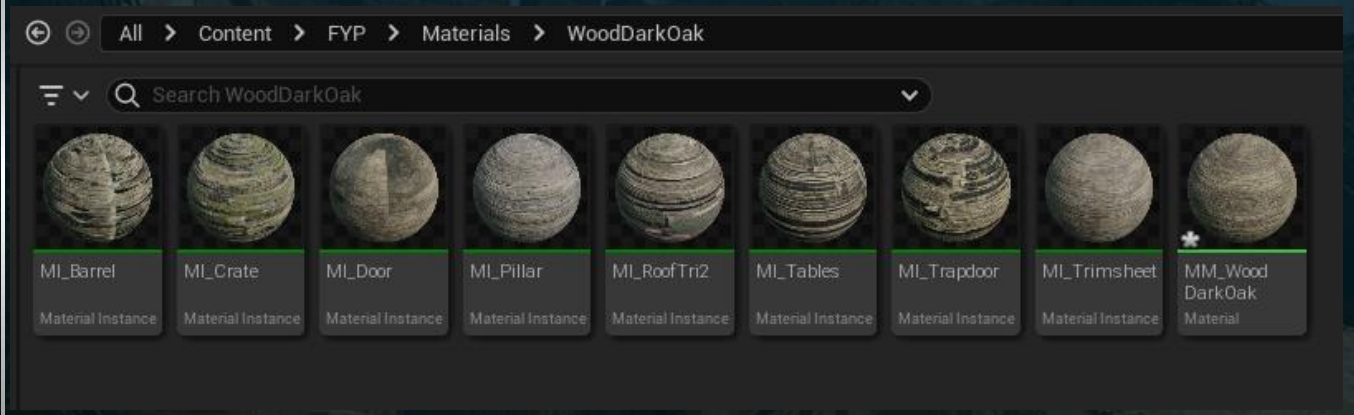
- The main approach I have taken to try reduce draw calls is working with RGB masks and detail normals with tileables.
  - RGB Masks for colour variation, mostly unique per asset
  - Detail normals from tileable paired with baked normals blended
  - Also works with World Aligned.



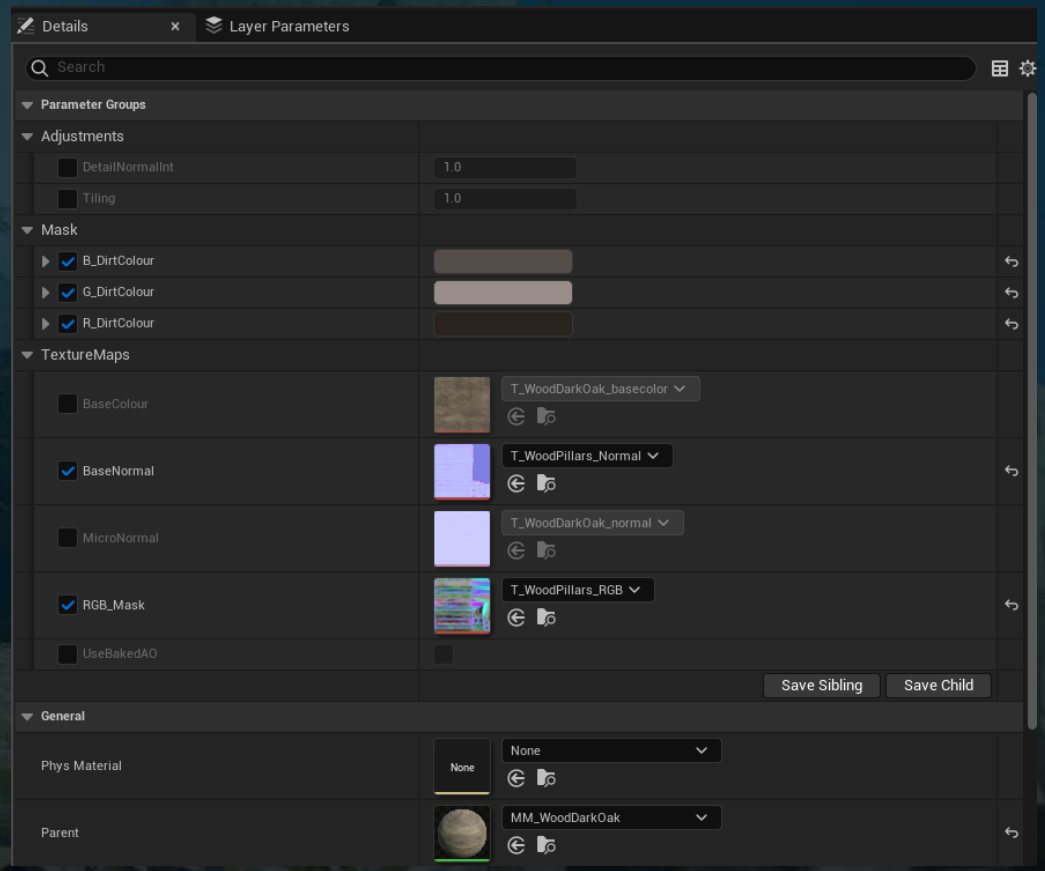


Material Setup

- This workflow ensured that quality was consistent across assets and allows for more control within engine. This could be optimised even more by having a general RGB mask for all assets however, having unique bakes and RGB masks adds a lot more precise detail which is what I wanted to achieve.
    - Very time saving in comparison to texturing each asset individually to a high quality.



Above is how I set my materials up, organising in folders by tileable master material base then instanced for the assets using it which needs individual parameters adjusted. If there is no need for its own baked maps then it can use the trimsheet or Master material.

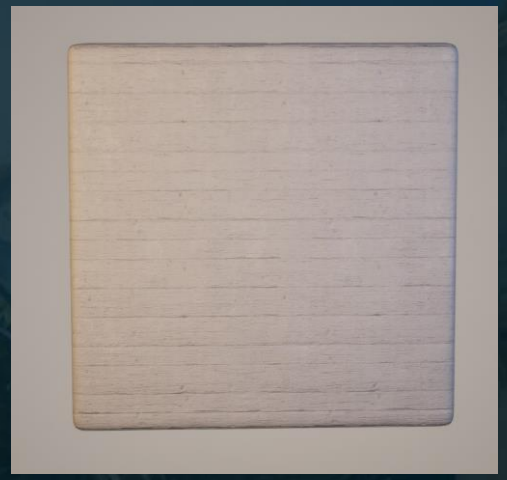


Texture parameters

Trimsheet Production

For my trimsheet I wanted to take inspiration from Lego Dimensions (2016), using a trimsheet for wooden planks. This allowed me to use it on assets that didn't need sculpting due to repetitive detail and not close to the player.
I then paired this normal trimsheet texture map and RGB mask with the tileable master materials within the instances to be able to have more control over the variation within the tileable.

The assets highlighted in green below are assets that are using the trimsheet textures.

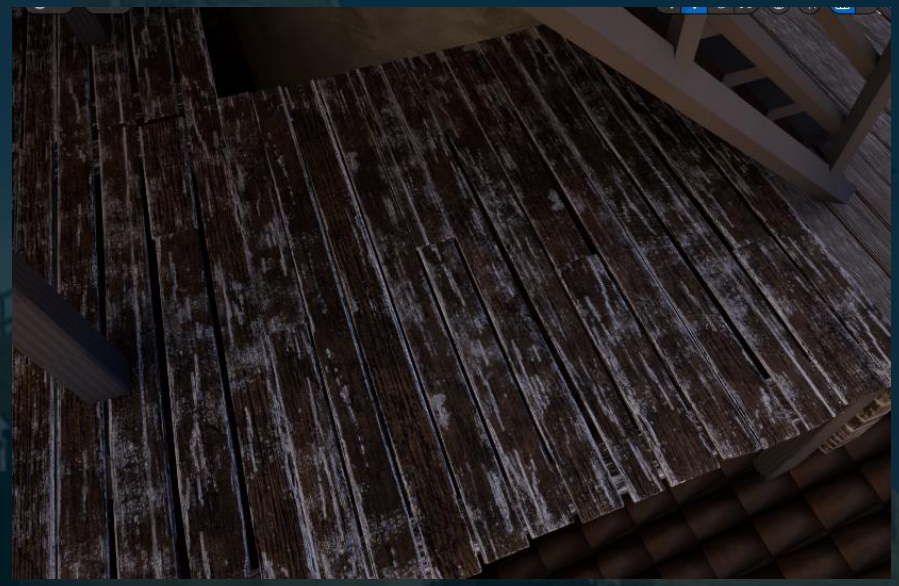


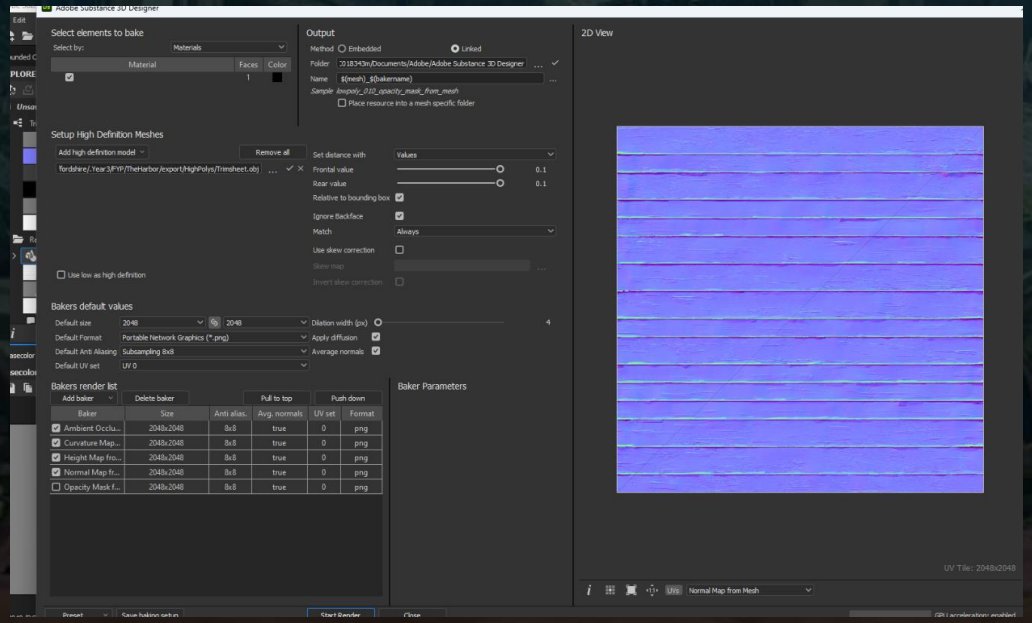
My trimsheet normals

'Lego Dimensions – Assets' - Anthony O Donnell (2016)

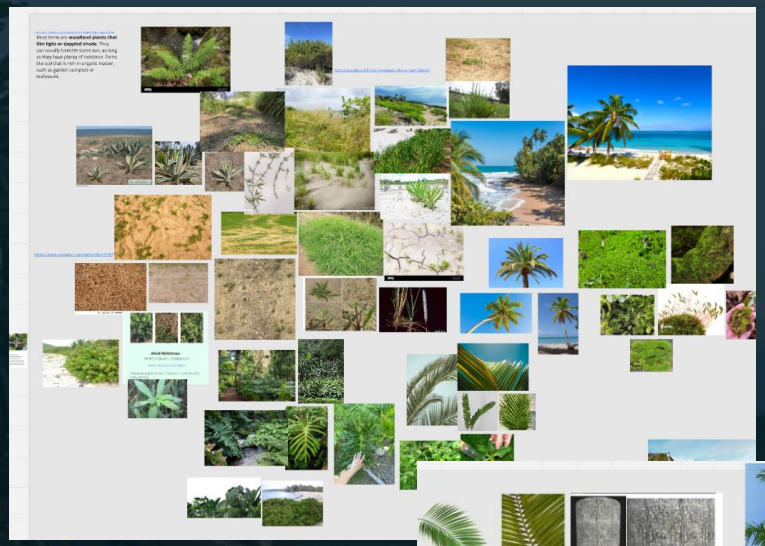
Wood Trimsheet

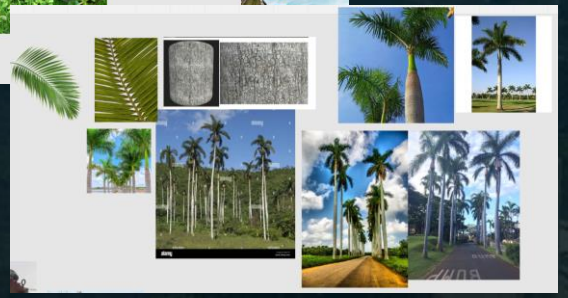
- After sculpting the wood trimsheet in Zbrush it was baked in designer for any tweaks and to ensure it tiles, then in 3DS Max I align the assets UVs to the trim bake.
- Examples of use on the right:



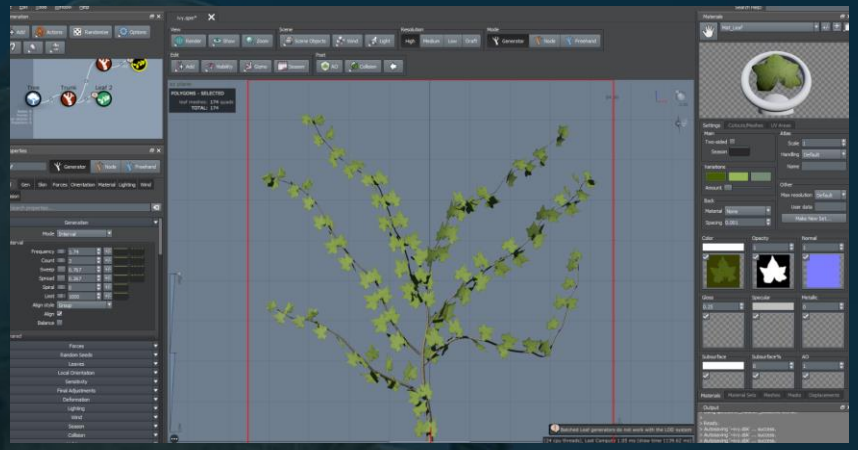


Foliage

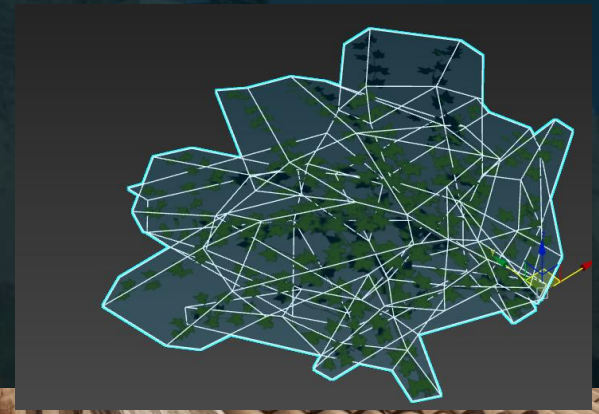


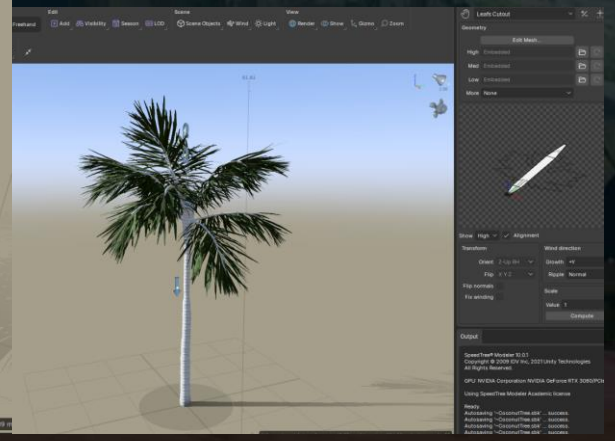


- Gathered lots of reference of plants that grow within the Caribbean and tried to match them up with the ones seen in the concept. The concept was not entirely accurate with the foliage species so I had to get as similar as I could ensuring they still made sense to grow in the area.

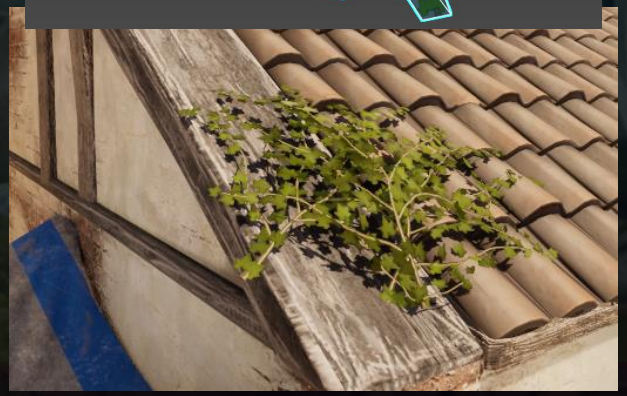


- Clumps of vines made more sense than the original moss I thought it was. Adding vines helped with creating a tropical atmosphere within the environment.





- The palm trees aimed to portray the spiked and messy appearance of the Cuban palm trees

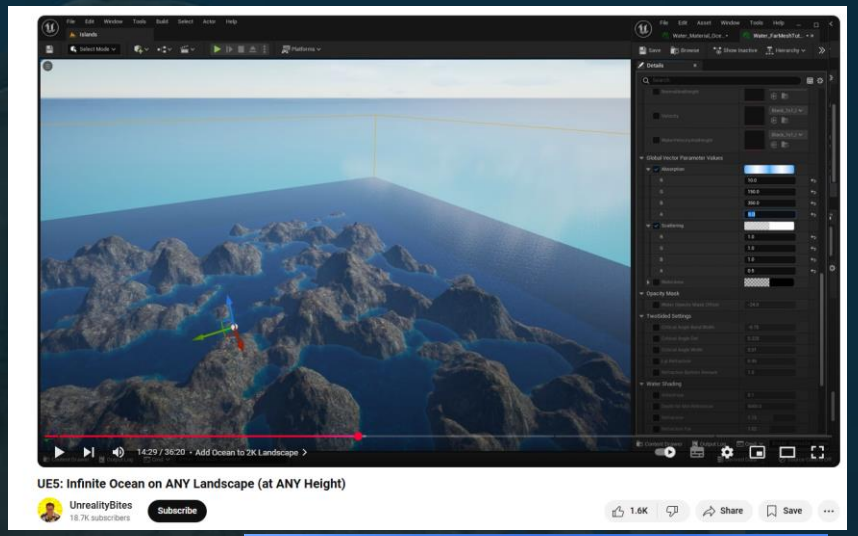


Water

Using the Unreal Engine 5 water volumes to create oceans lets you adjust the colours, waves and speed amongst many other settings. This video by UnrealityBites (2023) showcased different ways that the plugin can be used and the sort of material settings that are useful when adjusting the appearance.

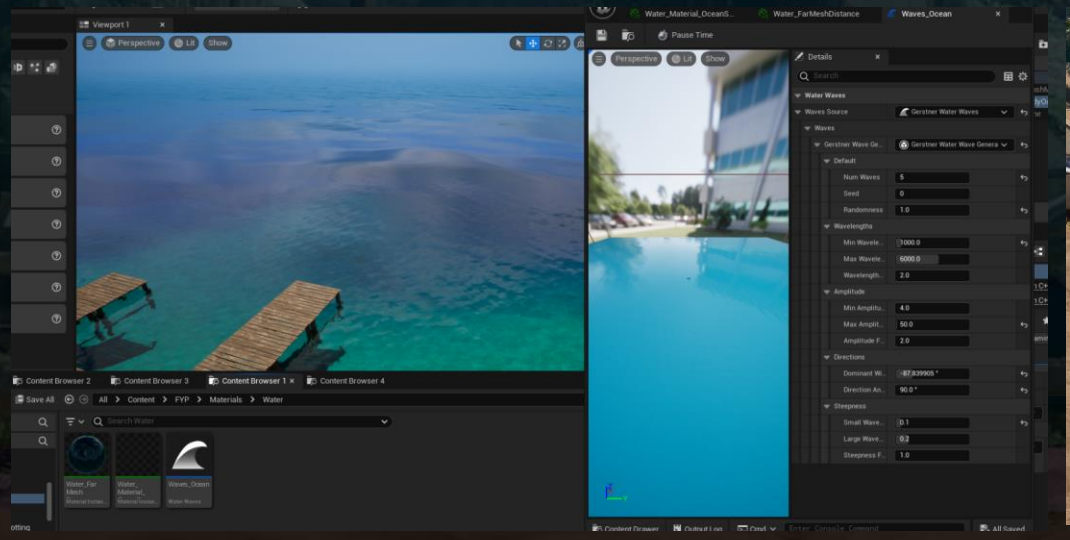
Editing duplicates to save the originals and using their parameters allowed me to create larger waves moving towards the shore.

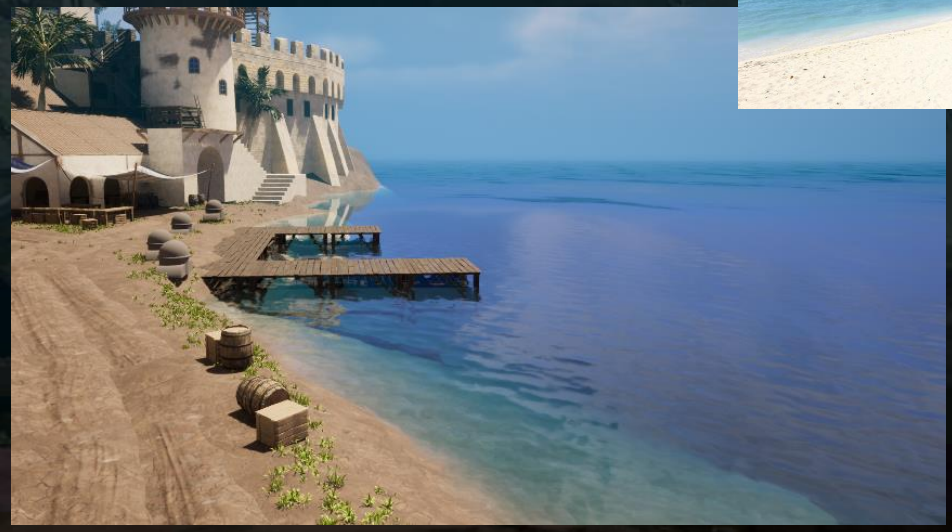
Using reference like the image found on Mark Hewitt's (2018) website helped me to adjust the colours more accurately.



'UE5: Infinite Ocean on ANY Landscape (at ANY Height) '- UnrealityBites (2023)

Mark Hewitt (2018)





Materials

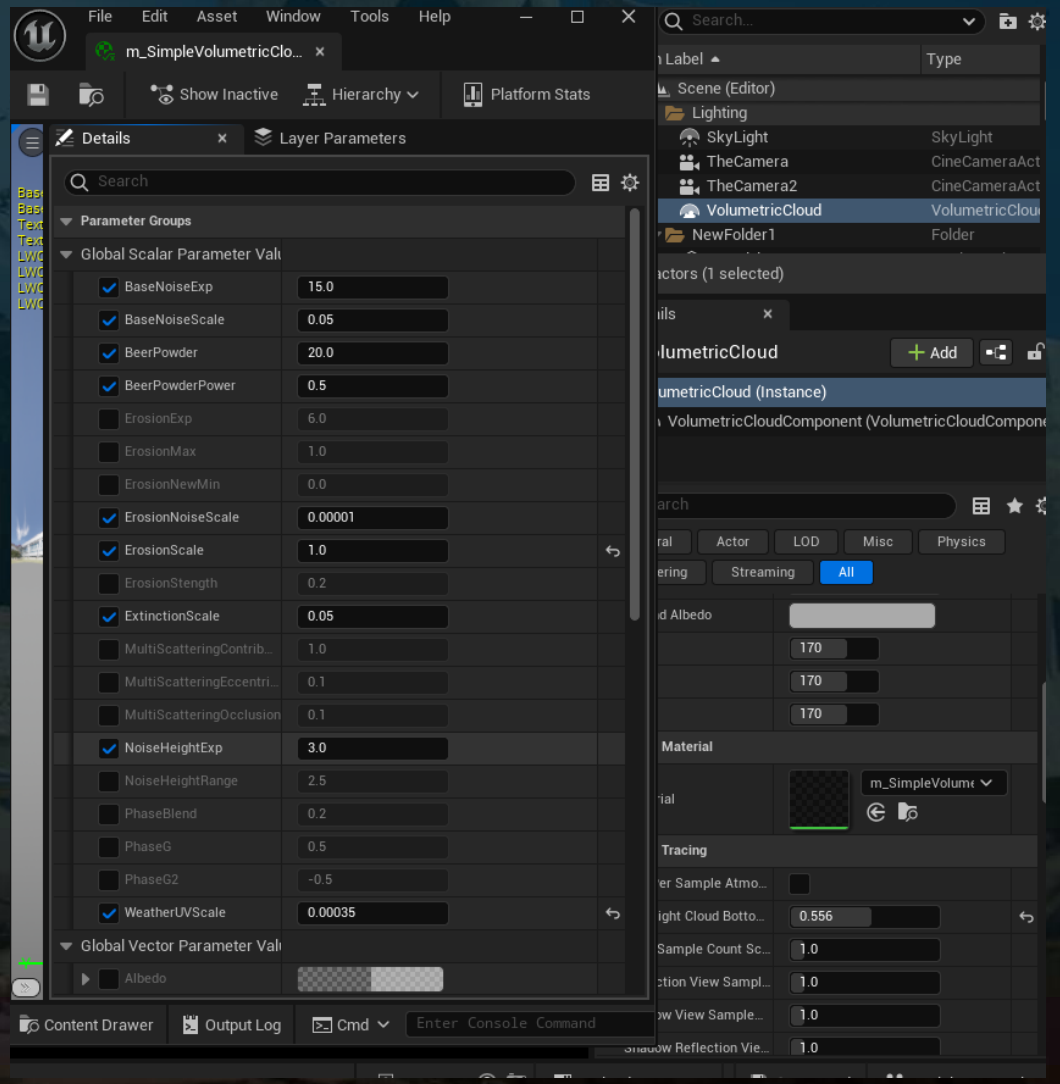
Created a sandy / dirty ground with darker more compact sand where is common foot traffic and commonly has wagons pressing the ground down.

Blended with landscape layers/ material

Both materials have same base to help them blend more naturally.

Lighting

- When lighting, to match the concept art closer, adjusting the volumetric clouds material settings helped to clear up some of the sky.



Lighting

Initial lighting

Matching lighting closer to concept

- Adjusted warmth
- Clouds clearer
- Sky atmosphere – set to realistic blue-sky colour
- Adjusted volumetric fog

Lighting

Previous lighting with majority of materials.

- Changed dramatically due to the bounce light added from materials

Readjusting lighting with materials in consideration

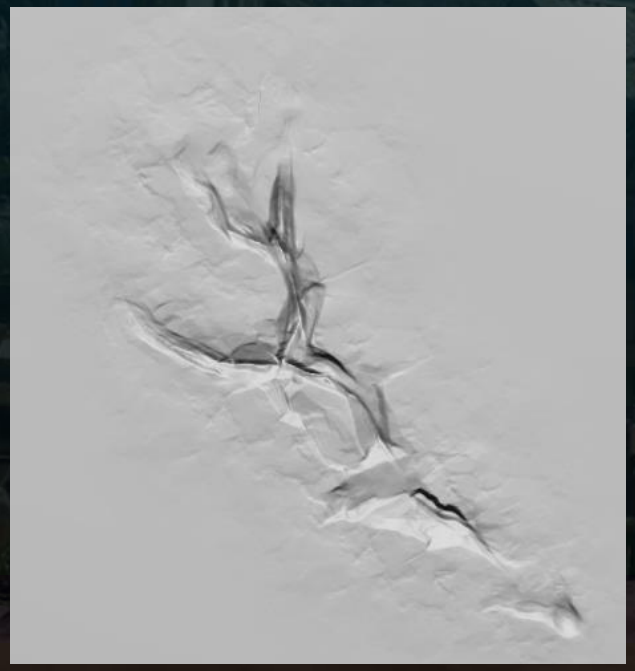
- Adjusted slope and toe in post process for more contrast
- Reduced intensity of directional light to prevent over exposure

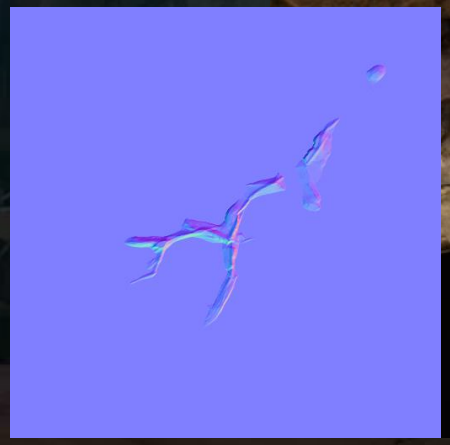
Decals

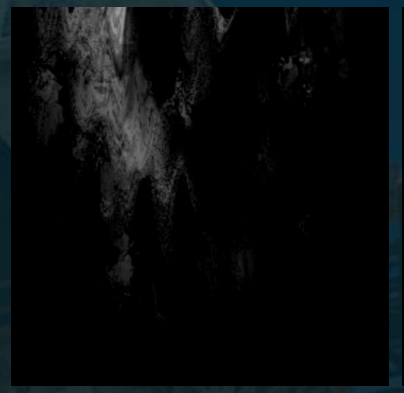
Decals created using two different techniques:

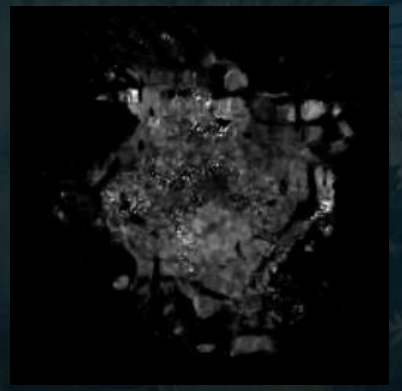
- Zbrush for sculpting normals
- Designer for more natural dirt marks
    - Also used to create the paint streaks on the paint decal.

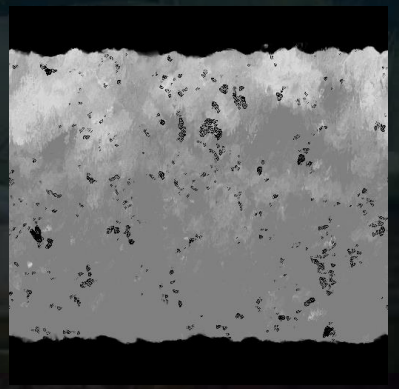
- Normal decals are useful for adding extra wear on top of an asset in engine.

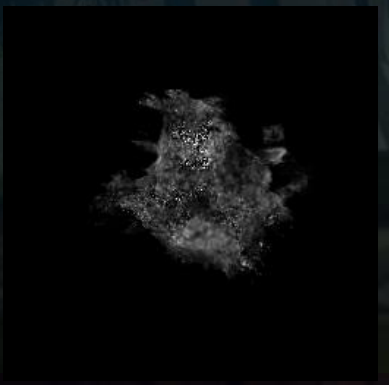












Industry Comparison

In comparison to industry work, the quality of 'The Harbor' doesn't quite reach the same level. One of the main reasons is the leaves for the palm trees. If to use a texture for the entire branch like Viktoriia's (2021) then the foliage would be able to show off a lot more detail instead of looking so thinned out.

Within Alex J Wood's (2024) environment the quality is consistent throughout the entire environment whereas the quality in 'The Harbor' is inconsistent with the dark fort walls and tower windows lowering the realism and quality of the environment.

'Loch na h-Airde - Viking Harbour' - Alex J Wood (2024)

'Harbor Before the Storm' - Viktoriia Zavhorodnia (akbutea) (2021)

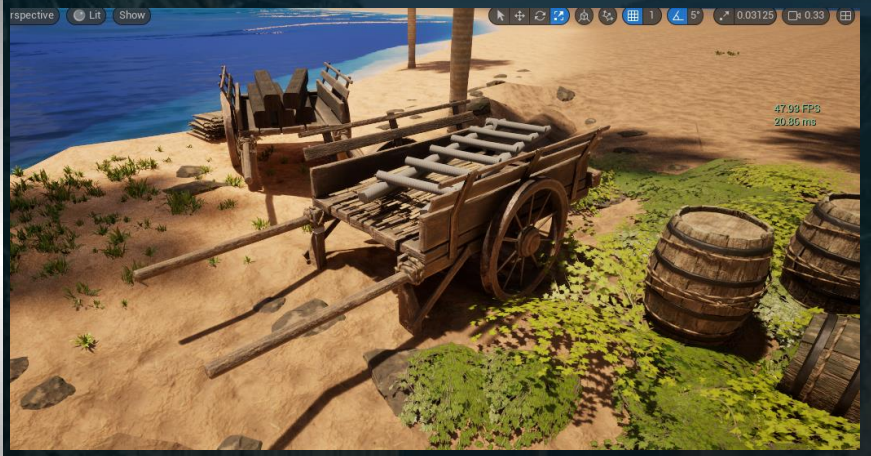
Playability

- To ensure the game is playable, collision is set up appropriately allowing players to freely walk around the level but are blocked by the bushes and wagons from leaving the area.
- Thought about affordance with adding white streaks similar to games such as Uncharted 4 (2016), for example, to indicate it is climbable.

Uncharted 4 (2016)

Set Dressing

When set dressing the areas around the level that aren't shown by the concept art, focusing on reusing the modular assets creatively helps to achieve a unique feeling from the same assets. Thinking about what the spaces would be used for by the community and what areas need to be blocked off to prevent players from leaving.
Below are some areas not shown by the concept art.



Comparison To Concept

One of the main goals of this project was to get the environment as close to the concept as possible but within a realistic artstyle. Creating 3D from a 2D concept is difficult due to perspective differences however I feel as if I have managed to achieve fairly close to the concept art with the scale changes that were required for the level to make sense. Some areas of improvement would be:

- Positioning and scale of the housing above
- Skinnier tower – not possible completely due to needing to match the scale of everything surrounding
- Move watch towers forwards

Strongest areas:

- The crates and barrels in front got pretty accurate as well as the market.
- The wagon
- Building on the right is closer after lots of adjustment
- Scale of walls.

Evaluation

- Overall, ‘The Harbor’ was successful in meeting the project goals and deliverables. The project aimed to be optimised to run at a minimum of 30 FPS on a university PC and it runs at 92 FPS which is much higher than aimed for. The project considered gameplay elements such as affordance with indications on areas to climb and the pathways which are darker to indicate the common foot traffic. The scene focuses more on the community instead of violence however, it does not feel as alive as would have liked. Due to time management, there was no time left to be able to add grass wind and move the birds in the sky however, they did get animated to flap. Adding simple grass wind is only a few nodes in the material editor but had to be cut.
- A lot of time was spent on tiny tertiary details in sculpts on wood assets especially which ended up being incredibly time consuming – although providing good results, were too time consuming for the project.
- The project taught valuable skills in modelling and texturing for realism as well as optimisation and scanning/photogrammetry which were big interests. Issues in time management was the main problem and in future tasks need to be prioritised better.

Evaluation

- The lighting for the environment, whilst following the concept art, doesn't compliment the environment best with the most detailed area of the environment being in shadow so your eyes are drawn somewhat away from where it should.
- Majority of the project was on sculpting wood and making wood textures with other areas being neglected. In future to avoid this happening the tasks should be split as the scene could have survived with two wood variations and less detailed sculpts but each prop was being dedicated time as if it were a hero prop.

'Assassin's Creed Valhalla – Foliage' - Adrien Paguet-Brunella (2021)

The foliage could be more realistic; looking at Assassin's Creed Valhalla's foliage, the grass is a lot thinner and darker which creates a more realistic and fluffy look rather than clumps put together. Spreading out the strands and thinning them out along with colour adjustment could help bring my foliage quality up a lot more.

Overall, I am happy with the result of this project as the project covers all deliverables to an acceptable standard, and created most assets to a high standard, while maintaining a good level of optimisation following industry standard techniques.

Renders

Clay Renders – Detail Lighting

Clay Renders – Lighting Only

Clay Renders - Unlit

Renders

Renders

Renders

Renders

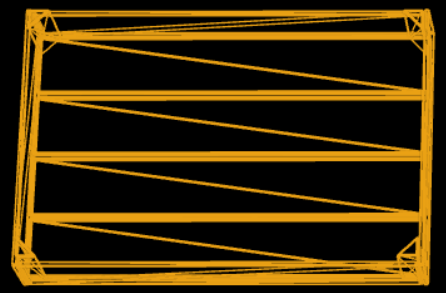
Renders

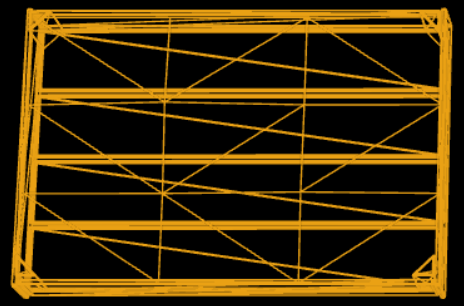
Renders

Renders

Wireframe

Wireframe





Material Renders

Material Renders

Asset Zoo

Asset Zoo

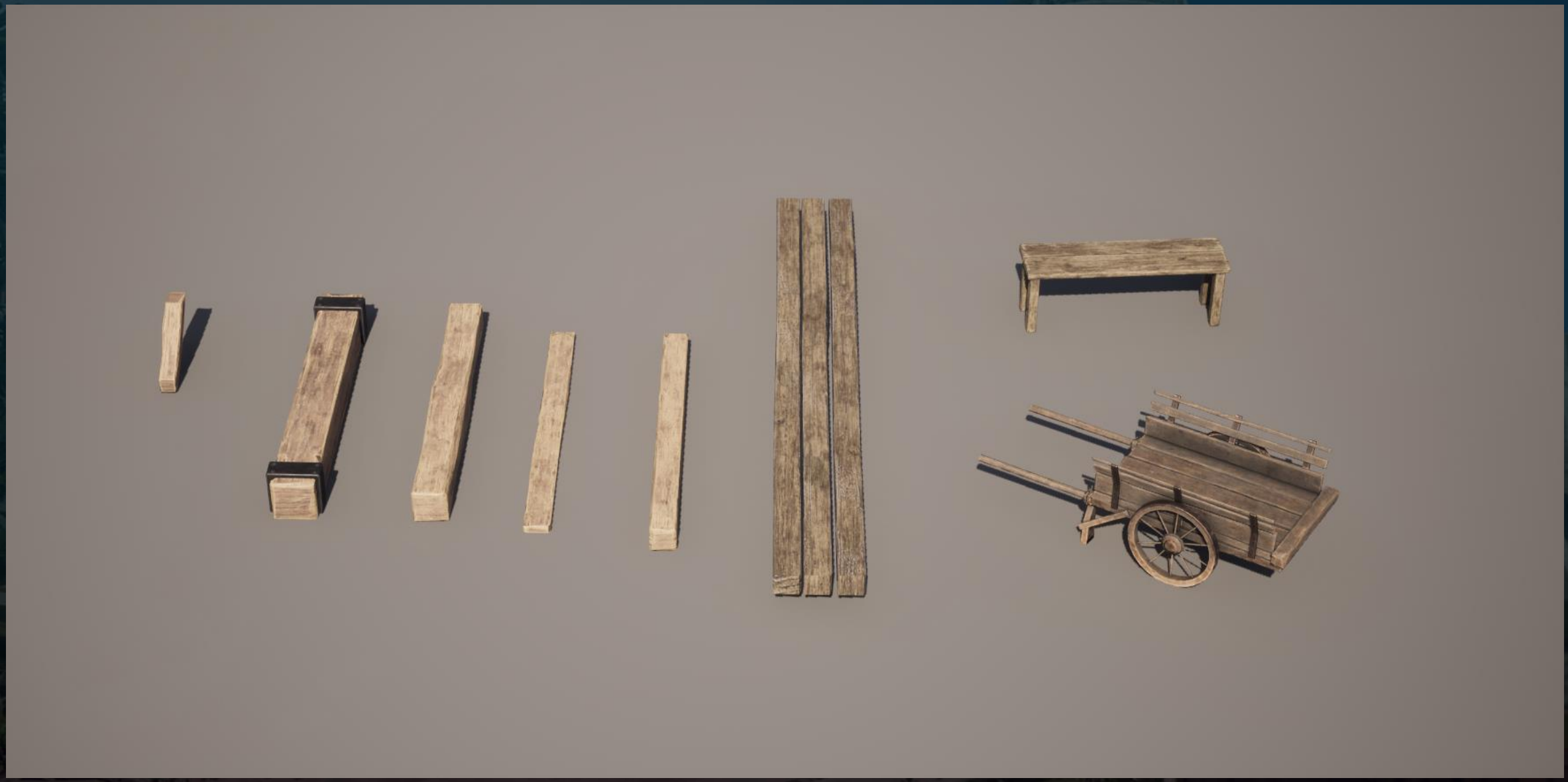
Asset Zoo

Asset Zoo

Asset Zoo

Asset Zoo

Asset Zoo



After assignment improvements

- Improved cloth textures/meshes, set dressing, added pots, created blueprint actors to group fruit on top of the baked fruit baskets, added virtual textures to blend path in more with floor, improved textures/decals and tree leaves.

Renders

Renders

Renders

Renders

New assets renders

New assets renders

- Blueprint actors using separate fruit/veg meshes to layer on top of the original asset, avoiding having to layer many fruit and veg to improve optimisation.

New assets renders

References

- Max Suleimanov (2021). *The Harbor.* [image] ArtStation. Available at: https://www.artstation.com/artwork/18qvbe [Accessed 1st Dec. 2024].
- Corentin Marquet (2024). *Assassin's Creed Mirage - Baghdad Residential District.* [image] ArtStation. Available at: https://www.artstation.com/artwork/GeDdwW [Accessed 1st Jan. 2025]
- Pierre Fleau (2019). *Assassin's Creed Odyssey - Fortifications Texturing.* [image] ArtStation. Available at: https://www.artstation.com/artwork/l3Ama [Accessed 3rd Feb. 2025]
- Froyok (2013). *Technical Breakdown: Assassin's Creed II.* [image] MAPCORE. Available at: https://www.mapcore.org/articles/development/technical-breakdown-assassins-creed-ii-r24/ [Accessed 3rd Feb. 2025]
- Dekogon Studios (2022). *Artstation Learning - Environment Production in UE5.* [image] ArtStation. Available at: https://www.artstation.com/artwork/nE0Lxe [Accessed 3rd Feb. 2025]
- Nathan Rose (2022). *Attikan Farmlands.* [online] GamesArtist. Available at: https://gamesartist.co.uk/attikan-farmlands/ [Accessed 4th Feb. 2025]
- unreal magic (2023). *landscape landmass in unreal engine 5.* [video] YouTube. Available at: https://www.youtube.com/watch?v=Gtddt6_n0bc [Accessed 3rd Feb. 2025]
- AlexG (2015). *UE4: Guide to Player Scale and World/Architecture Dimensions.* [online] World of Level Design. Available at: https://www.worldofleveldesign.com/categories/ue4/ue4-guide-to-scale-dimensions.php [Accessed 4th Feb. 2025]
- Joe Taylor (2024). *Joe Taylor – Substance Designer.* [video] StaffsUniversity Sharepoint. Available at: https://staffsuniversity-my.sharepoint.com/:v:/g/personal/mja5_staff_staffs_ac_uk/EX_NscPvu8tDiVngpCigaNABVRzi6vhYNA7Z8cRJjYXLQw?nav=eyJyZWZlcnJhbEluZm8iOnsicmVmZXJyYWxBcHAiOiJTdHJlYW1XZWJBcHAiLCJyZWZlcnJhbFZpZXciOiJTaGFyZURpYWxvZy1MaW5rIiwicmVmZXJyYWxBcHBQbGF0Zm9ybSI6IldlYiIsInJlZmVycmFsTW9kZSI6InZpZXcifX0%3D&e=DxY2Oq [Accessed 4th Feb. 2025]
- Niki Marinov/Staffs Games Institute (2024). *FUSE: Niki Marinov (Material Artist).* [video] YouTube. Available at: https://www.youtube.com/watch?v=Dt0B8uemKLg [Accessed 4th Feb. 2025]
- Enterables (2022). *WATCHTOWER PLATFORM MEDIEVAL SLAVIC TOWER VILLAGE COLLECTION AAA.* [image] TurboSquid. Available at: https://www.turbosquid.com/3d-models/3d-watchtower-platform-medieval-slavic-tower-village-collection-aaa-model-2001703 [Accessed 4th Feb. 2025]
- Polygon Academy (2019). *TUTORIAL: Sculpting Wood in ZBRUSH - 3 EASY STEPS! | Polygon Academy* [video] YouTube. Available at: https://www.youtube.com/watch?v=HiwV_C3IWQI [Accessed 4th Feb. 2025]

References

- Harrison Snatt (2023). *Fishmonger's Stall.* [image] ArtStation. Available at: https://www.artstation.com/artwork/3q58oJ [Accessed 4th Feb. 2025]
- Hoj Dee (2024). *Detailed Texture Blending with Height Lerp & Vertex Painting | Unreal Engine Materials* [video] YouTube. Available at: https://www.youtube.com/watch?v=VgyyHE6Vkn8 [Accessed 4th Feb. 2025]
- Anthony O Donnell (2016). *Lego Dimensions – Assets.* [image] ArtStation. Available at: https://www.artstation.com/artwork/4qX6q [Accessed 4th Feb. 2025]
- UnrealityBites (2023). *UE5: Infinite Ocean on ANY Landscape (at ANY Height).* [video] YouTube. Available at: https://www.youtube.com/watch?v=4zTgJSm8eP0 [Accessed 4th Feb. 2025]
- Mark Hewitt (2018). *Come out and playa: 6 of the best beaches in Cuba.* [image] Intrepid. Available at: https://www.intrepidtravel.com/adventures/best-beaches-in-cuba/ [Accessed 4th Feb. 2025]
- Uncharted 4 (2016) [video game]
- Assassin's Creed Origins (2017) [video game]
- Assassin's Creed IV Black Flag (2013) [video game]
- Alex J Wood (2024). *Loch na h-Airde - Viking Harbour.* [image] ArtStation. Available at: https://www.artstation.com/artwork/lDo4oO [Accessed 4th Feb. 2025]
- Viktoriia Zavhorodnia (akbutea) (2021). *Harbor Before the Storm.* [image] ArtStation. Available at: https://www.artstation.com/artwork/685rXw [Accessed 4th Feb. 2025]
- Assassin's Creed Mirage (2023) [video game]
- Adrien Paguet-Brunella (2021). *Assassin's Creed Valhalla – Foliage.* [image] ArtStation. Available at: https://www.artstation.com/artwork/YebdDd [Accessed 4th Feb. 2025]

Bibliography

- Colin Valek (n/d). *Creating Foliage for Videogames.* [video] Gnomon Workshop. Available at: https://www.thegnomonworkshop.com/tutorials/creating-foliage-for-videogames [Accessed 4th Feb. 2025]
- PrismaticaDev (2024). *Parallax Occlusion Mapping | 5-Minute Materials [UE5].* [video] Youtube. Available at: https://www.youtube.com/watch?v=h0xytNFiqbQ&ab_channel=PrismaticaDev [Accessed 4th Feb. 2025]
- Kingdom Crafter (2024). *Stone Wall Creation: Substance Designer Masterclass.* [video] Youtube. Available at: https://www.youtube.com/watch?v=E-L29-DJT3k&ab_channel=KingdomCrafter [Accessed 4th Feb. 2025]
- LDN127 (2024). *Dirt Track & General Dirt Decals.* [online] FAB. Available at: https://www.fab.com/listings/2c09298e-d8ba-4b45-bcc1-d26261f269fe [Accessed 4th Feb. 2025]
- CG Ammo (2021). *SUBSTANCE Designer - Sand Tutorial* [online] Youtube. Available at: https://www.youtube.com/watch?v=oPauF1fwZuU&ab_channel=CgAmmo [Accessed 4th Feb. 2025]
- RinaldsB (2024). *Final Year 3D Projects.* [online] TheRookies. Available at: https://www.therookies.co/entries/27533 [Accessed 4th Feb. 2025]
- Epic Games (n/d). *Instanced Materials.* [online] Unreal Engine Documentation. Available at: https://dev.epicgames.com/documentation/en-us/unreal-engine/instanced-materials-in-unreal-engine?application_version=5.4 [Accessed 4th Feb. 2025]
- Brecht Sohier (2024). *Building Assassin's Creed Odyssey Modular Scene With UE & 3D Designer.* [online] 80LV. Available at: https://80.lv/articles/building-assassin-s-creed-odyssey-modular-scene-with-ue-3d-designer/ [Accessed 4th Feb. 2025]