Creating a Fortiche-Inspired Environment in Unreal Engine 5

Master-Thesis

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Abstract

This master thesis explores Studio Fortiche's unique graphic art style and attempts to experimentally build a scene inside Unreal Engine 5 achieving a fortiche-inspired visual look by analyzing the digital techniques used in their latest production Arcane: League of Legends (2021). Specifically, analyzing how the studio was able to blend 2D and 3D in such a coherent way together, resulting in this very unique visual look. My research points out that Arcane, despite appearing to be a 3D animated film, has more in common with traditional hand-drawn animated films from the past, adopting some modern camera and animation techniques found in newer 3D movie productions. To evaluate the resemblance of my final UE5 scene with the picked reference from the show, I conducted an online survey. In conclusion, the likeness of the scene was overall good with room for improvement. Partly because my art skills aren't on the same professional level as an artist working at Studio Fortiche, but also a noticeable discrepancy in environment lighting due Unreal Engine being an engine focusing on realistic rendering and therefore being limited in how much materials and lighting support a stylized look like Fortiche.

Keywords: Unreal Engine, Fortiche, Stylized, Arcane, League of Legends

Table of Contents

1. Defining Fortiche-Inspired

1.1. Fall and Rise of Animated Movies

The golden age of hand-drawn animation began with the release of Snow White and the Seven Dwarfs in 1937 before it gradually faded out from the early 50s to the late 60s, due to theatrical animated shorts beginning to lose popularity to the newer medium of television. In 1980 hand-drawn animations resurfaced with Anime becoming mainstream in Japan reaching its peak in 1990, leading to the production of a lot of influential anime series with a lasting impact on pop culture today.

Alongside traditionally hand-drawn animation, first experimental computer animation began as early as the 1940s and 1950s, but computer generated imagery (commonly called CGI) took till around 1990 before technology improved far enough to play a supportive role in live action films, like Alien or Terminator 2: Judgment Day. The initial reaction to CGI from the audience was mixed and hesitant due to clear limits in visual quality achievable at that time, still especially filmmakers recognized the potential of computer animation early and pushed to develop this technology further.

In 1995 the film Toy Story was released, being the first completely computer-animated film in history, and succeeded financially, opening the door for further productions. For some time, both hand-drawn as well as computer generated animation have coexisted, but due to computers drastically improving in capability, making digital production more cost and time efficient than traditionally drawing frame by frame, a clear shift happened, pushing 2D and hand-drawn animated films into the background. Bigger studios like Dreamworks, Pixar and Disney solely focused on 3D animated films, which ultimately lead to an overuse of CGI in films like Star Wars prequels and Transformers series, exhausting the audience with explosive spectacles and shallow storylines, while the production costs of CGI movies greatly increased due to having to overtrump previous films. At the same time smaller indie films were left struggling to compete.

In the last five years there has been a noticeable shift in animation films, especially short films being on the rise, appearing now everywhere, like television advertisements, music videos of famous bands and intros for computer games.

> In fact, I started to do this 2D and 3D mix for 20 years with music videos. For me, it's a new way to do animation. It's not anime, it's not full CG. It's a mix of everything.~ Jérôme Combe, Studio Fortiche Founder (Arcane: Bridging the Rift - *Part 1, 2022*)

To a greater extent computers have become very accessible for households, resulting in artists being able to produce experimental films at home, focusing on artistic expression rather than financial viability. I believe this to be the main reason why hand-drawing was recently rediscovered and spliced with computer-generation, basically allowing artists to purposefully breathe an artistic soul into the animation, visually outstanding from the competition and also refreshing for the Audience. While Arcane and Spiderman: Into the Spiderverse(2018), Love Death+Robot (2019), and Arcane: League of Legends (2021) are (obviously) the flagships and getting a foot into the door for the upcoming generation of 2D/3D spliced movies, a crucial part of this success roots in Animes, experimenting and failing a lot with implementing CGI into a medium dominated by hand-drawing, and productions like those of Studio Ghibli, focusing on finding ways to convey an artist's vision to the audience rather than maximizing revenue.

I was at dinner recently with the directors of Fortiche, and they said they're happy now because when they got into this industry, they really wanted to create something to be history of the animation world. And they were smiling and they were saying, it's such a relief that after six years now, they feel like they know they worked on something that is part of animation history. It doesn't matter if the project is a wild success or it's doing fine or worse than that. If anything, we've crafted something that pushes the animation world forward by a significant margin.~ Christian Linke, Studio Fortiche Creator, Writer
(Arcane: Bridging the Rift - Part 5, 2022)

1.2. Production of a Masterpiece

Netflix's series Arcane (2021) is an animated action-adventure television series based on the popular computer game League of Legends. Thanks to previous collaborations between Riot Games and Studio Fortiche, releasing cinematics and music videos, like "Get Jinxed" (2013), the game developer greenlighted a first pilot despite being very reluctant due to video game adaptations having the reputation to catastrophically fail and displease their player base, leading to damage to the brand.

We knew Arcane was going to be the very first deep story expression of League of Legends. There's enough video games where the audience asks for a movie or a show for years and years and years and they make it, and then it sucks. And then, guess what? People stop asking. We were afraid of that~ Christian Linke, Studio Fortiche Creator, Writer
(Arcane: Bridging the Rift - Part 1, 2022)

Despite initial fears,the release of Arcane was a global success, the series set multiple records within the first weeks of its premiere, is considered to be the best video game adaptation of all times and by far Netflix's highest-rated series (ranked According to IMDb, last checked on 15.11.2023). As reported by the developer Riot Games, League of Legends daily number of players increased by more than 50 percent due to Arcane in the following months, remarkably for a free to play game that has been on the market for over a decade.

Arcane tells the tale of two sisters trapped in a conflict between the elite class of Piltover and the oppressed worker class of Zaun. As the sisters survive in the streets other factions get involved and separate the sisters from each other. As a consequence they become more and more astray from each other as the story progresses. In the last act their broken sisterhood becomes the final spark that ignites the revolution, forcing the sisters to stand on opposing sides in the coming war. The story of having two siblings drifting apart due to political struggle and fighting each other over a love interest strongly reminds of the musical *Blood Brothers* (1983).

League of Legends offers a wide roster of heroes, each one offering its own unique background story, so Studio Fortiche was in a unique position to freely pick any story they wanted. An obvious choice would have been the invasion of Ionia or the mageseeker war, both story arcs well established in the universe thanks to additional source material like dedicated comics and being the community favorites. Interestingly Studio Fortiche decided to animate a more secondary conflict in the fictional universe, the independence war of Zaun against Piltover. I can imagine that due to the studio being located in France, the team drew significant inspiration from one of the nation's pivotal historical events, the french revolution.

Going forward, I will refer to the *Lane* and *Piltover's Undercity* as *Zaun*. Despite the series not having established the city yet, Zaun is a term well known among people who play the game and Studio Fortiche also

internally communicated the city as Zaun. It helps to understand specific choices the team made regarding art design and story choices, most establishing Zaun's fight for independence from Piltover.

Remarkably, I can't tell if the story established the art direction or if Studio Fortiche, due to feeling very comfortable in their art style, decided on a setting that supports it. The series masterfully intertwines Art Nouveau and Art Deco with a splash of Neon Aesthetic, similar previous works of Studio Fortiche incorporate partly such elements, showing the artist at Studio Fortiche being well versed in this art style. That Piltover looks like a (French) European city during the industrial revolution is either due to the architecture being influenced by Art Nouveau and Art Deco, the studio's French roots, or a reinterpretation of the French revolution happening in a fantasy setting, which makes it impossible to decipher which of those things caused the other one, and is in my opinion the reason, why everything fits so perfectly together.

This impression is reinforced by Studio Fortiche adaptation and reference of multiple famous European paintings throughout the series, like L'Ange Dechu (1847) by the French artist Alexandre Cabanel or the famous cigarette papers advertisement poster by Alphonse Mucha (Figure 1).

Figure 1: Arcane's woman on the wall is inspired by a cigarette papers advertisement poster by Alphonse Mucha (right side)

As previously mentioned, Arcane tells the story of Zaun's fight for independence, and Studio Fortiche found a clever way to artistically tease this looming conflict. Because despite originally being one city, at the time of Arcane the city Zaun is already culturally and politically deeply fractured from Piltover, and far too much time has passed for the people to unite again. The first time the series enters Zaun, the viewer notices drastic visual cues, indicating that despite being part of Piltover and keeping some form and shape in architecture, this is a completely different city (Figure 2).

Figure 2: Piltover, City of Progress (left side) and Zaun, City of Iron and Glass (right side)

Previous to the production of the series, Piltover was depicted as a steampunk city, built upon moving gears and other mechanical contraptions. Studio Fortiche created their own interpretation, their vision for Piltover clearly inspired by Art Deco, and while there are still moving gears, everything is now orderly and has structural purpose, the architecture is defined by bold geometric designs with sharp edges, houses are symmetrical and streamlined, a cityscape adorned by neatly-designed intersections, sidewalks decorated with big futuristic monuments, tidy roads patterned with angular tiles and walls cladded in bright materials, basically everything looks glamorous and exuberant.

> *"Piltover, also known as the City of Progress, is a thriving, progressive city whose power and influence is on the rise. It is Valoran's cultural center, where art, craftsmanship, trade and innovation walk hand in hand. Its power comes not through military might, but the engines of commerce and forward thinking."* ~ Riot Game's own website, Description of Piltover

In contrast Zaun was always depicted as an urban and industrial city, shrouded in poisonous green gas and decorated with steampunk elements to highlight its rebellious nature towards Piltover. I believe Studio Fortiche masterfully delivered and exceeded expectations. While their vision of Zaun is far less steampunk than I (and probably other viewers) anticipated, Zaun's buildings immediately reminded me of the Hotel Tassel in Belgium. Art Nouveau is omnipresent in Zaun, a style of art openly rebelling against industrial revolution, a city rebelling against its own imposed industrial nature, feeling very Zaun -like. In strong contrast to Piltover, buildings in Zaun are round and curved, from spiraled windows to curved whiplash lines decorating walls and exterior props, further buildings are overgrown by vines, which by extension creep over the floor visually reclaiming parts of the building. The cherry on the cake is a Tiffany lamp on the table (Figure 3), any interior scene of Zaun looks like a brochure advertising for antique furniture in Art Nouveau style.

> *"Zaun, also known as the City of Iron and Glass, is a large undercity district lying in the deep canyons and valleys threading Piltover. What light reaches below is filtered through fumes leaking from the tangles of corroded pipework and reflected from the stained glass of its industrial architecture."* ~ Riot Game's own website, Description of Zaun

Figure 3: Tiffany lamp on the table (right),

Studio Fortiche genius shows in their choice to intertwined Piltover and Zaun by design Piltover's architecture in Art Deco and Zaun's in Art Nouveau, both famous art directions which can be confused with each other due being culturally and temporally close in history, and here being masterfully separated by the show, allowing both cities to breath their own charm.

1.3. Matte Paintings & Billboards

Traditional animated shows typically rely on either 3D models, moving in a three dimensional environment, or 2D drawings, simulating depth by moving the foreground at a different speed than the background. Arcane breaks this mold by blending 3D characters and 2D props in a 3D environment, giving the show its distinct appearance.

Their setup reminds of a theater stage, props are two dimensional billboards placed in either foreground and background, boxing the moving actors on a predefined stage, while one giant hand-drawn matte painting looms in the background. Whenever the camera shifts, everything moves accordingly

Figure 4: Instead of 3D modeling all the houses (left), similar results can be achieved with 2D drawn billboards (right)

With the exception of a few objects that characters directly interact with, like chairs, objects are commonly 2D billboards placed in three dimensional space, like a cup of tea held by a character or the landing boat, which brings Caitlyn to the prison island (Figure 5). Studio Fortiche's reason for keeping the number small might be

that it's easier to keep a consistent look, each frame resembling a painting in motion, and drawing is quicker than modeling individual objects, even if multiple camera shots are required.

Figure 5: white outline marks 3d characters, blue outline marks forward and backward 2d billboard of boat

1.4. Characters

Arcane's characters are modeled and sculpted using traditional 3D techniques and textured by talented artists to fit the aesthetic of the environments in a very recognizable stylized paint stroke look (Figure 6). More details are placed around the area of the eyes, purposefully drawing the audience's attention towards the character's face, while clothing is kept plain and less remarkable.

Figure 6: 3d model of the main character Jinx, (left) stylized texture in detail, (middle) model without texture, (right) model with texture

A curious artistic choice is that characters have a very bright creamy skin color while the environment is kept in very saturated colors. Creamy colors do reflect more light and human eyes are attracted to bright areas, so probably this constitutes an intentional choice to separate the silhouettes of characters from the darker background. Further it visually reminds of old oil paintings, especially famous portraits like Raphael, the Cardinal (1510) and Mona Lisa (1503).

1.5. Visual Effects - VFX

All VFX such as explosions, smoke and motion trails are a sequence of frame by frame hand drawn images similar to a flipbook, animated following the fourth principle Straight Ahead (The Illusion of Life: Disney Animation, 1981), therefore resembling very much old disney cartoons (Figure 7).

> *So, let's say you have, like a character smoking a cigarette. Instead of having 3D smoke, being simulated by 3D tools, it's actually 2D, drawn frame-by-frame, and it gets this almost cartoony effect.* ~ Jérôme Combe, Studio Fortiche Founder
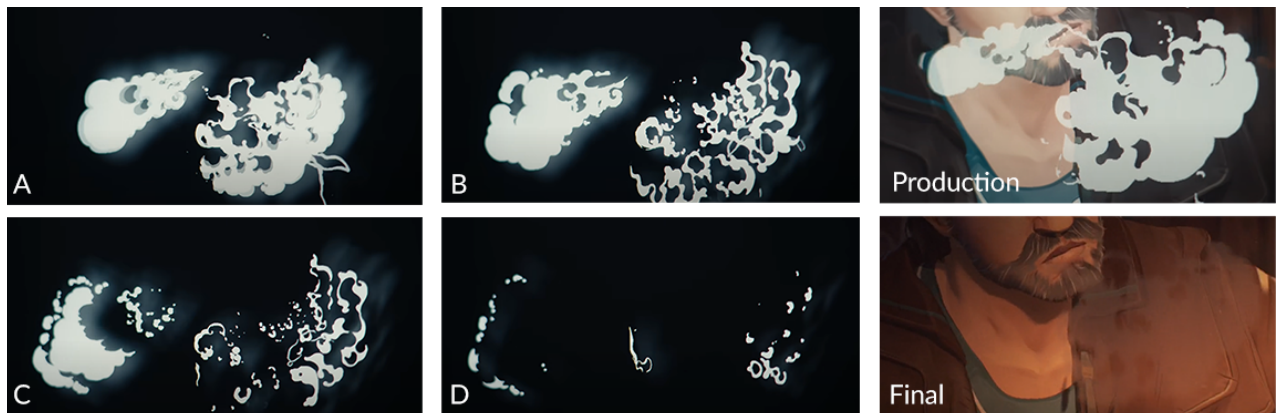> (Arcane: Bridging the Rift - *Part 1, 2022)*

Figure 7: Working process behind Smoke VFX, A-D shows frame by frame drawing, Final shows how it looks in the series

Noticeably all VFX effects are kept intentionally flat and ignore any lighting or shadow, additionally frequently appearing to be self-illuminating, but without visible color bleeding between overlapping objects, making VFX perceivable popping forward towards the viewer from the background (Figure 8). If a scene requires a specific effect to be more subtle, it's made transparent in a monotonic way, appearing softer while keeping the noticeable transition line.

Figure 8: The fog's silhouette drastically noticeable from the background due being very flat and colored pink

1.6. Animation

Arcane uses a lot of tricks and techniques from Anime (japanese Animation) and traditional western animation, distinctively following the 12 Principles of Animation introduced by Disney as a guideline for their house produced 2D animated films (The Illusion of Life: Disney Animation, 1981), the latter especially observable on multiple occasions in fighting montages.

> *Our goal was to find a good balance between realism and 'cartoon' style. Since our characters have semi-realistic proportions, they have to move and behave in a realistic way with weight and solid body-mechanics. But to keep the appeal and avoid any uncanny valley effect, we also had to bring traditional animation techniques. That's why we didn't do mocap [motion capture] but only keyframe animation that allows us to control our acting performance and aesthetic. ~ Barth Maunoury, Studio Fortiche Animation Supervisor*

A good example is Vi's fight against the training dummy (Episode 2, 7:48), Vi's arm exhibits movements that deliberately exceed the natural bend behavior of her arm in exaggerated movement (Figure 9), which follows the first principle Squash and Stretch (The Illusion of Life: Disney Animation, 1981).

Figure 9: Squash & Stretch makes the arm longer and gives the hit motion a more perceptible impact

It's probably the main reason why Fortiche decided against actively using motion capture, since animations tend to be stiff, and instead using captured material as references, while falling back on traditional keyframe animation. This allows more stylistic freedom, like exaggerating facial expression to better deliver a character's emotions to the audience, something the show does incredibly well.

Opposed to traditional animation Fortiche uses fully rigged 3D characters instead of drawn ones. One benefit of having bones to animate, apart from easily reusing assets and allowing the camera to move freely, is the smooth transition between key frames, resulting in the audience perceiving all movement as being very fluid. Commonly an animation with good flow is visually appealing. Smooth transitions, realistic movements, and a cohesive visual style contribute to a more engaging and aesthetically pleasing experience for the audience.

1.7. Shadows

Another example of additional artistic freedom with the rendering are shadows. Depending on the distance to the light-source an object throws either a hard shadow or further away a soft one onto the surface. With the usage of matte paintings artists are able to delude the audience, able to build up excitement with unnatural sharp and dark shadows, or steer the audience gaze towards an object in the scene by showing an additional unseen light source. Artists at Fortiche Studio go even a step further and draw static shadows on characters or objects (Figure 10). This is possible due to film cuts, allowing textures to be swapped for each scene.

Figure 10: Shadows marked with red circles are drawn on texture, the blue circle indicates a rendered shadow, noticeable softer transition

2.   Building the Scene in Unreal Engine 5

Due to time-constraints working on my master thesis I decided to focus on a single scene without any characters in it, conveniently also skipping rigging and animating, so that I can focus on parts like modeling and texturing. Further building a whole scene gives me the opportunity to work on its illumination, which I expected to be the biggest challenge to replicate in Unreal Engine 5. As reference I picked an original matte painting by Geoffroy Thoorens (Figure 11), available on Artstation (https://djahal.artstation.com/projects/d0KX0K), which appears in Episode 6 of Arcane:League of Legends, depicting a back alley of Zaun's underground city.

Figure 11: Hand-drawn matte painting used in Arcane as background by Geoffroy Thoorens

2.1. Blockout

The first step after picking a reference was building a blockout scene to quickly iterate my scene, I used Blender as a modeling tool due to being available for free and having an active community. Blockout is a term used for a rough draft, in this case, a level scene containing all major objects, yet displayed in minimal details, like cubes, allowing me to primarily focus on positioning, while still being able to make bigger changes very quickly. Along the process before texturing, I swap those placeholders with the final modeled geometry.

Before placing any cubes into my scene I had to estimate a camera position and rotation to simulate the same perspective in my scene as in the reference picture, otherwise the scaling and form of objects would be off. For this task I used a tool called fSpy (Figure 12), which is specifically designed to approximate a camera setup for an image by using user-predefined points and calculating the vanishing point, returning the camera's focal length, orientation and position.

Figure 12: Calculating camera perspective through vanishing points with fSpy

.

The approach worked pretty well, except the inconvenience that the reference image is cropped, meaning the image center doesn't align with the lens center of the camera. By guessing the image center before cropping through trial and error, this can be solved, but the final result is less accurate. Additional inaccuracy happened, because the image is hand-drawn, meaning some vanishing lines don't perfectly cross the same vanishing point, an edge case never occurring with photographs taken by a camera. Despite those errors my result was pretty close to the reference, and I was able to place my camera in Blender. By setting the background of the camera to be the reference image, I'm able to blockout in front of my reference(Figure 13).
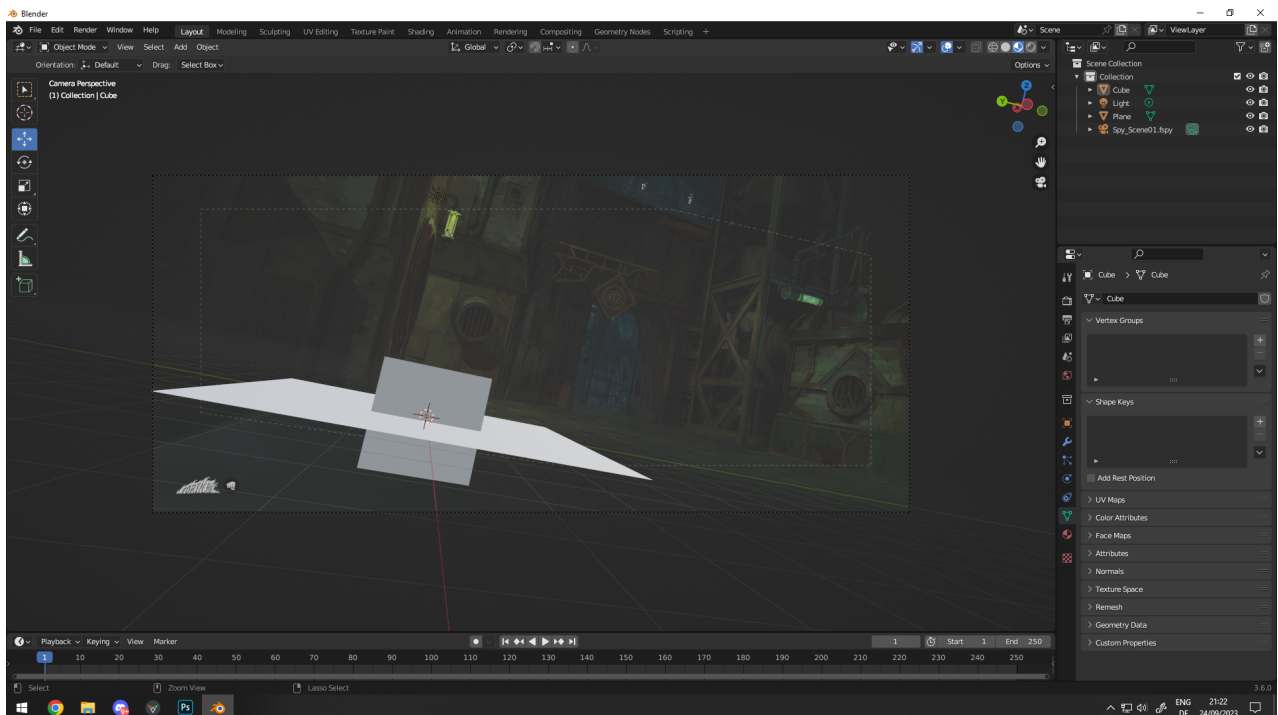

Figure 13: Using the reference image to blockout the scene

Another unexpected obstruction I encountered while blockouting my the scene was an optical illusion referred to as Forced Perspective. While this effect is often used in films, resulting in objects or people to appear smaller or bigger than they really are due to being further away or closer to the camera, I had no way to

tell the height of an object, because I didn't see the distance between object and camera. I creatively solved this problem by placing mannequins in human size through the entity scene, assuming how big a normal person would look like in the image at a specific position. By using these mannequins as visual guidelines I was able to construct blockouts in close proximity, expanding blockout by blockout to build a scene with all the props having a fitting scale.

2.2. Modeling

Reviewing the concept, I identified the essential assets of the scene, those I would need to model first, like those two sewerage pipes sticking out of buildings, while keeping intricate details for last, amongst them the overhanging shop sign inspired by Art Nouveau. At first I wasn't sure if I had the time to model everything, because it was more complex in the form than other props, but earlier test reviewers immediately spotted the missing sign, so I subsequently modeled it. The shop sign turned out to be the primary eye-catcher of the scene, so I'm happy I added it.

At first glance the scene has a lot of big flat surfaces, easy and comfortable to model with polygons. As the scene slowly took shape I noticed that some props had a lot of edges and corners, like the furnace and iron beams, basically smaller details I didn't pay much attention to at first. Originally I planned to draw those details onto the texture directly, similar to how the show handles shadows, yet UE5 has a global illumination solution built in, allowing me to have higher quality shadows in key areas by fully modeling these edges and gapes. In the end I was able to finish nearly everything except the merchant crates on the street and the railing on top of the iron gate (Figure 14).
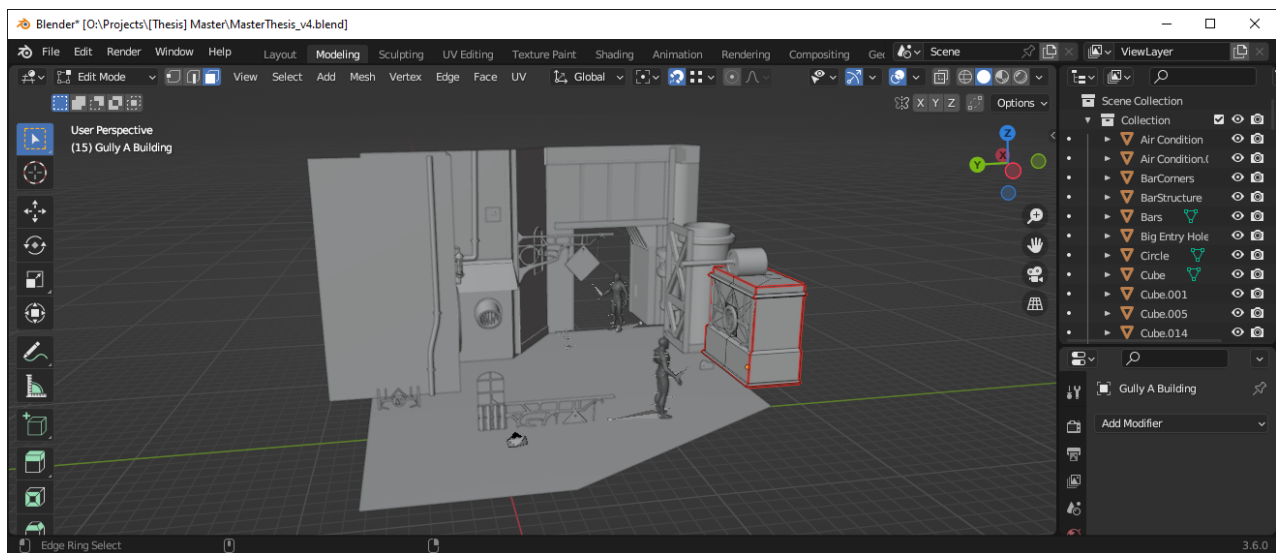

Figure 14: Modeled scene in Blender, mannequins are used as reference

Once all props of the scene had been modeled, the next step was to unwrap each mesh onto a UV map, allowing me to texture in an external program. The task of unwrapping is generally more time consuming than modeling, and while Blender offers helpful tools to speed up some tedious parts of the process, it is necessary to manually create and control any UV map, otherwise there is a risk of having problems later in the texturing process, which could mean, redoing the whole process of unwrapping and texturing, therefore I took some additional time to pretest al UV maps with a grid texture (Figure 15).
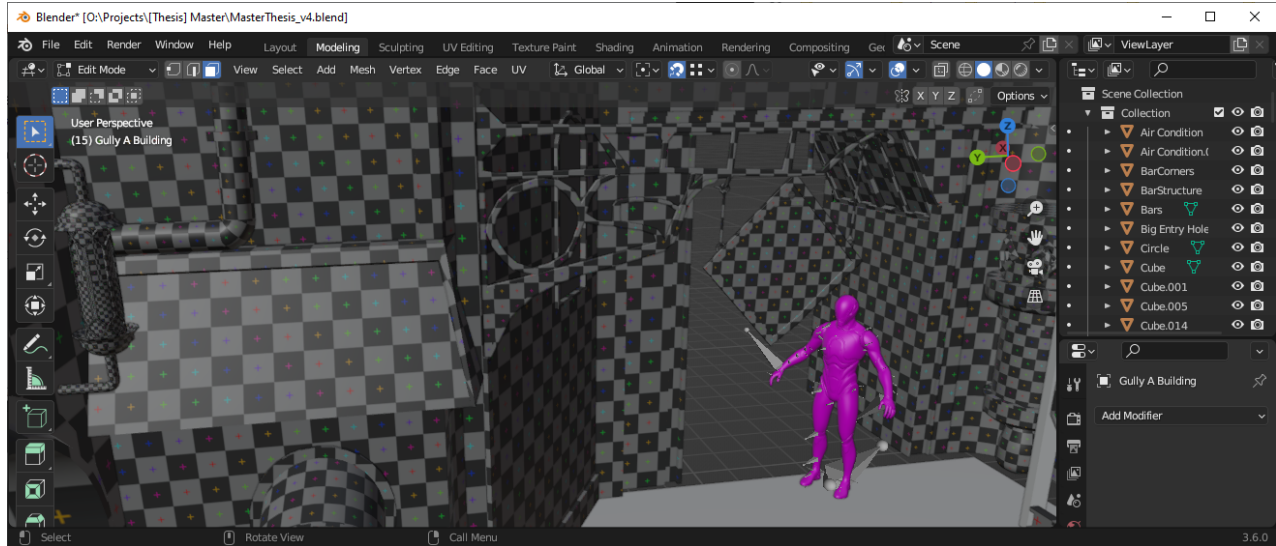
Figure 15: Using such grid textures allows for visually detecting errors within the UV map.

2.3. Texturing

After completing the modeling phase I imported the assets into Unreal Engine 5 to detect errors I might have missed like inverted faces or n-gons (polygons with more than 4 vertices). Softwares like Blender seem to be less susceptible to rendering those defect faces, while in game engines those faces can be immediately spotted.

Thankfully I had only to fix a few minor errors, so I shifted my focus on texture generation itself. Admittedly I have never hand-drawn a texture, so I explored alternative methods to replicate Studio Fortiche's art style. At first I used software like Substance Painter to generate textures mathematically by incorporating various noise textures. Initially results were ok, but not as good as hoped and I spent a lot of time constructing just one texture, so it wasn't sustainable working like that (Figure 16).

Intrigued by recent breakthroughs in artificial intelligence and image generation, I experimented with some text-to-image diffusion model, primarily Stable Diffusion, due to being able to run it offline and have better control over it. Unfortunately the generated outcome was dissatisfying and inconsistent (Figure 17). Even minor changes in the input prompts produced vastly different images, further I still had to make those images align with the UV maps and upon importing these results into the Unreal Engine project, the scene diverged visually significantly from the intended reference.

Figure 17: Texture generated by Stable Diffusion

After trying different approaches, I found the greatest success and efficiency by drawing textures directly on the meshes using a software called Procreate, assisted by an iPad screen and a pressure-sensitive pencil. Even though I struggled to draw straight lines, this approach immediately outperformed the visual quality of all previous used generative methods. Since Arcane's artstyle is composed of a lot of scribbling and keeping rough color transitions, the drawing experience was as enjoyable as the achieved results.

2.4. Stable Diffusion

An early idea of mine was to let an AI help me generate the props I required for my Unreal Engine scene. In the last two years AIs have drastically improved through more sophisticated machine learning algorithms and accelerated hardware, especially in fields of procedural content generation like image generation and 3D mesh generation.

The initial struggle with procedural image generation was to output anything that even closely resembled the art style I was aiming for (Figure 18). Frustratingly common, the generated image resembled a picture taken by a camera rather than a flat surface material, or the texture was spliced with some human faces (Figure 17).

These problems occur because text to image models are generally trained on datasets of human or building pictures, rather than surface textures without perspective. One solution is to change the stable diffusion model towards one specially trained on game textures. The Stable Diffusion community (https://civitai.com/) offers a wide variety of such specialized models, yet due to those models mostly being trained on a smaller dataset, the range of results is noticeably limited.

In my opinion a better solution is the usage of LyCORIS models, which are separately trained from the Stable Diffusion model, and applied on top of the chosen model, filtering images used by the generating process and therefore leading to optimized output results (Figure 18).

Figure 17: Image generated by Stable Diffusion, attempting to recreate a scene from Piltover in Studio Fortiche's unique art style

Prompt: (arcane style:1.5), (arcan3l0l:1.5), old painting, best illustration, illustration, (vibrant colours:0.8), masterpiece, best quality, (volumetric lighting:0.7), (best shadow:1), illustration , depth of field, bokeh, Rembrandt light, a painting of a knight talking with a police officer, next a couple drinking tea close to an ice shop, city with lots of tall buildings, kingdom hearts 3, outer worlds, tony sart and an anime artist, in - game screenshot, azure sky, tekkonkinkreet, relaxing concept art, medeival fantasy town, screenshot from the anime film, unreal5, europe, kuwahara filter in the depth,people on the street, high above the european medieval city,lots of tall houses, daytime,steampunk, pilltover,<lora:Arcane_LoL:0.9>

Negative prompt: (worst quality, low quality:1.4),simple background, badhandv4, easynegative, (bad anatomy), extra digit, fewer digits, (extra arms:1.2), bad hands, bad eye, girl, boy, person, castle, water, water ways, sea, ocean,

~ Prompts used for Figure 17

Figure 18: Image generated by Stable Diffusion, fine tuning output with multiple LyCORIS models

Prompt: (arcane style:1.5), (arcan3l0l:1.5), old painting, best illustration, illustration, (vibrant colours:1), masterpiece, best quality, (volumetric lighting:1), (best shadow:1), illustration , depth of field, bokeh, Rembrandt light, a painting of a knight talking with a police officer, next a couple drinking tea close to an ice shop, city with lots of tall buildings, kingdom hearts 3, outer worlds, tony sart and an anime artist, in - game screenshot, azure sky, tekkonkinkreet, relaxing concept art, medeival fantasy town, screenshot from the anime film, unreal5, europe, kuwahara filter in the depth,people on the street, high above the european medieval city,lots of tall houses, daytime,steampunk, pilltover, art by greg rutkowski,art by tooth wu,art by wlop,art by artgerm, <lyco:thesabu_T1_v4:0.4> <lora:reiq_v0.8:0.4> <lora:houk1se1:0.4> <hypernet:oov1wq_v10:0.3> <hypernet:mjv4_v1:0.3><lora:Arcane_LoL:0.9>

Negative prompt: (worst quality, low quality:1.4),simple background, badhandv4, easynegative, (bad anatomy), extra digit, fewer digits, (extra arms:1.2), bad hands, bad eye, girl, boy, person, castle, water, water ways, sea, ocean,

~ Prompts used for Figure 18

In my opinion the biggest weakness of procedural image generation is the inconsistency of the results. Even small changes, like swapping the word order of the params, leads to noticeable different results. Further params have different weights in the context, due to an unbalanced selection of images used to train, meaning one param might affect the image stronger than another.

A good example for this behavior is the following. *"Draw a woman with blonde hair"* will generate an image of a white european female with blonde hair, while *"Draw a black woman"* will generate an image of an black african female with black hair. Combining those prompts to request "draw a black woman with blonde hair" most likely results in the image of a white european female with blonde hair. As mentioned, this happens due to selection of images being used to train the model. While European women are depicted in those images with black, brown, red and blonde hair, African women are depicted solely with black hair. The dataset does not differentiate between *"blonde hair"* and *"white European"*, because the params share the same images in the dataset. Furthermore, most trained datasets contain more pictures of European people than other ethnic races combined, imbalancing the weight of params further. An easy way to detect such "preferences" is by simply requesting multiple images of the model while keeping the params more generalized, like "draw me a human".

2.5. Materials

An important choice was how I would implement the stylized look into Unreal Engine.
Generally, I had the following choices:

- use physical based rendering (PBR) and make a material with very neutral PBR parameters,
- use post process effects, but then you are limited in what effects you can achieve and it throttles the performance,
- use an unlit material and fake lighting, but lose access to Unreal's more advanced lighting, like Lumen,
- write your own custom shader model and implement it into Unreal Engine.

I chose to work with PBR materials to have access to Unreal's most advanced technology, like Lumen, a new lighting technology simulating global illumination in real time without baking, greatly improving quality and control over shadows and theoretically allowing me to flood a scene with volumetric light. In my experimental scene it wasn't necessary, though Arcane has a lot of such sequences requiring simulation of thick fog reflecting light and long shadows, inking the frame in soft light (Figure 19).
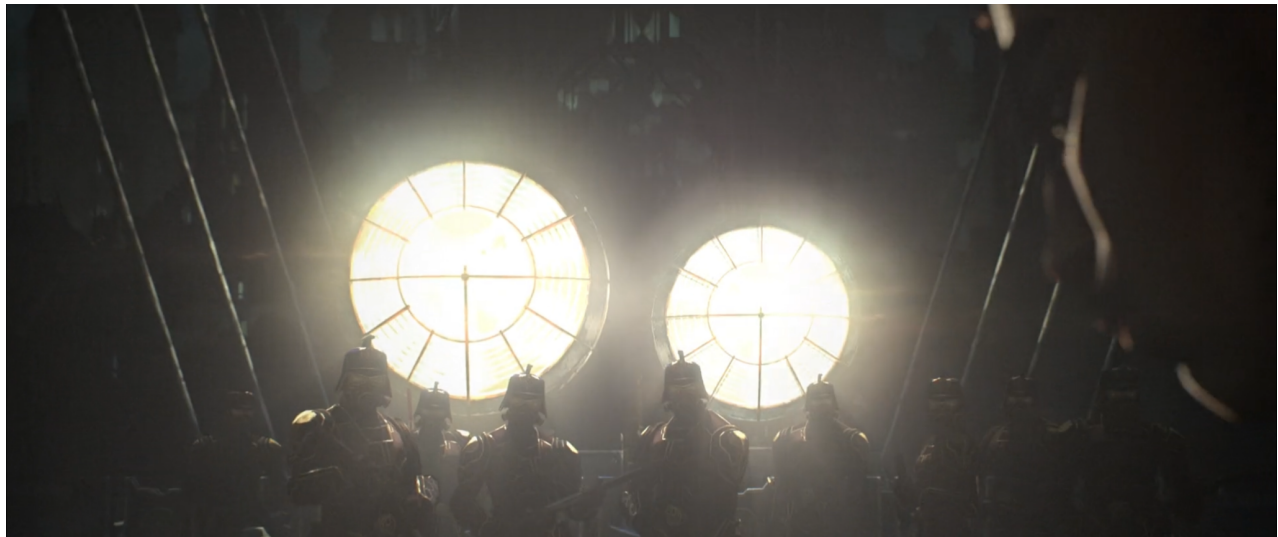

Figure 19: Arcane frequently uses volumetric lighting to build up spooky scenes

When I finally built the scene together, having all objects and lights in the scene, I struggled using physical materials. Light is simulated and reflected from the surface depending on the defined material, so observed colors in the scene frequently varied from those in the texture. For example, defining an object being built from metal turns the perceived color really dark. To quickly solve this problem I added additional parameters to modify each instance of material, allowing me to artificially raise or decrease values, like the brightness of the texture. Doing so I somewhat achieved my scene to look similar to the reference, but the downside of this fix method is being unable to work down a predefined pipeline, so the end result is only visible in Unreal Engine itself and any small change in lighting drastically affects how the composition fits together.

Surprisingly I didn't encounter an expectable problem whenever working with stylized visuals. Objects tend to have a texture set of two for colors , one for being in light and one for being in the shadow (Figure 20, Figure 21). The final rendered result is an interpolation between those two depending on the illumination, allowing the artist full control of how the object interacts and behaves within shadows.

Figure 20: showing light texture for color, shown asset from Guilty Gear

Figure 21: showing shadow texture for color, shown asset from Guilty Gear

I still believe Arcane to apply this technique, but as far as I observed, all matte paintings pick very reasonable colors for shadow spaces. In the end I achieve similar results by solely placing lights and casting shadows.

2.6. Lighting and Shadows

Interestingly Arcane uses a wild variety of light and shadows and still preserves a pleasing to watch composition. As mentioned in previous chapters a lot of fake shadows are drawn on the texture itself. Since my reference is a matte painting, everything is drawn, therefore I focused more on being able to mimic most shown shadows in the image with an actual light source. Using drawn shadows has the disadvantage of being limited in how to react to light source changes, like a different angle, occurring for example in games with a day and night cycle. Basically every game uses at least one fake shadow texture. I refer to the Ambient Occlusion Map, mimicking shadows that naturally occur in tight spaces, like corners, basically places that prevent the light from bouncing off equally. There is an argument to use Raytracing for a realtime solution, but in practice, an Ambient Occlusion Map delivers a very satisfying result without requiring additional intensive hardware calculations.

3. Methodology

My thesis examines how feasible it is to replicate Studio Fortiche's art style in a real-time game engine environment, due computer games being more limited in areas like post production and therefore unable to achieve specific effects than films can easily accomplish by having an artist overdraw a sequence frame by frame.

To test my hypothesis that it is indeed possible to create a Fortiche-Inspired environment inside a computer game environment, I attempted to recreate a scene from the show Arcane:League of Legends inside the Unreal Engine 5. For my reference I picked a matte painting by Geoffroy Thoorens appearing in Episode 6 (at timestamp 11:36 for a few seconds), which is accessible as an image and in high detail on Artstation (https://djahal.artstation.com/projects/d0KX0K)

To evaluate my success in recreating the scene, I conducted a quantitative online survey, using online channels like the reddit forum of Arcane, but also work-related communities like Artstation. Participants will be questioned on multiple statements and can reply with numerical values between 1 and 10, 10 indicating they strongly agree while 1 means they strongly disagree. Such can be, if the participant has experience with any modeling software. At the beginning, the survey tries to evaluate the participant's knowledge and separate them into three different groups, participants A, who have little contact with computer games, participants B, who have a lot of contact with computers or play League of Legends , and participants C, who due to working in this field offer a more professional opinion. In the middle part I analyze if the participant likes the art style of Arcane. Next participants will be shown the reference from Arcane and an image from my built Unreal Engine scene and questioned regarding different areas, like composition and lighting, allowing me to pinpoint which areas delivered a good result and which need more refinement.

After grouping all survey responses, in the best case a dominant trend will be visible, meaning the plurality of values being close to each other, signifying that multiple participants share similar opinions, representing a more stable result, while spread values indicate a less conclusive result, with some exceptions. Questions like "Do you have a background comparable to game development?" are preferably more distributed, indicating a more random sampling of participants.

The online survey can be found under following link: https://forms.gle/bYEa2ZPjGV7MHC178

3.1. Survey Questions

Questions 1-3 helped to determine how versed the participant is with the medium computer and game development. I expect people professionally working in the field to vote harsher than people just consuming computer games.

1. Are you familiar with computer games?
2. Do you have a background comparable to game development?
3. Are you familiar with modeling, texturing or sculpting software?

Question 4-6 helped to determine how interested the participant is in the series Arcane, because it's very likely to reflect in his/her voting.

4.   Are you familiar with League of Legends or any other game of the franchise?
5.   Have you watched all 9 episodes of Netflix Serie "Arcane" (2021)?
6.   Do you like the visual look of Netflix Serie "Arcane" (2021)?

Question 7 served to determine if I had modeled enough props.

7.   Composition of Perspective and Objektes placed in the scene looks the same

Question 8 served to determine if I was able to replicate art style and texturing.

8.   Textures/Color in the scene look the same. (Ignore Lighting, right is original)

Question 9 served to determine if I was able to replicate the lighting in Unreal Engine 5

9.   Lighting and Shadows in the scene look the same (Ignore Textures, right is original)

Question 10 served to determine if my experimental attempt worked to make the result visually more appealing by applying specific post process effect (Kuwahara) for a more stylized painterly look

10.   Here a Kuwahara Filter was used to achieve a more painterly and stylized look (left is the one with the filter)

At the end of the survey I added a text field for comments to collect additional insight. Generally if people take the extra time to write a comment, they intend to contribute to the survey with their opinion or advice.

4.   Results

Figure 22: Final scene in Unreal Engine 5

5. Conclusion

While working on my scene, I came to the realization that achieving a stylized look goes beyond delivering a scene populated by high detail mesh props and to wrap them with intricate textures. It depends on how the environment is perceived by the viewer. Working in a messy fashion on a texture, incorporating exaggerated brush strokes and allowing colors to bleed, might produce a visually appealing result assuming it was intentional and a consistent looking scene.

One particular challenge I encountered when working with the Unreal Engine was dealing with physical materials. Because the Unreal Engine simulates realistic light, bouncing from surfaces, resulting in the observed color deviating from the texture one, very noticeable on reflective materials, like metal, letting the color appear significantly darker. To address this issue, I added additional parameters to my material, allowing me to artificially adjust specific values in the scene, such as the brightness of the color. It worked, but the drawback of this approach was the inability to adhere to a defined pipeline, even a slight change in lighting could dramatically impact the overall composition.

Still I learned a lot by trying to mimic Fortiche's art style, learning their sources of inspiration, and I'm definitely up to implementing a character with animations from Arcane into my scene next.

5.1. Interpretation of Results

The smallest group participating in the survey were people unfamiliar with League of Legends, Group A, the biggest group taking part was Group B, in all probability, due to me posting in the official reddit forum of the series Arcane. People of Group C are part students and part artist from Artstation, separable by the time the survey was taken, because Artstation was the first place I posted the survey.

2. Do you have a background comparable to game development?
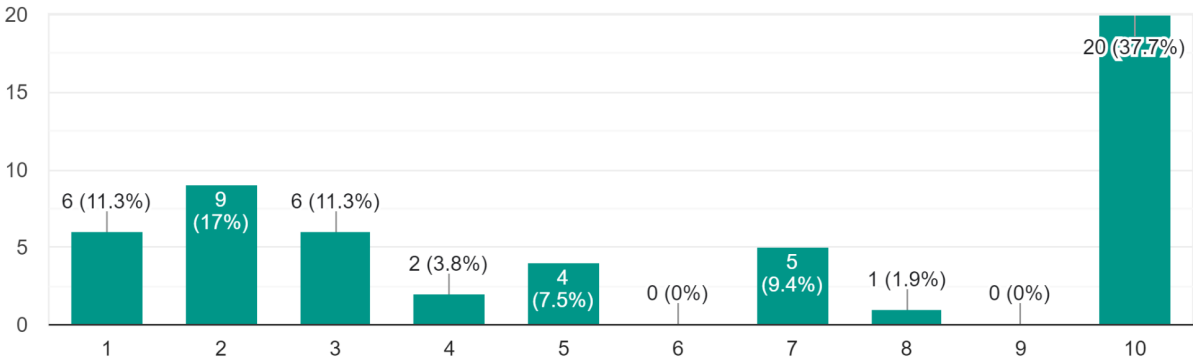53 responses

Figure 23: Only 7.5% percent of participants stated to be less familiar with computers, therefore the biggest participant groups are B and C

As previously expected, group C rated my scene in all categories overall lower than A and B, interestingly though only around 50%, the rest voted similarly to group B. Over 80% of participants visually enjoy the artstyle of Arcane, noteworthy participants of the group A, mostly consisting of people unaware of League of Legends and Arcane, gave a high rating.

8. Lighting and Shadows in the scene look the same (Ignore Textures, right is orignal)
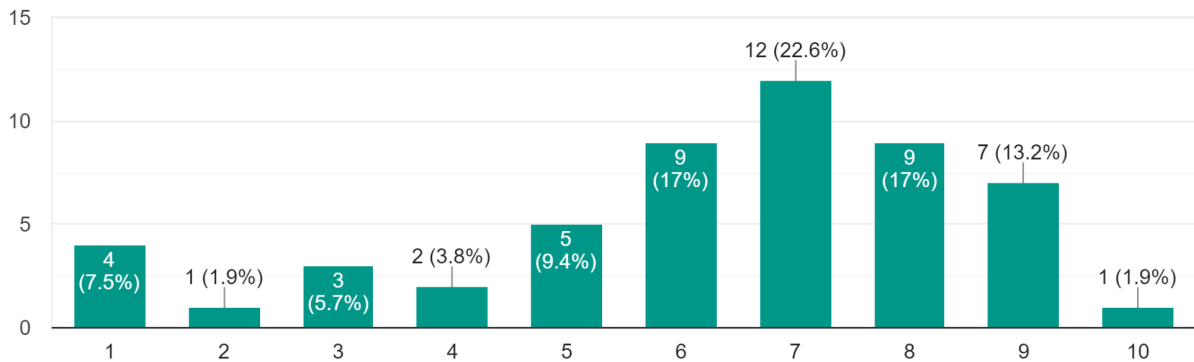53 responses

Figure 24: Lighting was considered by participants to be the weakest part of my scene

Modeling the Probs received the highest score with an overall rating of 7.73, Texturing got a solid overall rating of 6.75, and lighting as expected at the rear with an overall rating of 6.24.

5.2. Limitation

It is important to acknowledge limitations of this research due to the findings being highly influenced by the participant's opinion. Factors like having actually seen the series Arcane or a trained eye due to work related experience shift the result. As expected participants with professional work experience rated harsher than those being consumers. To overcome this variation a higher number of participants would have been required.

5.3. Avenues for Future Research

As previously mentioned better results are achievable by adding a custom shader model, which allows it to interact with light but behaves more like a stylized material than a physical one. It's possible by directly modifying the freely available source code of the Unreal Engine, yet any new shader has to be registered to all the key functions of the render pipeline, otherwise the engine crashes with a critical null-pointer exception due to accessing an invalid address in memory. It's a difficult task requiring a lot of experience and time, thankfully some users wrote guides on how to add a custom shader model:

- https://medium.com/@solaslin/learning-unreal-engine-4-implement-cel-shading-w-outline-using-custom-shading-model-in-ue4-22-2-308bcbd7950c
- https://dev.epicgames.com/community/learning/tutorials/2R5x/unreal-engine-new-shading-models-and-changing-the-gbuffer

Sadly there is one big downside to using a custom shader model, because each new release of the Unreal Engine has the potential to break previous written source code, as the Unreal Dev Team while working actively on like Lumen, Nanite, Substrate and Virtual Shadow Maps, with internal changes to those technologies might directly affect the render pipeline.

6. References

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Letzter Zugriff auf alle Webseiten am 30.11.2023

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7. List of Abbreviations & Work-related Terms

Artstation	Portfolio website for artists and companies
UE5	Unreal Engine 5, a real-time game engine
Mesh	A mesh is a collection of vertices, edges, and faces that together form a three-dimensional object.
UV Unwrapping	A UV map is the flat representation of the surface of a 3D model used to easily wrap textures. The process of creating a UV map is called UV unwrapping.
Kuwahara	The Kuwahara filter is a non-linear smoothing filter used in image processing for adaptive noise reduction.
Stable Diffusion	Stable Diffusion is a generative artificial intelligence model that produces images from text and image prompts.
LyCORIS, LoRA	*Lora beYond Conventional methods, Other Rank adaptation Implementations for Stable Diffusion* model is an alternative method for implementing different algorithms to do parameter-efficient fine-tuning on Stable Diffusion.

Eidesstattliche Erklärung

Ich versichere, die vorliegende Master-Thesis mit dem Titel „*Creating a Fortiche-Inspired Environment in Unreal Engine 5*" selbständig ohne fremde Hilfe verfasst und keine anderen Quellen und Hilfsmittel als die angegebenen benutzt zu haben. Die aus anderen Werken wörtlich entnommenen Stellen oder dem Sinn nach entlehnten Passagen sind durch Quellenangaben eindeutig kenntlich gemacht.

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Hamburg, den 30. November 2023