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L6 - Advanced Lighting and Rendering (ACCA6032)

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Submission Due Date:

16th January 2026

Link to Final Product/s: OneDrive

[Jonathan_Frise_ALR_Submission.zip](#)

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1.0 Module Introduction & Initial Planning

1.1 Understanding the Assessment Brief

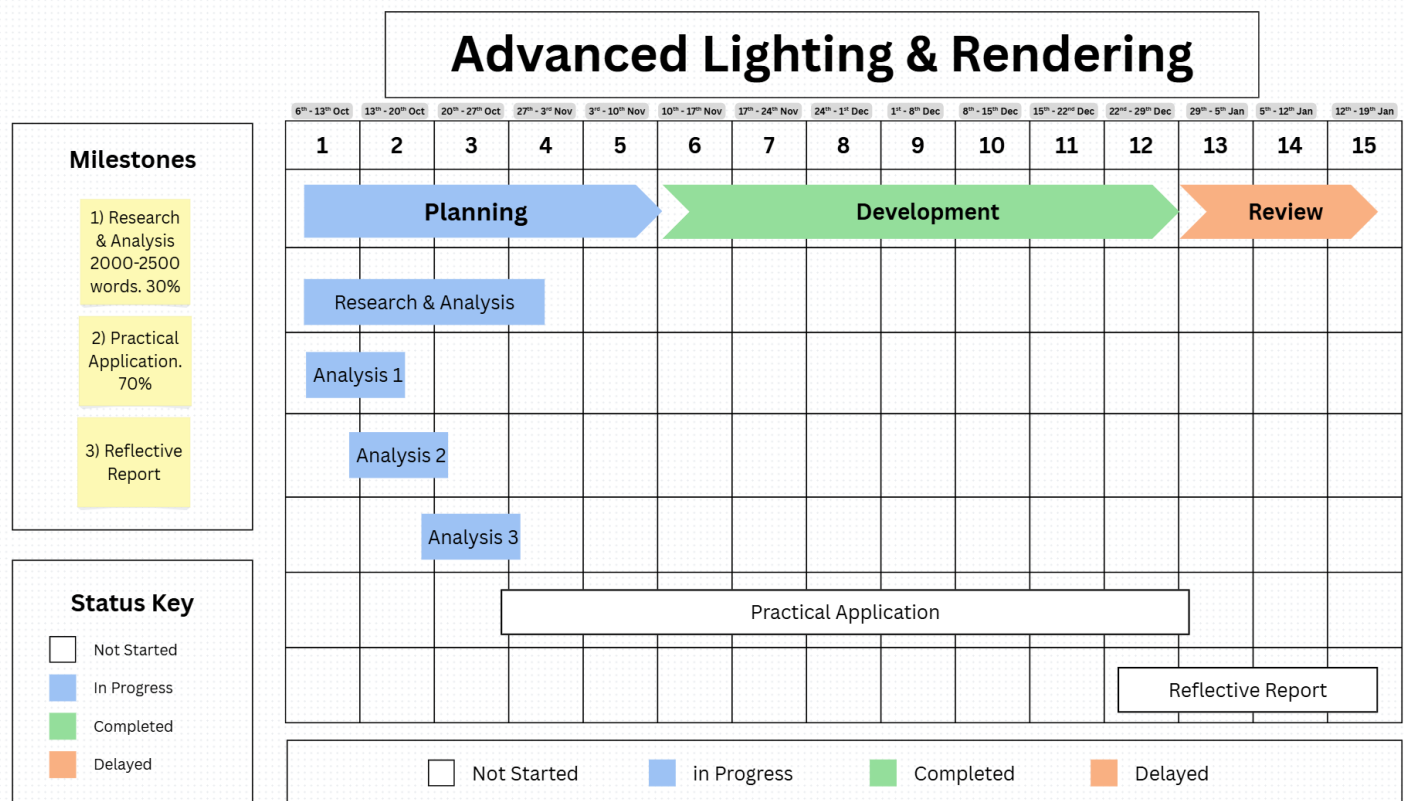
- **Key Deadlines:** Submission on 16th January 2026.
- **Assessment Breakdown:**
 - Part 1: Research and Analysis (30%).
 - Part 2: Practical Application (70%).
 - Part 3: Reflective Report (Word count incorporated into written submission).
- **Gantt Chart:**

The Gantt chart below shows an important management method to track my progress on each of my modules individually, it allows me to easily keep track of milestones, where and when I should be assigning new tasks and allows me to effectively switch between modules and tasks while easily being able to look back and link relevant parts to other areas during my study and independent project.

While using a Gantt chart can be useful to manage a project at a glance, it can lack the detail and complexity that I may need, however it is this reason will I also utilise extensive segments in the form of content tables, note taking, and thus breaking down each section into tasks to be completed and evidenced in my reflective journal here, this will allow me to flexibly add tasks that I may think off during the planning phase etc. Likewise, will provide a more detailed method in documenting and analysing my work this way as I go opposed to purely relying on a Gantt chart that can be difficult to add the detail it may need but can still be invaluable as a project timeline.

Other methods I could use and have done in the past would be a Trello board, to create an interactive schedule, while also acting as a timeline that I can add tasks in a tab format that is extremely customisable, however for all intents and purposes the reflective journal will be acting as this instead to avoid over complicating the process of a module spanning 15 weeks, however if it were for example a year long project or

longer then this would definitely be a good option especially for collaboration and ease of use.



- **Personal Aims:** What I want to learn and achieve in this module.

Though I understand I will not be able to incorporate this module with my independent project in the same way I will with my advanced character performance module I can however implement the techniques and methods found with various forms of lighting in games, film and TV.

My main goal is to research these methods thoroughly with my chosen 3 from the list and learn how these could benefit different workflows in the industry but more importantly how I can actively use these techniques to realistically light my scenes weather I achieve this with real time techniques in Unreal Engine, and/or post-production in After Effects, DaVinci Resolve or Nuke.

Being able to understand the differences between these techniques and why they are used as well as getting to know their limitations will influence the direction I take with my independent project. In doing so I will also be simultaneously gathering inspiration material and new knowledge of how I can exactly implement these methods into a self-directed project.

- **Generative AI Guidelines Review.**

In keeping in line with previous years I already understand the significant importance of using AI ethically and responsible, the growing role it has in the industry in every sector, as well as how I can specifically use it not as a shortcut or cheat, but an aid, a powerful tool that can expand creativeness, not as a replacement.

I believe this strongly and as such, and in conjunction with my other modules, I will only be using AI to create reflective journal structure, for example, titles and headings as per the assignment specification, and not the content itself, as it is very important I can show my creative thought process behind each decision I make and be able to evidence that here without AI is not only ethical but appropriate to learn in order be effective in any working environment to not become reliant on AI as a crutch as this is not how it should be used.

In doing so, also ensures I am keeping with university policy, whiles learning how to use AI tools responsibly and actively as it grows at a faster pace than ever in any previous years.

In writing this review I reinforce this ideology and context of use cases that AI can be applied to as per the specific areas allowed by the specification, that being, research, structure and proof reading.

Areas in which AI have been used such as specific research will be expanded on at points in this document, explaining the reasoning and context to why AI can aid research by saving countless hours, whiles still retaining an effective and ethical approach.

For example, as someone who has ADHD, it can be hard to focus for longer periods, time in which research will likely take. As a result, using tools such as AI audio overviews allows be to take a breather from reading and allows me to listen instead, this being a key learning method for myself. However, it is important to note, to always double check references from AI sources to make sure the information is accurate and credible for use with my IEEE referencing system.

2.0 Part 1: Research and Analysis

2.1 Technique 1: Analysis of Global Illumination (GI)

Global Illumination abbreviated as (GI) is a foundational technique in most modern computer graphics used to achieve absolute photorealism by simulating the complex nature in which the way light bounces off surfaces within a scene. Unlike direct lighting, and component GI accounts for, which only calculates light travelling in a straight line from a source to a surface, GI accounts for the indirect light that is reflected and scattered throughout the environment/scene.

The simulation of this bounced light produces several very critical visual attributes, as shown in Figure 1. These include **indirect lighting**, which illuminates areas not just in the direct path of a light source; **colour bleeding** for example, where light picks up the colour of a surface it hits and then "bleeds" that hue onto adjacent surfaces surrounding; and **indirect shadows**, which are the soft, subtle shadows that can give objects a sense of weight and contact with their environment/scene.

The dramatic impact of these attributes is actually clearly visible in the comparison provided in Figure 2. The "Direct Lighting Only" image appears stark and unrealistic, with deep black shadows. While, in contrast to this, the "Direct + Indirect Lighting" version feels far more natural, as the bounced light fills the space and softens the shadows, grounding the character in his environment as well as any other props and surfaces in the scene, this essentially is what GI excels at.

The reason GI is so effective is that it attempts to solve the "Rendering Equation," a model that describes the global transport of light. Prior to my research I hadn't even heard of this equation. But as simplified in Figure 4, this equation must calculate light coming from a multitude of different directions at once, and not just from the primary source, which is essentially why GI has historically been computationally expensive, not just in the power needed but resources such as time and money also being a varied factor, depending on the size of the company and scope of project.

We see a successful, high-quality implementation of these principles and in many cases other methods in simultaneous use in complex game environments, such as the scene from *Assassin's Creed Unity* (Figure 3), where the bounced sunlight from large windows creates a softer, convincing ambiance throughout an ornate hallway.

It may also be important to note how many environments are designed with lighting and rendering in mind, for example, if one was to create a stylistic environment, it may not need as much detail in the modelling as a photorealistic scene would, and such how

that lighting will ultimately affect the final output and how we the audience will perceive it according to the core vision and concept of the piece, of course this depending on the goal that is trying to be achieved.

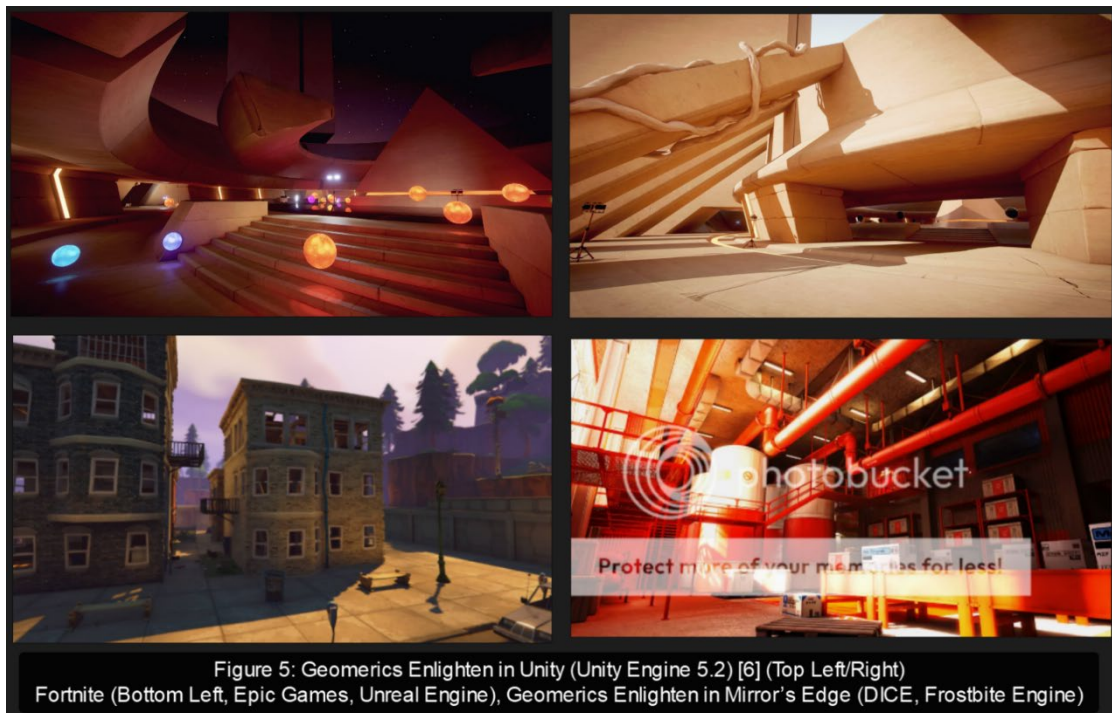
And contextually this can mean different things for different mediums, for example, in a game such as *Assassins Creed Unity*, the models in the environments need to look accurate and realistically represented when the player moves around the environment depending on and relative to their position and real time lighting method used, in this case GI.

This is opposed to a more filmmaking perspective where an animation/film can be more directed to what the director wants the audience to see and feel. Therefore, it quickly becomes a web of complex notions to overcome and must be thought out thoroughly in pre-production as advanced lighting and rendering will indeed influence what direction it takes and what emotions are evoked from the audience.

These principles are directly applicable and vital to my short film, "THE BUNKER." As planned for my independent project linking the subsequent module. The enclosed, artificially lit bunker requires GI to feel like a real, cohesive space. For instance, during the emergency sequence, the "ominous red glow" of the alarm lights will very much rely on **colour bleeding** to realistically bathe the metallic and concrete walls in a crimson hue, also keeping in mind how PBR textures come into play here.

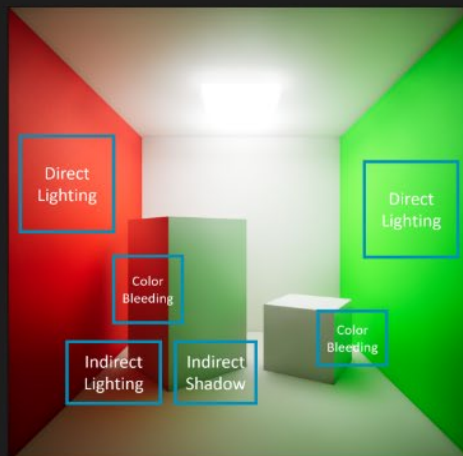
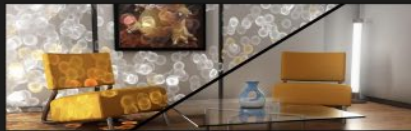
Furthermore, **indirect lighting** will be essential to prevent the bunker's cluttered corners and machinery from disappearing into pure blackness, creating the softer **indirect shadows** that are much needed to give the environment an accurate depth and a sense of tangible realism that I am going for. By leveraging a modern real-time GI system like Unreal Engine's Lumen, my goal is to achieve the kind of atmospheric fidelity seen in examples like *Assassin's Creed Unity* to make the world of "THE BUNKER" immersive and believable, while using high resolution textures in relation to my PBR materials used in conjunction with GI.

Please see below, a few more examples of GI in effect.

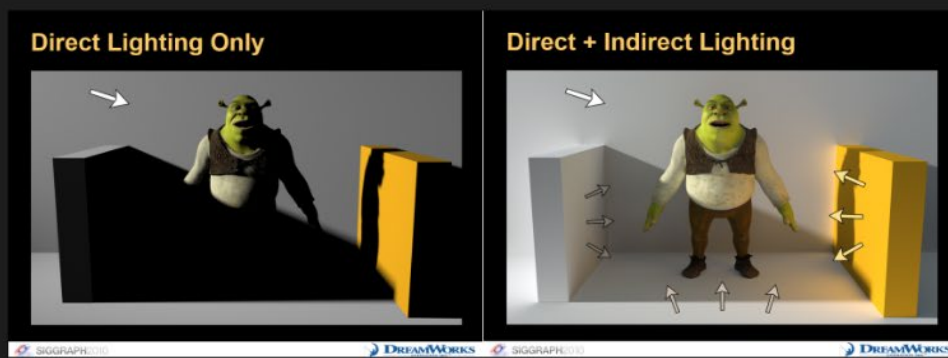


These are some prime examples, taken from various games, we can see how GI is utilised to create realism while capturing atmospheric detail as well as using indirect and non-indirect lighting to achieve this look. These examples are from the Unity and Unreal Engine software's which Unreal for example excels with the use of its Lumen system because of everything I has talked about so far.

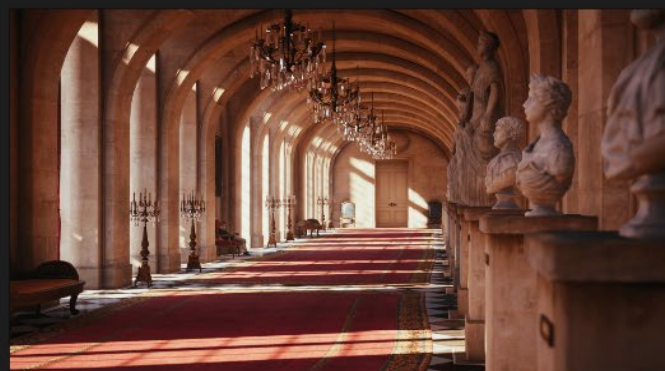
While it is prevalent here and widely used in games as seen in these examples, it can also be a key and astonishing tool/method for filmmakers to use in physical sets to create atmosphere and ultimately the desired effect. I will take a closer look at some of these now, from a prime example, various scenes/stills frames of the film Blade Runner 2049 (2017) above.



[1] Figure 1: The 4 critical attributes of global illumination.



[2] Figure 2: Direct and Indirect Illumination from a single directional light source.



[3] Figure 3: A scene from Assassin's Creed Unity, showcasing visually convincing lighting from sky and a directional light

directions for making pictures using numbers
(explained using only the ten hundred words people use most often)

position on the stuff direction towards the eye

light made by the stuff (sometimes because it is very hot)

the light that comes from an interesting direction towards the position on the stuff

the answer to how much light from an interesting direction that will keep going in the direction towards the eye, after hitting stuff at the position (this is easy for mirrors, not so easy for everything else)

how much the light becomes less bright because the stuff leans away from the interesting direction

$$L_o(x, \omega_o) = L_e(x, \omega_o) + \int_{\Omega} f_r(x, \omega_i \rightarrow \omega_o) L_i(x, \omega_i) (\omega_i \cdot n) d\omega_i$$

light that leaves the position on the stuff and reaches the eye

light can be added said a man who sat under a tree many years ago

for lots of interesting directions inside half a ball facing up from the stuff, add up all the answers in between

this idea came from <http://xkcd.com/1133/>

@levork

[4] Figure 4: The Rendering Equation, using only 1000 most used English words. [5] Additionally in red, why GI is not simple

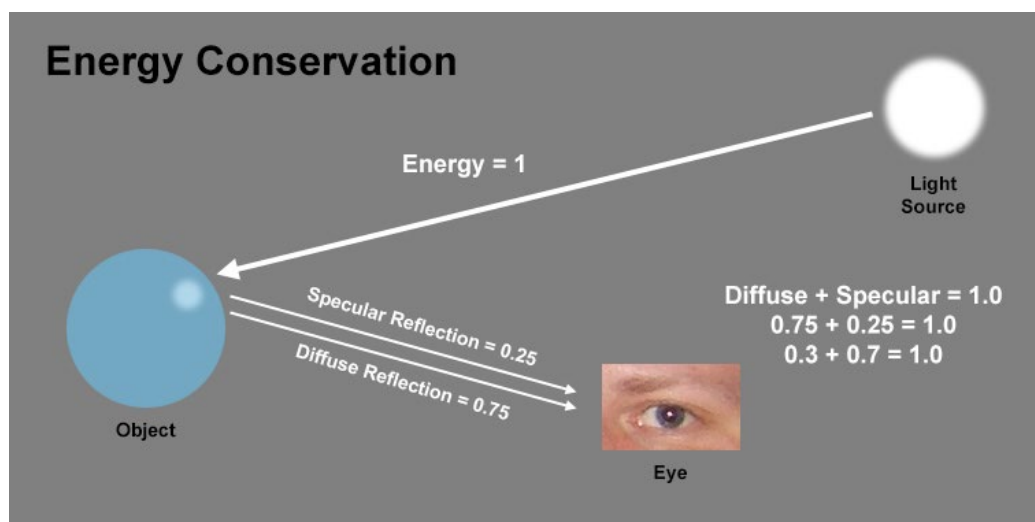
2.2 Technique 2: Analysis of Physical Based Rendering (PBR):

The first thought when it comes to PBR is that it follows one vital law, the law of energy conversion. This simply meaning, energy cannot be created nor destroyed and that a material cannot reflect more light than it receives.

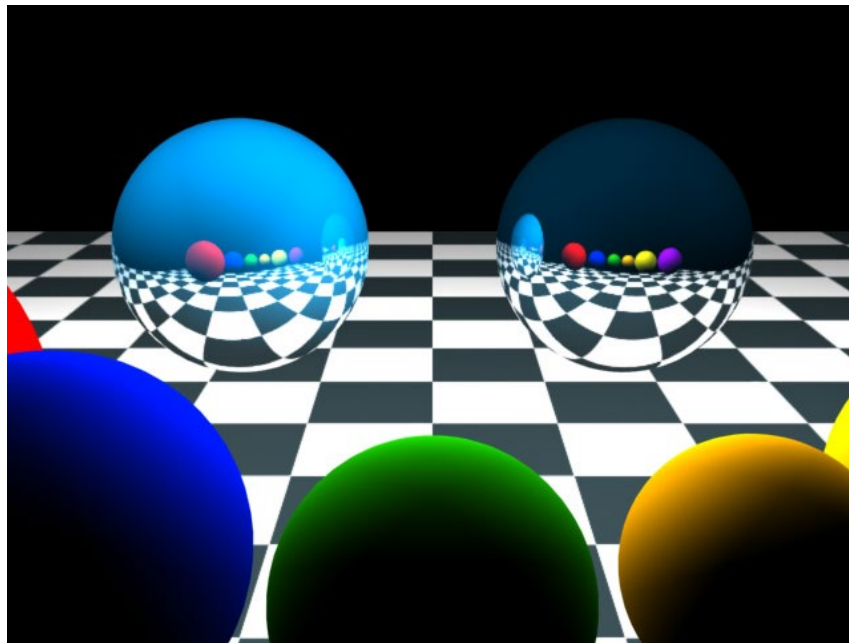
So, what exactly does this mean. Well, this law consists of 2 components, specular and diffuse. While yes there are other components to shaders these days such as transparency and translucency the law remains the same. For example, the relationship of these 2 components is what makes a material and how it is perceived by the eye.

An example of this would be a mirror, having virtually no diffuse and very high specular. Therefore, when calculating these 2 components they cannot go over 100% as this would be giving more energy than it is receiving. The mirror for example would be 95% specular and 5% diffuse. Or another way to look at it is the light source having a value of 1 means the material would have Specular Reflectivity set to 0.25, while the Diffuse Reflection is set at 0.75 or vice versa.

The graph below shows this in action.

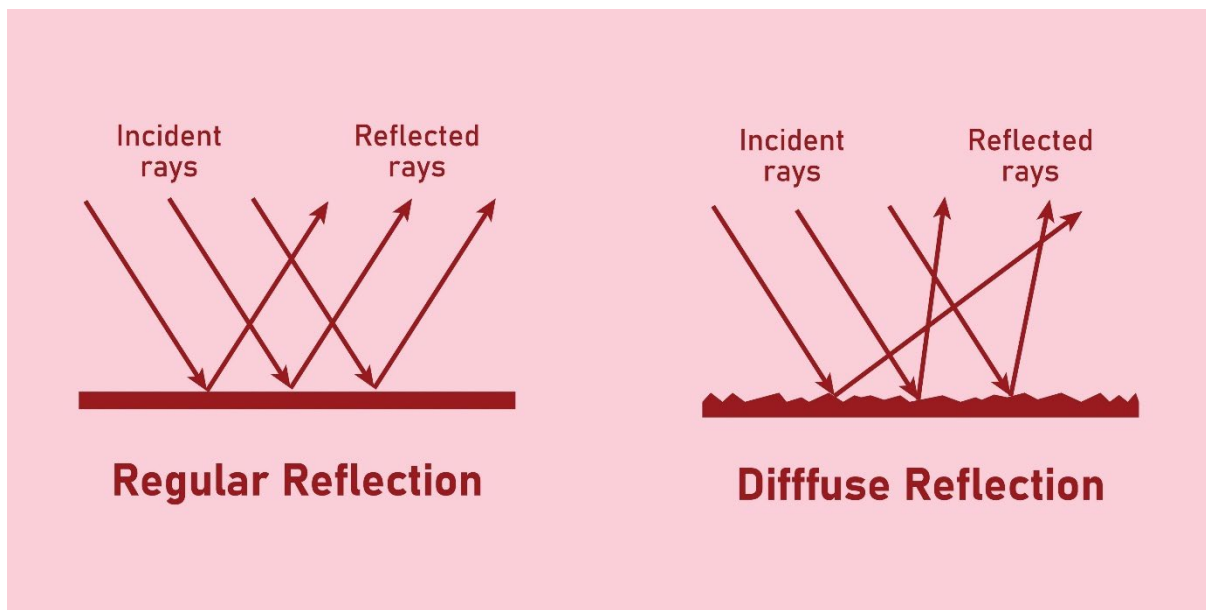


Here is an example of how this graph looks in practice.



The sphere on the right takes the black background into account, calculated automatically when adjusting the values, this is usually the case in most software's now, such as Vray's 3dsmax, VrayMtl and Blender's Principled BSDF all uses energy conservation.

While the sphere on the left still has blue which is just adding the reflection on top of the diffuse to compensate which breaks the laws of energy conversion. This example can be recreated and compared with other shaders to see if it follows the law of energy conversion helping to create photorealistic materials in the renderer.



The diagram above shows the two different types of light ray reflection: left, the regular reflection and right, the diffuse reflection. In physics, this reflection is the change in direction of a wavefront at an interface between two different media/points so that the wavefront returns into the medium from which it originated (the light source) and out into the scene.

The Three Holy Grail Maps of PBR:

Here I will explain what they *physically* represent.

- **Albedo:**

Albedo maps, focus entirely on a material's pure colour without baked-in lighting or shadows. Commonly used in specular workflows, they separate metallic reflectance into an separate specular map.

Unlike traditional diffuse maps, which often include baked-in lighting details, albedo maps emphasize pure colour accuracy. This then makes them a cornerstone in physically based rendering (PBR) workflows and essential, allowing rendering engines to simulate light interactions more realistically.

- **Microsurface (Roughness):**

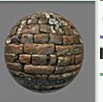
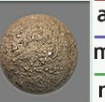
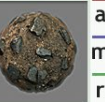
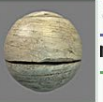
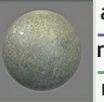
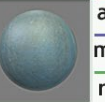
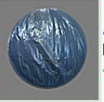
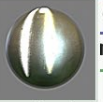
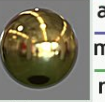
A micro-surface (Roughness) in Physically Based Rendering (PBR) materials describes the microscopic geometric details on an object's surface. It dictates how light interacts with the material at an atomic level.

This microscopic scattering of light directly translates to the blurriness or sharpness of reflections and highlights.

- **Reflectivity (F0/Fresnel):**

Fresnel Effect is the principle that reflectivity changes with the viewing angle, the surfaces become more reflective as you look at them from a sharper angle (grazing angle).

F0 (Fresnel at Zero Degrees) is the minimum reflectivity a material has when viewed straight-on (0 degrees).

material values chart			
	a m r		a m r
canvas		rubber	
	a m r		a m r
plaster		brick	
	a m r		a m r
rock		dirt	
	a m r		a m r
coal		rust	
	a m r		a m r
leaves		satin	
	a m r		a m r
wood		concrete	
	a m r		a m r
plastic (rough)		mud	
	a m r		a m r
painted metal		ceramic	
	a m r		a m r
satin		brushed metal	
	a m r		a m r
rough steel		gold	
	a m r		
chrome			
a = albedo (sRGB) m = microsurface (linear) r = reflectivity (sRGB)			
			



Specularity



2.3 Technique 3: Analysis of Ray Tracing

The first aspect to understanding any lighting technique is to first understand it's mechanics, how does it work fundamentally. Ray tracing is firstly a technique used in modern movies and games special effects that create realistic reflections, refractions and shadows comparable to that of reality. This can create more expressive shots in films as camera shot scenes and of course in virtual production for example not needing a camera or lighting equipment therefore reducing cost and increasing creative possibility depending on what the director is looking to get from a creative standpoint, but like I say, equipment and SFX costs and logistics can be a factor in this early decision.

However, there is a downside to real time graphics, it requires much more power than the traditional rasterization method that would create millions of polygons, creating the 3d objects in the scene from triangles, which in many modern games also requires substantial GPU power to render frames in advance.

So, what actually is ray tracing comparatively then. It is a technique that captures computer graphics with the effects that the light has on the 3D objects. For example, it's shadows, reflections and refractions. This process was interestingly not as modern as you may think, it was first described by Arthur Appel in 1969 and has since been at the forefront and is considered the most 'realistic' approach when trying to achieve photorealism in movies, more specifically and commonly in virtual productions, animations and games.

However, as previously mentioned this method is one of the most taxing tasks for computers to render successfully. For many professional and even indie studios it requires large servers and what are known as rendering farms for complex special effects.

Recently, and in the boom in AI technology, as GPU's grow more powerful, ray tracing is being used by even product designers and architects to generate photorealistic mock-ups and previz's quicker than ever and is more widely accessible than previous years as the market value of high-end GPU being more affordable for the average consumer.

For example, NVIDIA announced their RTX range starting at the RTX 2090 all the way back in 2018, where lately there has been rumours of the development of their RTX 6090 series coming as soon as 2027, as evident, in the last decade technology in this field continues to grow exponentially. This rapid jump in technology has made endless creative possibilities come true, creating a somewhat saturated market for VFX and competitiveness which is another debate on its own and makes it easier for indie developers to utilise the power of ray tracing for themselves and their studios.

Also, on a more topical note from my research, RAM prices have recently shot up due to a large demand from AI data centres which diverts manufacturing capacity from consumer RAM, which creates a severe supply demand imbalance driving up the costs not only for PC's but Phones and other devices thanks to the rapid growth and demand of AI technology which can be seen as one of the downsides.

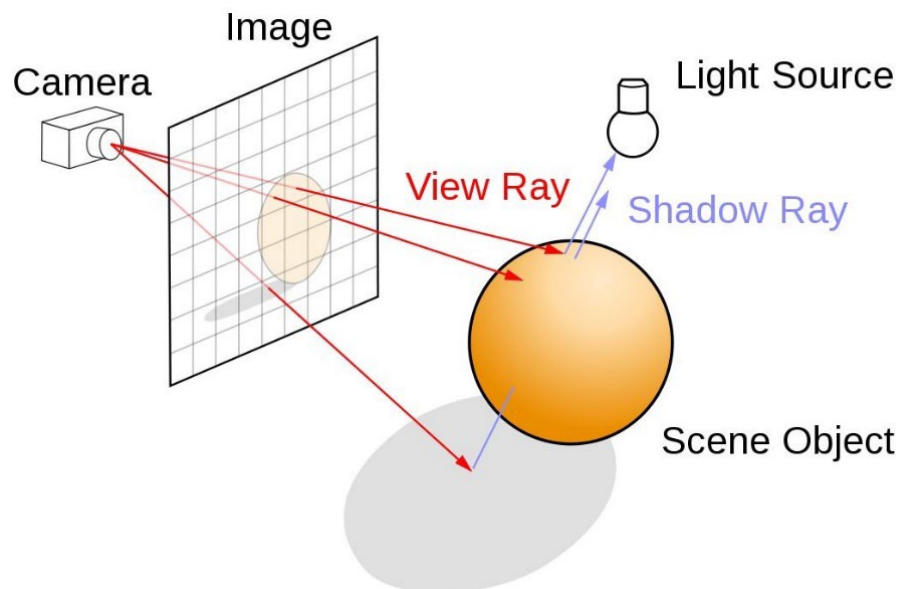
This said, and even an oxymoron, as AI becomes more needed and unfortunately relied on the more expensive it becomes for others to buy the equipment needed to advance in the creative industries. Simply put, it is undeniable that AI will be used in every corner of every industry sooner than we may think, and like I say there are pros and cons to this, where AI and it's safeguarding must be taught and used responsible to everyone in the creative industries as it expands but I divulge.

Thanks to the creation of raytracing, it can be used as a more effective and realistic way in creating impressive scenes provided you have the raw machine power such as the RTX range or alternately other comparable brands such as AMD's Radeons RX 9070 XT which is their newest GPU range built with Ray tracing in mind and uses a very similar architecture, however different depending on the individual consumers to choose which brand suits their needs as both will vary and excel at certain tasks but are undoubtedly the best when it comes to using Ray Tracing for these reasons.



The above for example shows the subtle yet powerful differences these technologies can present when used in games, this example is from Cyberpunk 2077, a well known

game for having many bugs upon release but undoubtedly can show of the latest in lighting and rendering methods through the settings menu, some games of which do not have the same level of accessibility and options in terms of graphics.

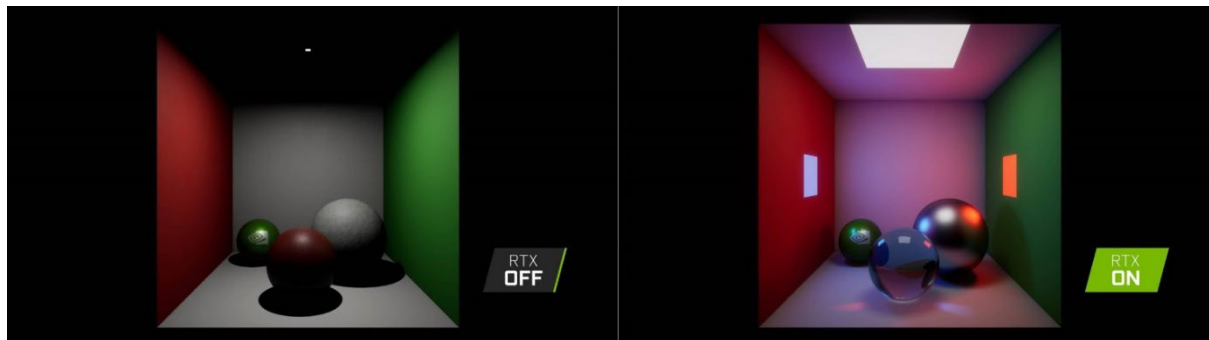


Ray tracing looks better than rasterization because it simulates how real-world light behaviour works, as mentioned, the bounces, reflections and refractions, to create far more realistic lighting and shadows. Whereas rasterization uses “hacks” and approximations leading to less natural effects like screen-space reflections or hard fake looking shadows that can create some unusual artifacts, which can be found in many older games prior to the big boom and incorporation of ray tracing as a “standard” in most modern games, AAA titles, and movies alike.

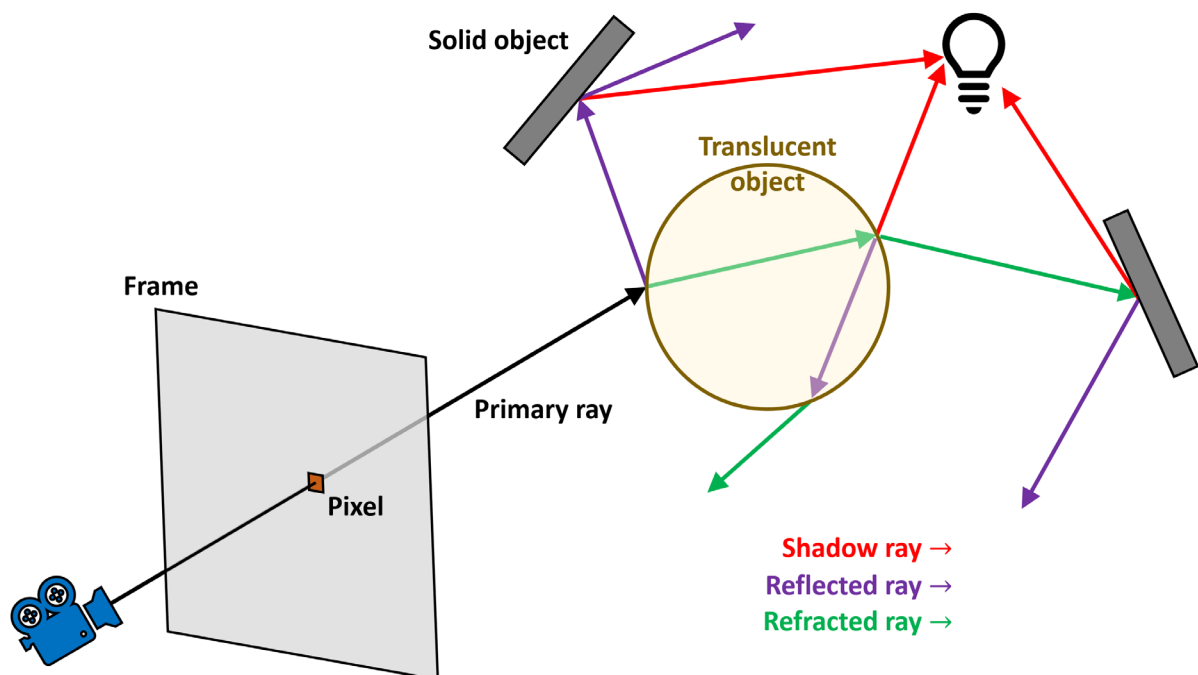
Therefore, due to rasterization’s simplicity, inherent parallelization, and optimization in dedicated graphics hardware (GPUs) Ray tracing is widely more used today and is also being enhanced with parallel technologies such as DLSS and newer internal methods including AI frame generation and anti-aliasing. However, for certain scenarios and budgets rasterization can be an effective “object centric” process that is optimised for real time applications such as games in conjunction to the more costly and power hungry alternative methods of Ray Tracing which is very dependant of budget.

In conclusion, rasterization can be used as the foundation core to many games rendering systems, for example Fortnite and Valorant, relatively newer games rely on rasterization as a core process while similarly older titles pre 2018 such as Doom (original) Half Life and the early elder scrolls titles all use this method as it was simply the best and most efficient method at the time and still has its advantages as a ‘good’

method but is becoming lesser used as AI becomes more prevalent in propelling GPU technologies into the promising future of lighting and rendering methods.



Another technical example of the Ray tracing and how it affects the interaction of coloured lighting on surrounding objects in a small simple yet effective scene.



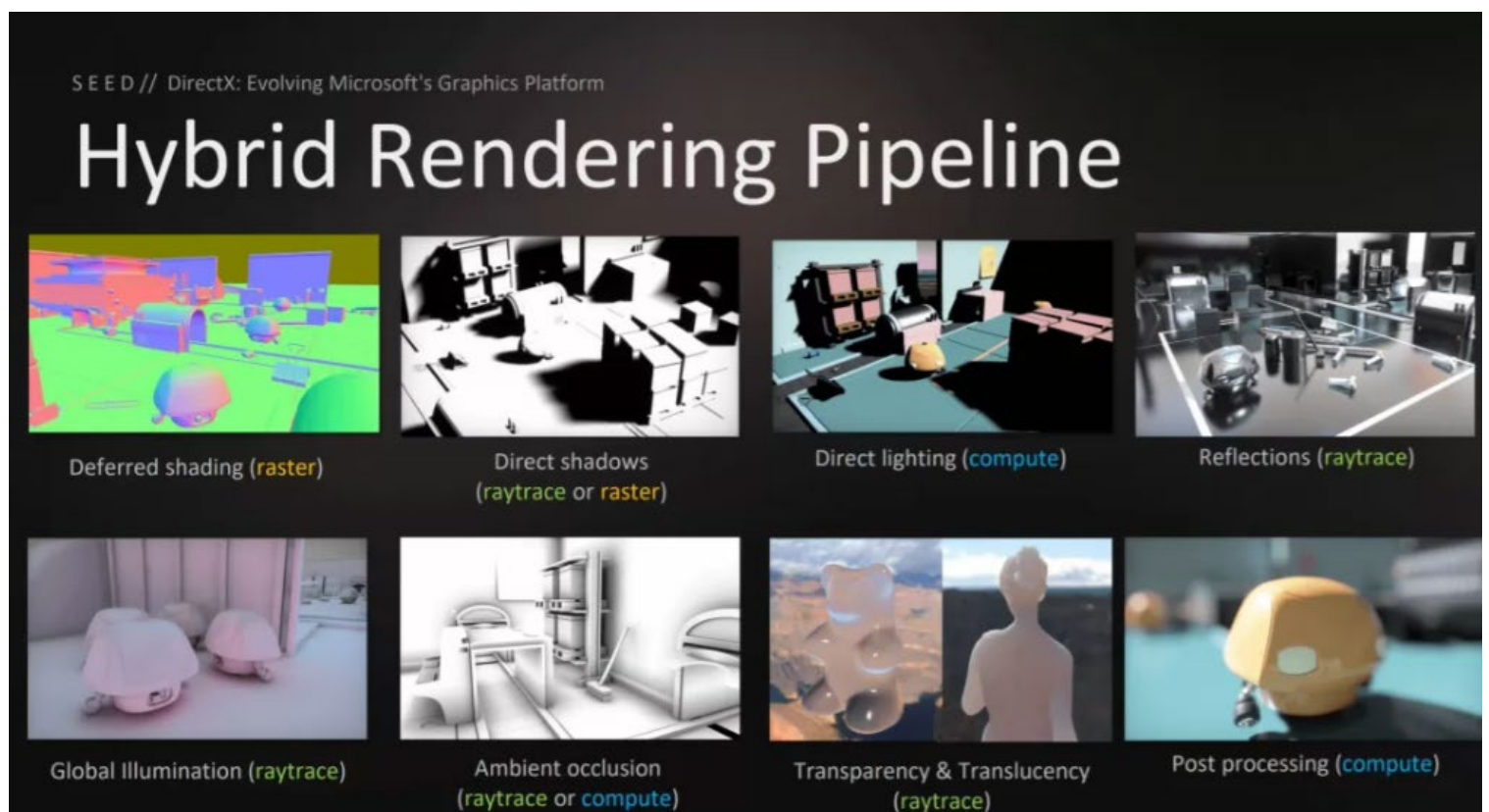
Here is a technical demonstration of how ray tracing works from techspot. About 10 years after the first inception of ray tracing by Arthur Appel, Jon Whitted developed a mathematical algorithm that did the same as Appel's approach, except when the ray hit the object it would generate additional rays which would fire in various directions depending on the object material properties.

However strictly speaking this process is actually backwards tracing, as it follows the ray from the camera and not from the objects. This method of ray tracing has been the 'holy grail' of computer graphics ever since its conception back in the late 1960s and

refinement in the 1970s and beyond, while subsequently it's rapid development of the technology and hardware from NVIDIA in the 2010s to present, showing no sign of stopping, especially since AI is consistently improving and opening new doors for this technology/method or rendering.

Since Ray Tracing is more widely known and used as the now dominating technique and is the used method of my rendering technique in both my modules, I have researched more deeply into this subject to understand it thoroughly, prioritising it. Another interesting article from TechSpot explains how they used a hybrid rendering pipeline, this resonated with me, learning how to use a variety of techniques to outputs allows a new forward way of thinking that I want to approach in my projects.

The core here is how to be flexible and adaptable in using new and older methods, combining, in most cases the best of both worlds to create the best version of the scene from my ideas, bringing them to reality not only faster but more creatively and realistically, maximizing its effect.



Additionally, the lumen 'a fully dynamic global illumination (GI) and reflections system technology' in unreal allows further enhancements to my approaches and use of ray tracing in my scenes to make my ideas as photorealistic as I can with the techniques and hardware limitations I currently have at my disposal.

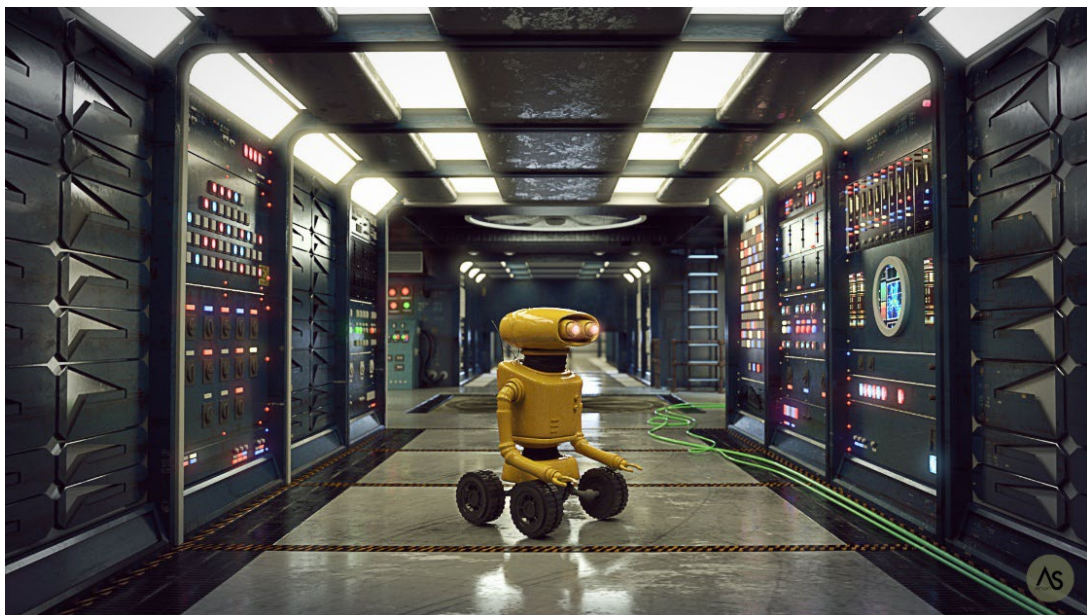
3.0 Part 2: Practical Application (70%)

3.1 Scene Selection

- Final choice for Scene 1: 'Science Fiction'.
- Final choice for Scene 2: Natural History.

3.2 Project 1: [Science Fiction]

- **3.2.1 Reference Image Analysis:** Deconstruction of the provided image's lighting, shadows, and mood.

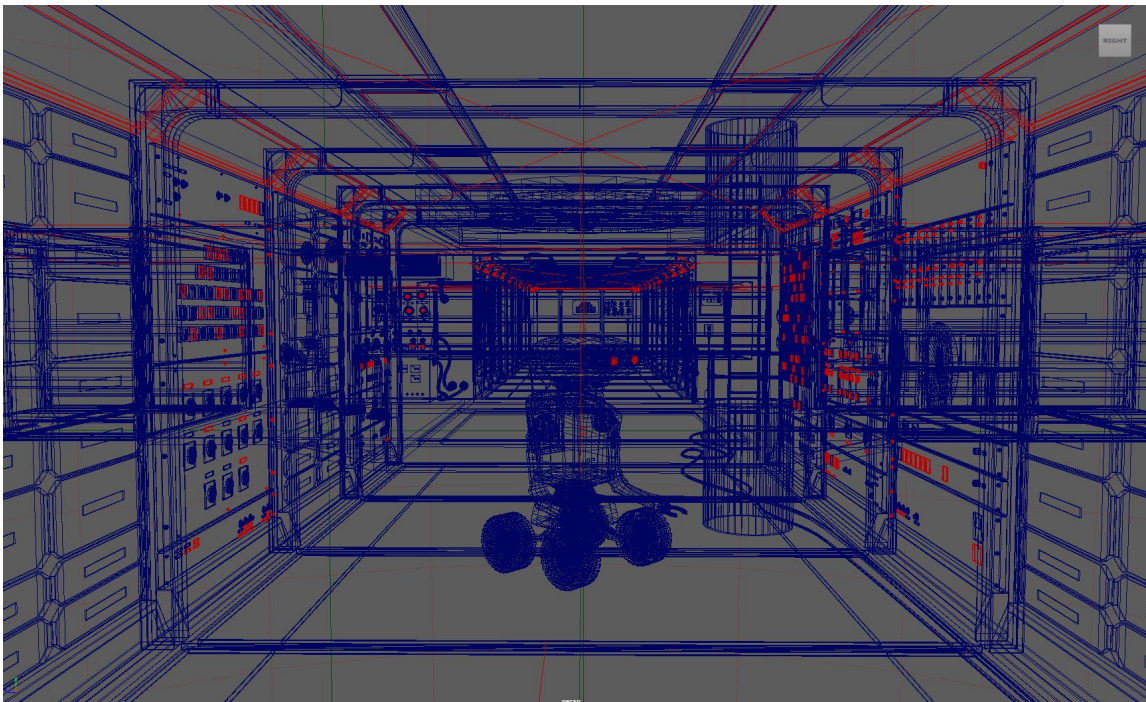
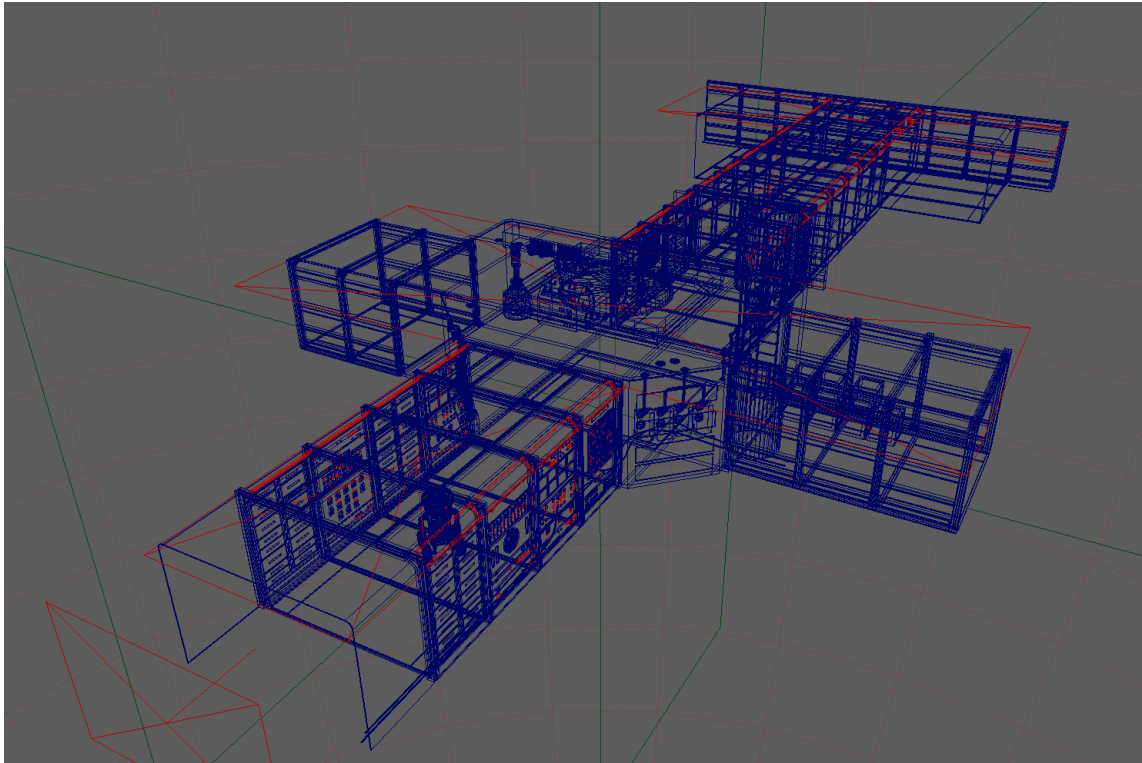


The above image shows the provided reference for recreation. The aim is not just to copy; it is to analyse the process involved with a lighting and rendering pipeline. Learning the techniques to enhance an image's lighting, taking how changing colour, intensity and position and the lighting system itself can inherently change an image's perception whether its mood or realism, or a mixture depending on what I am trying to achieve.

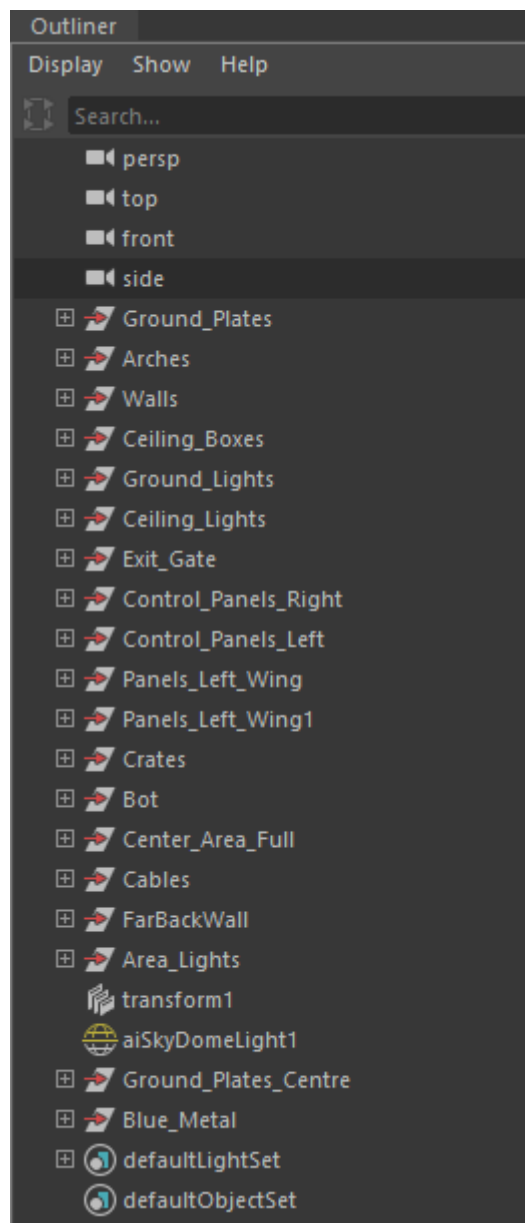
It is for this reason that trying to achieve a near same lighting scenario as of the above that will help me to further develop my understanding of advanced lighting and rendering not just in Maya, but in other software's, for example my more used program of Blender where the pipeline is the same apart from user interfaces, the same principles still apply.

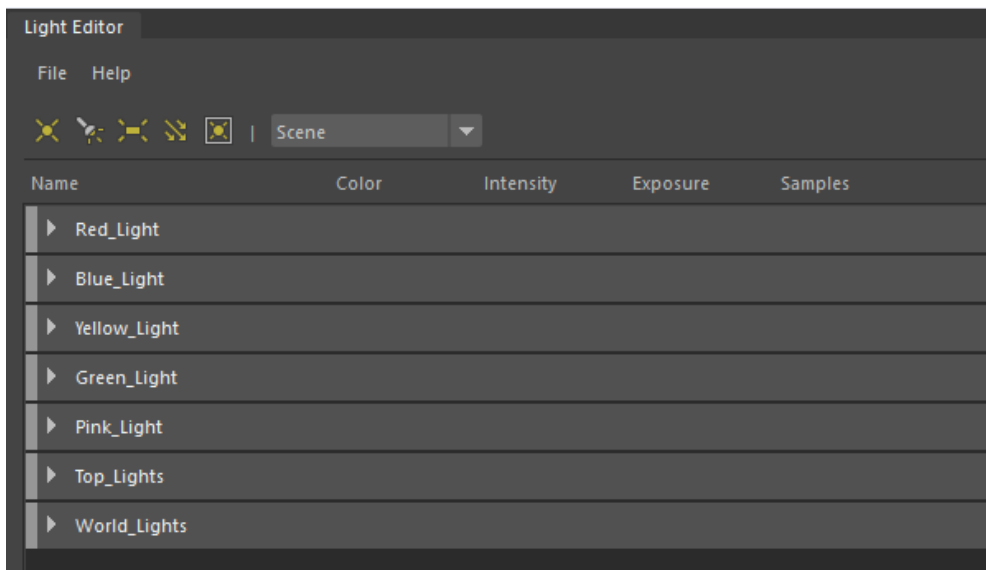
- **3.2.2 Production Log:**

- Camera and composition setup.
- Material and texture application.
- **Lighting Journal (with screenshots):**
 - Documenting the placement and settings of each light.

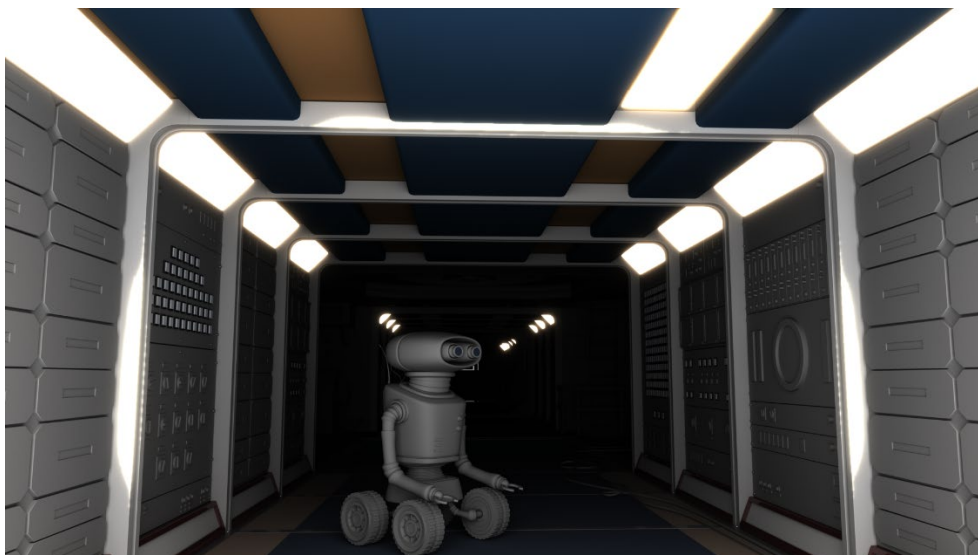


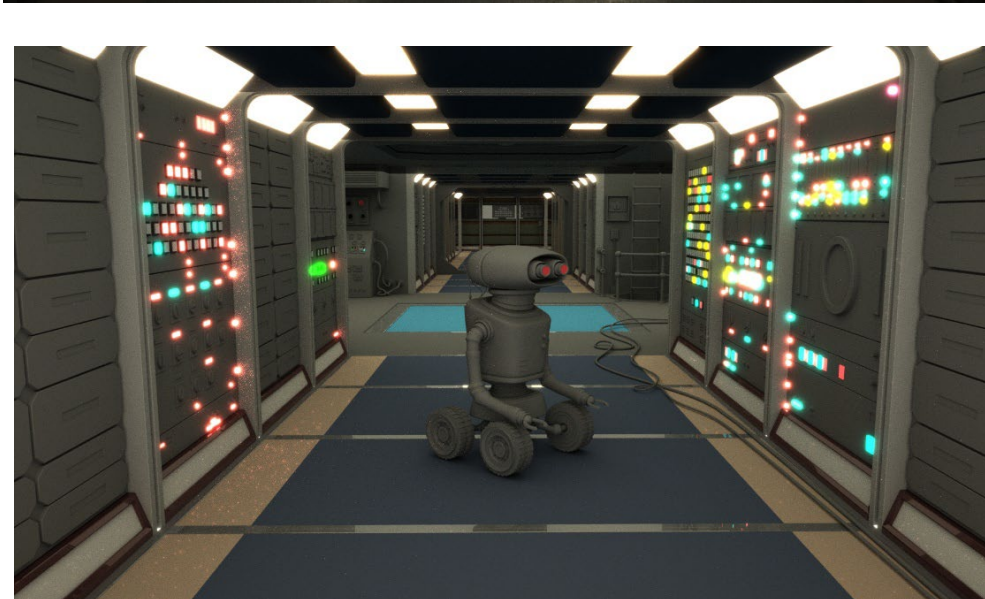
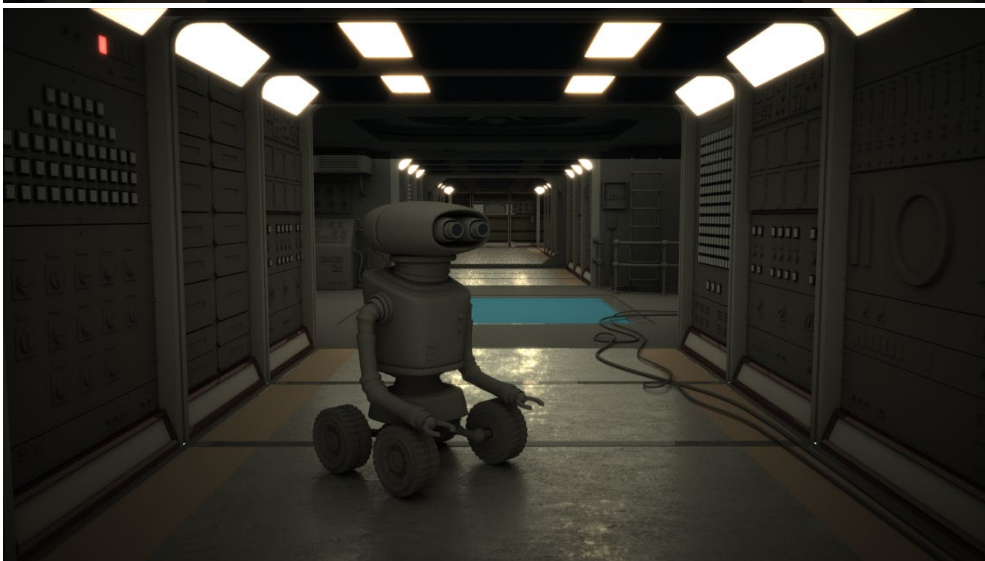
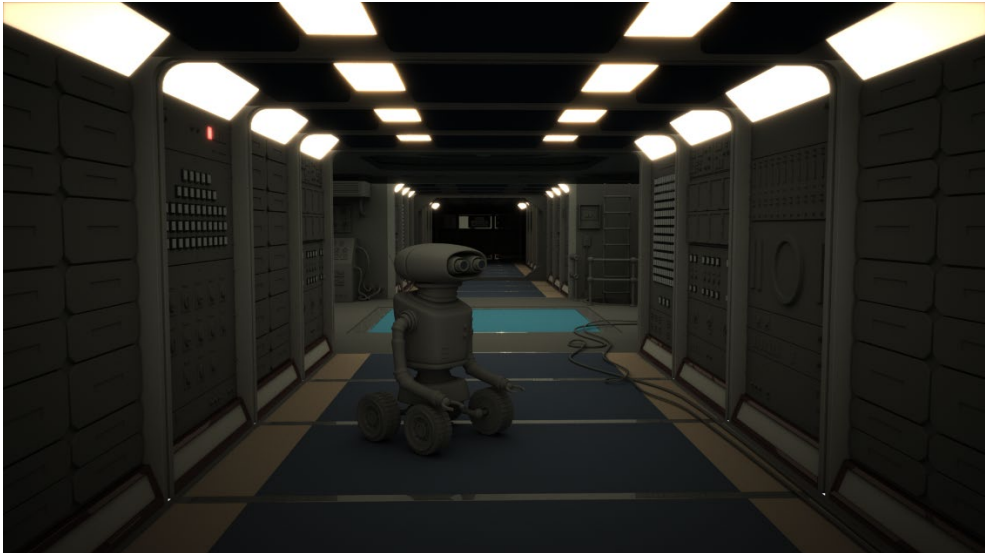
- Organising the lights in the Maya Outliner.





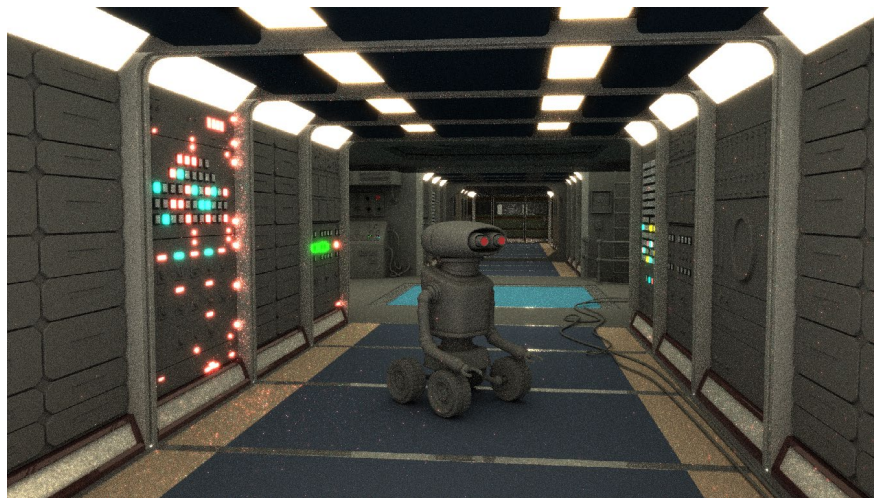
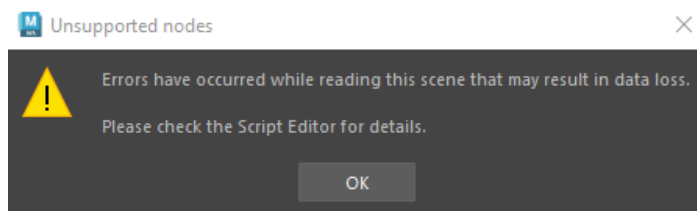
- Notes on replicating key, fill, and rim lights from the reference.
- **Render Settings Log (with screenshots):**
 - Documenting Arnold Sampling settings.
 - Documenting Ray Depth and Environment settings.
- **3.2.3 Iterations & Problem Solving:** A log of test renders, challenges faced (e.g., noise, render times), and how they were overcome.





Before Unknown Nodes Optimisation Error:

During my early work on the both the sci-fi and Museum scene, when opening the project file in either version Maya 2024 or 2025, it would appear with the below error. Though I did not immediately recognise anything wrong with the scene, this was a worrisome issue that needed to be fixed to ensure issues don't pop up down the line, especially relating to data loss.



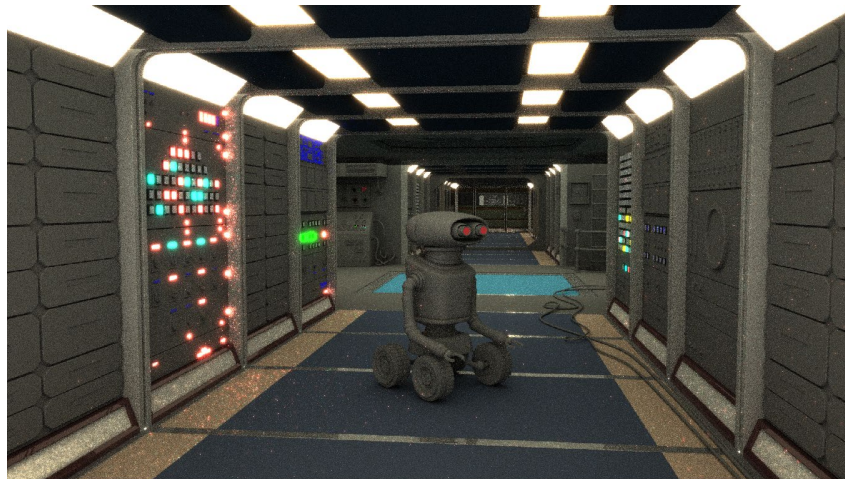
To solve this issue, we found that the scene needed to be optimised, specifically the unknown nodes box that needed to be selected and optimised to get rid of the outdated mental ray system that previously was tested for Maya 2023 with these scenes with is where is issue spans from.

I simply checked the box, optimised and applied all, then saved the scene as a new version and the error not long appeared on start-up, same for the museum seen, fixing this issue.

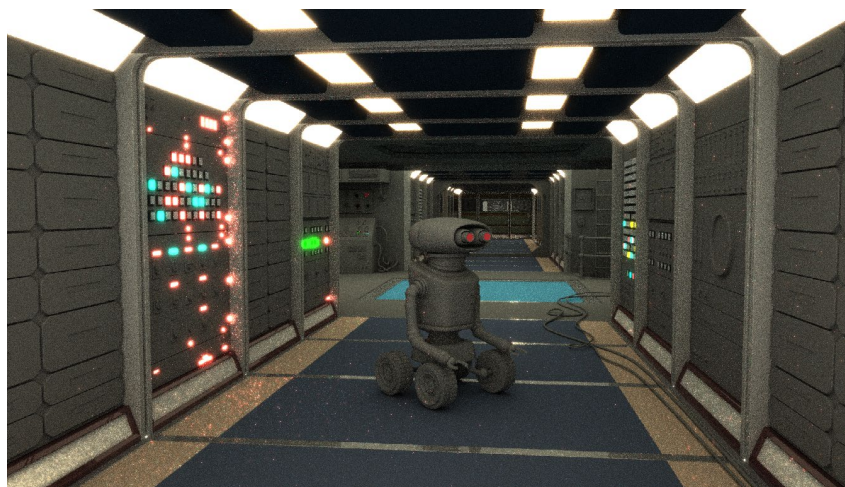
After Unknown Nodes Optimisation:

However, after testing a render immediately after this as seen with the before and after screenshots, we can see some blue artifacting, initially I thought it may be relating to materials, but after testing this by applying a standard ai surface to the affected area it still appeared in the render. It also seemed stretched over half of the asset, which actually suggests it's not relating to material and possibly lighting artifact.

To test this I tried removing the main light (ceiling and key lights) from the scene but it still appeared in the render, not changing at all. So this ruled lighting out. I began to think, that though I optimised one part (that being the unknown nodes) perhaps that broke other parts. So I optimised the entire scene instead, and saved as a new version. When testing a render in this version the issues were fixed. This shows that my process of elimination was effective and shows the thought process behind it this way of working through a problem.



Solution:

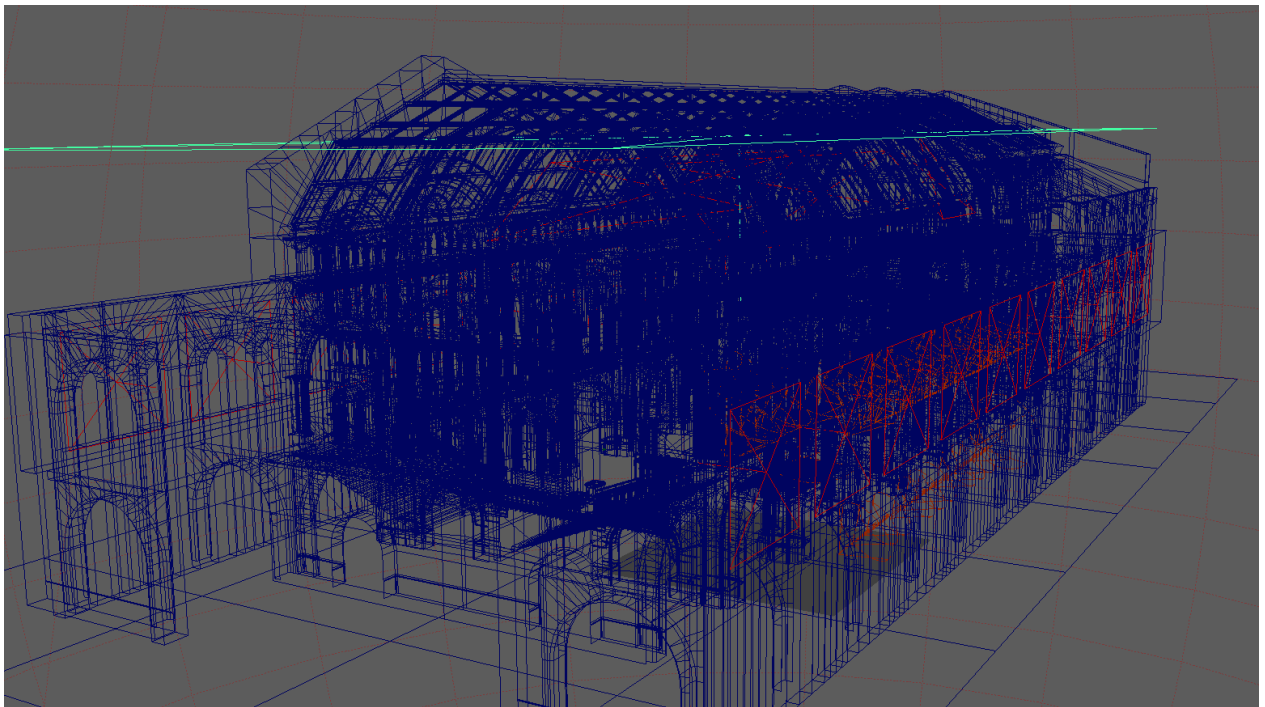
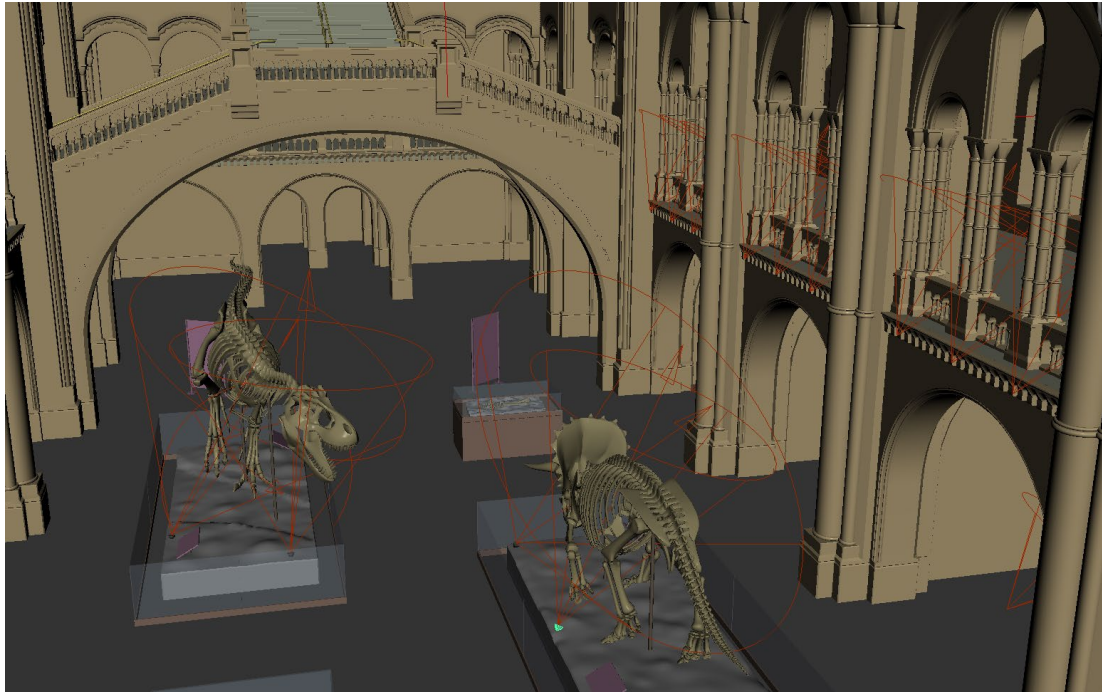


3.3 Project 2: [Natural Museum]

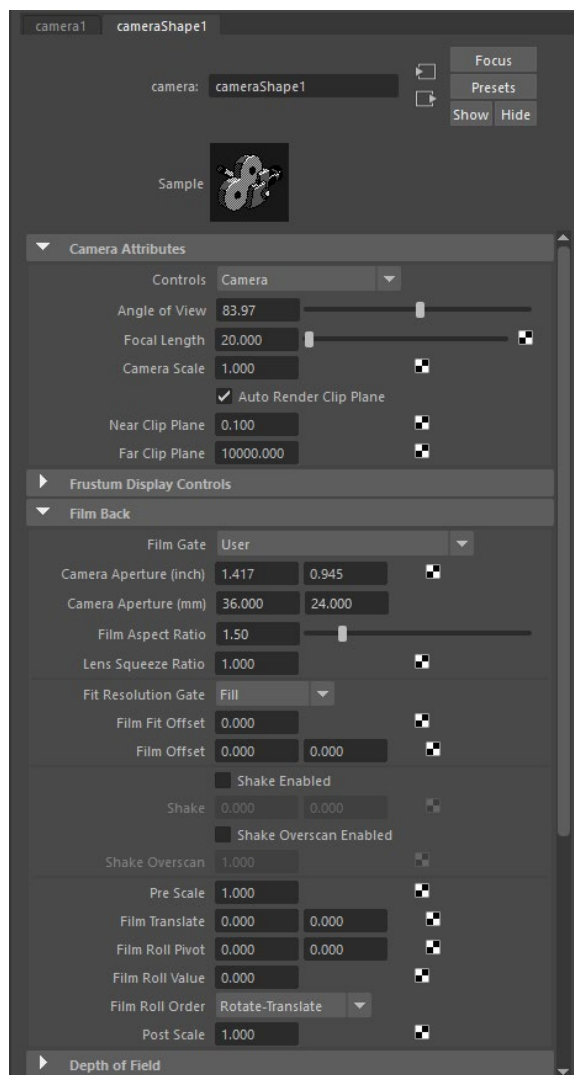
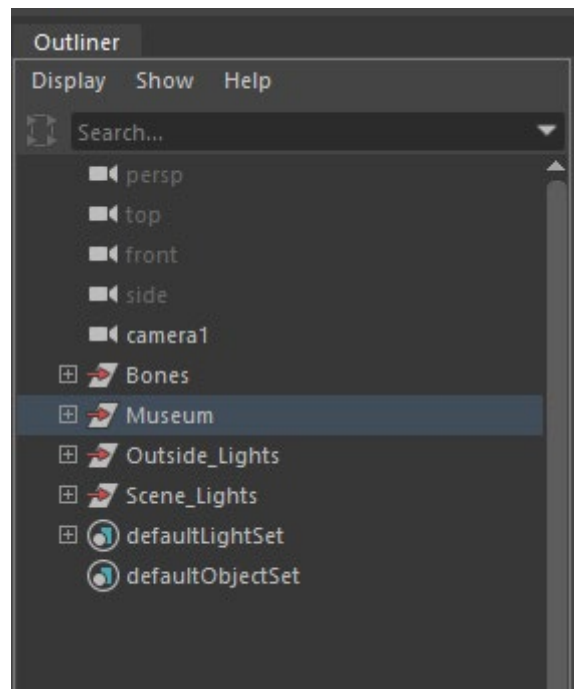
- **3.3.1 Reference Image Analysis:** Deconstruction of the provided image's lighting, shadows, and mood.



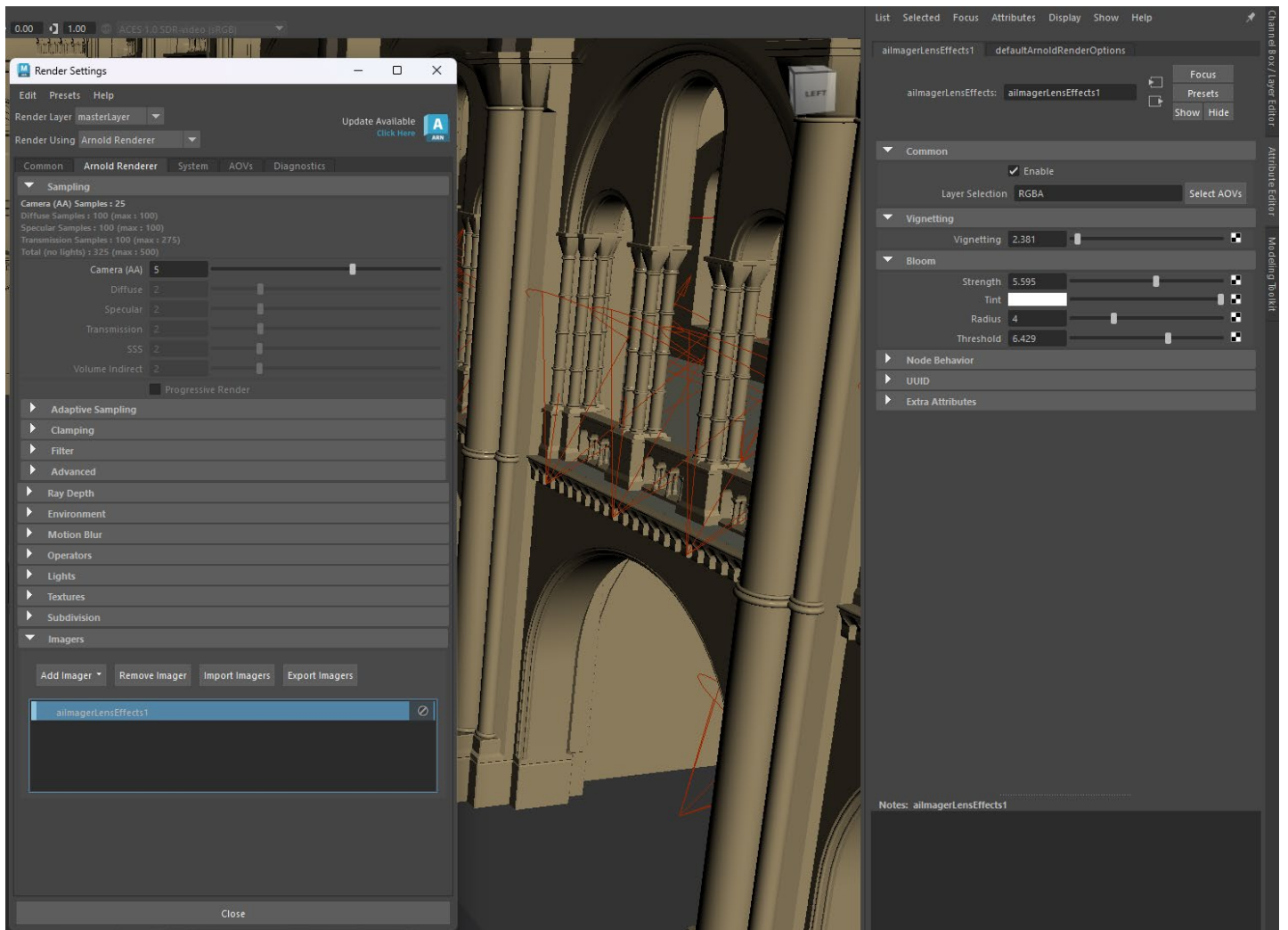
- **3.3.2 Production Log:**
 - Camera and composition setup.
 - Material and texture application.
 - **Lighting Journal (with screenshots):**
 - Documenting the placement and settings of each light.



- Organising the lights in the Maya Outliner.



- Notes on replicating key, fill, and rim lights from the reference.







- **3.3.3 Iterations & Problem Solving:** A log of test renders, challenges faced, and solutions.

The full log of test renders can be viewed in my project files. The main challenge with the museum scene was trying to have a balance between the contrasting light coming from the moonlight while effectively lighting the 2 subjects of the dinosaurs in the scene without it looking unnatural or unrealistic. I wanted to create lighting that utilised the previously talked about methods that would create the deeper black shadows and coolness of the scene while contrastingly having the warmth of the indoor spotlights. Balancing this took time and a lot of tweaking of the values such as the colour, temperature and intensity and mixing them together to create a variety of different look/moods.

Scheduled Session:

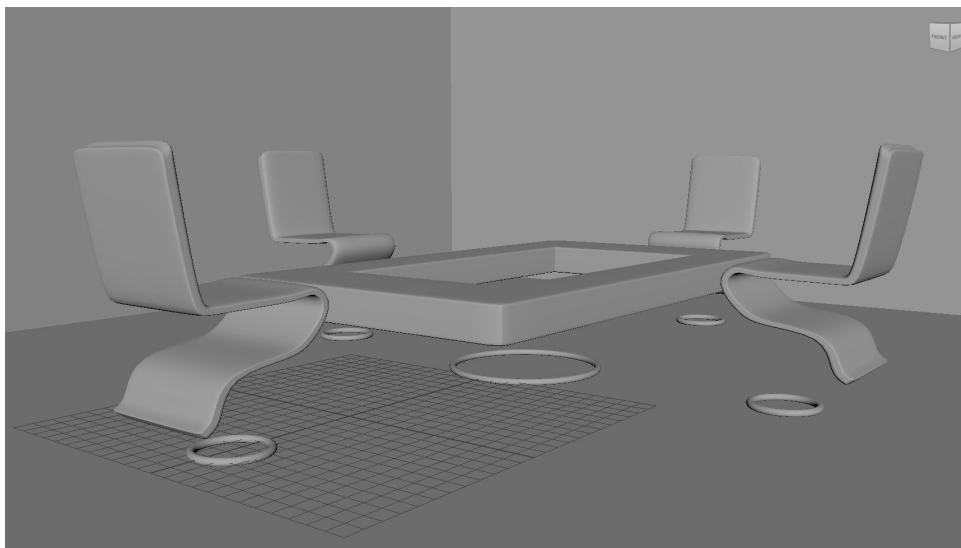
Week 1 Session 1 Summary:

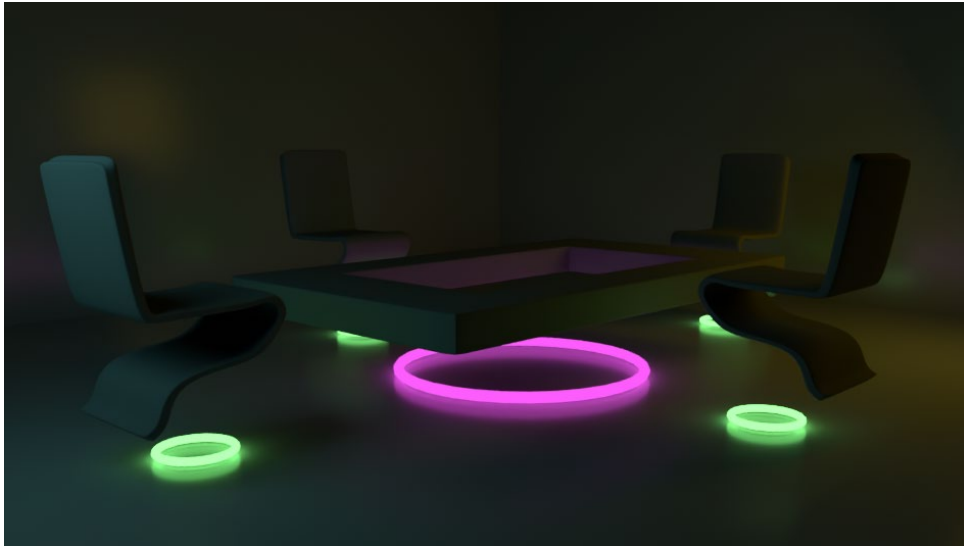
This session was an overview of the assignment specification, I learned about the module outcomes, and started to think on how specifically I want to use this module to influence and improve my independent project. This was extremely helpful to lay the foundation so could start to brainstorm new ideas and link each module with the knowledge I learn. For example, Lighting techniques I learn here will be able to improve all the work I do in my other modules as it will increase its overall impact and realism.

Week 1 Session 2 Summary:

During this session I started a lighting exercise, given a blank slate, a scene of a sc-fi living room, my task was to light it and primarily experiment with mesh lighting to do so.

As seen with the before and after below, I added 2 additional area lights to exaggerate contrast and to fill the upper areas that were very dark. Using these lights gives more detail to the scene and allows the complimenting colours to work together to give the look I wanted while testing the attributes to see how exposure and colour interact.





Week 2 Session 1:

Learning 3-point lighting and how it is utilised effectively is a foundation to learning more advance techniques. I have not only learned 3-point lighting practically via the module exercises, but I have also investigated, finding external examples in film.

I will break scenes down, creating sections where I talk about colour, depth, composition, advanced lighting, cinematic tools, camera movements and cinematic sequences, analysing these aspects, explaining why they are important, how they link to helping with my broader cinematic understanding and thus help with the modules.

Compiling here everything I learn during this time and putting it into active practice with my modules and independent project will allow me to instil these ideologies and methods in my head to use in real time projects.

Self-study:

3-Point Lighting:

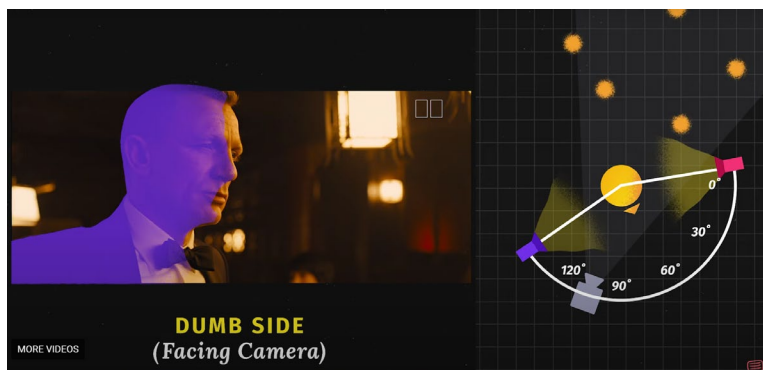
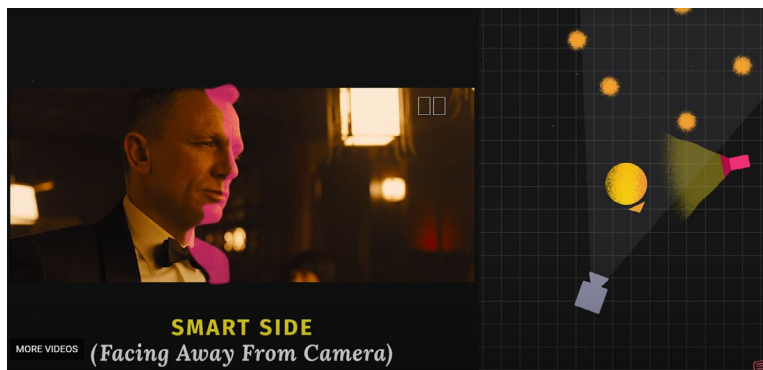
First of all, it's important to note that exposure is established with a combination of a key light and fill light. Let's break it down, the key light would be the main light in the scene, the fill light will counter the shadows cast by the key light, which literally fills exposure into the shadows.

To increase or decrease the contrast of the lighting on the subject you would move the fill light left or right, moving it closer to have less contrast, less shadows, and further away for more contrast, more shadows. Or very little to no fill light to create dramatic contrast.

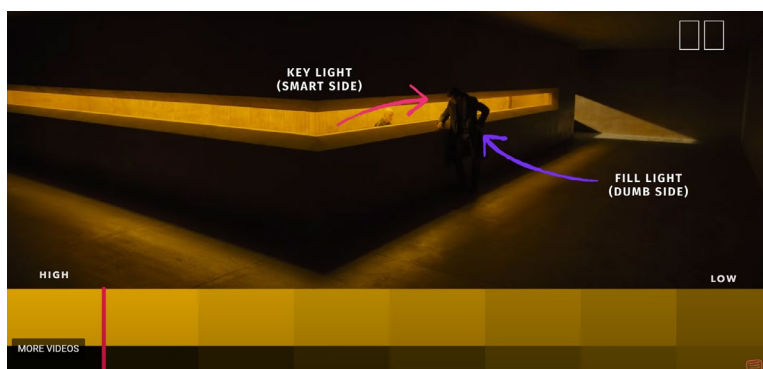
How do you decide if a fill light is best for the task at hand? There are 3 aspects to consider. These are as follows:

- **Motivation** – Where is the light coming from? Establish this first.
- **Angle** – The geometric relationship of the key to fill light. The key light being typically used on the subject's 'smart side' favoured away from the camera. As a result, fill light is introduced on the 'dumb side' facing the camera as this is where the shadow from the key will fall.
- **Ratio** – How much fill should be used? The intensity of the fill relative to the key determines the contrast ratio. This is why the fill light is so vital to the scene.

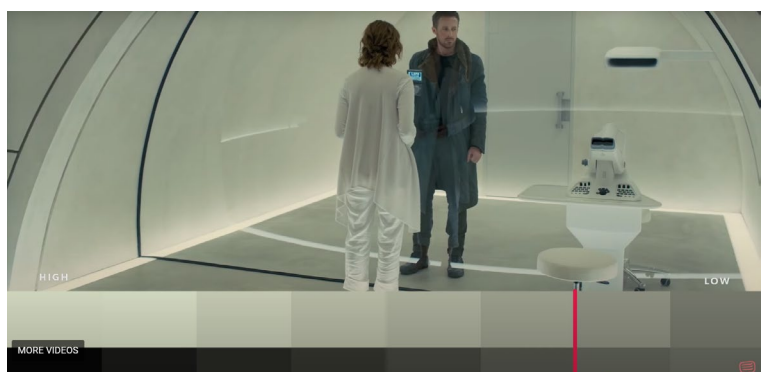
3 Point Light set up Examples:



High Contrast Example:



Low Contrast Example:



[7]

Maya Character Exercise Test Results:

Setup 1 – Neutral/Subtle



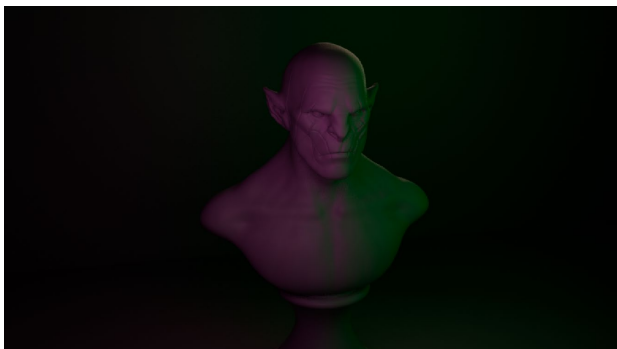
Setup 2 - Warm



Setup 3 - Cool

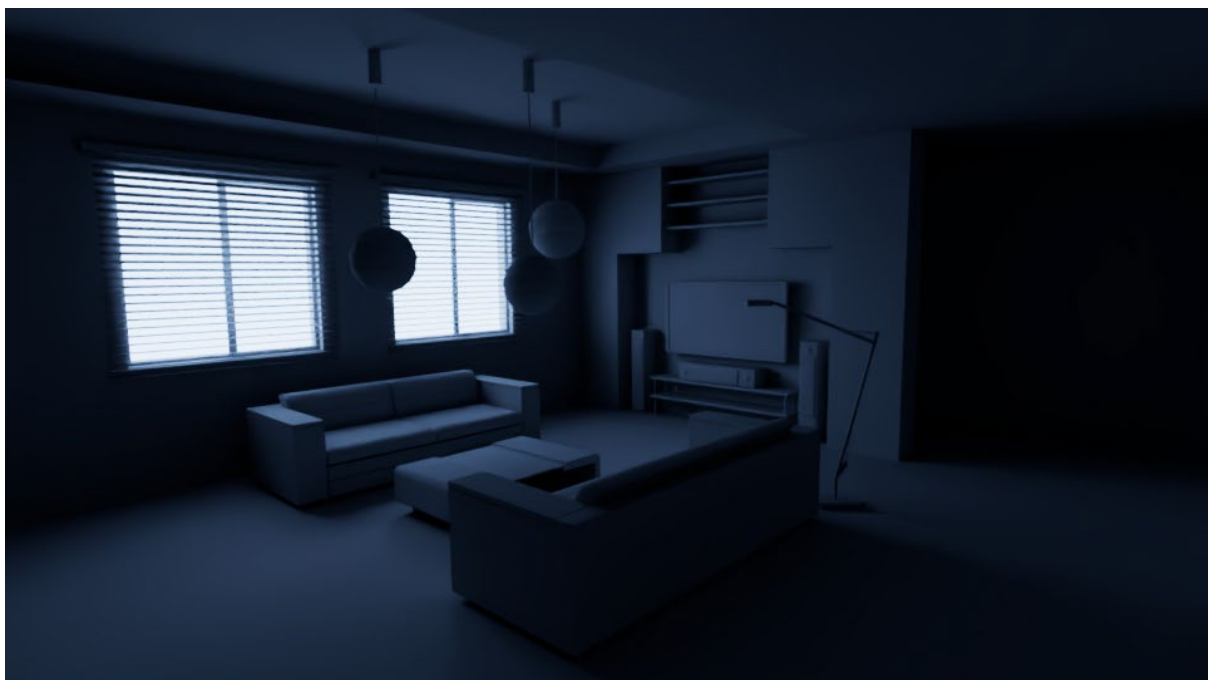
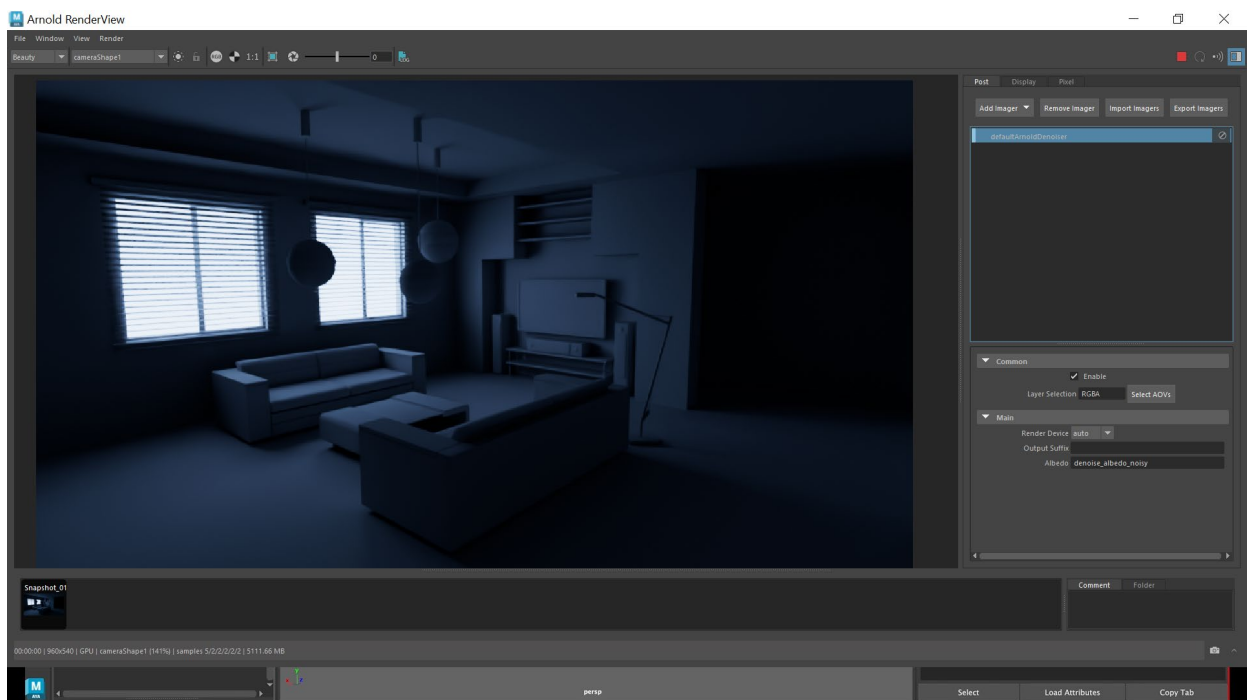


Setup 4 – Extreme/Contrast



Maya Hardware - Mental Ray – Exercise

Another exercise was to test the various hardware for rendering available in Maya. For this I use the provided test scene of a simple OBJ room. Below you can see how I used a skydome to create this simple effect of a room getting dark as day becomes night. I also tested how the denoiser works, utilising it to give the image more clarity and sharpness.

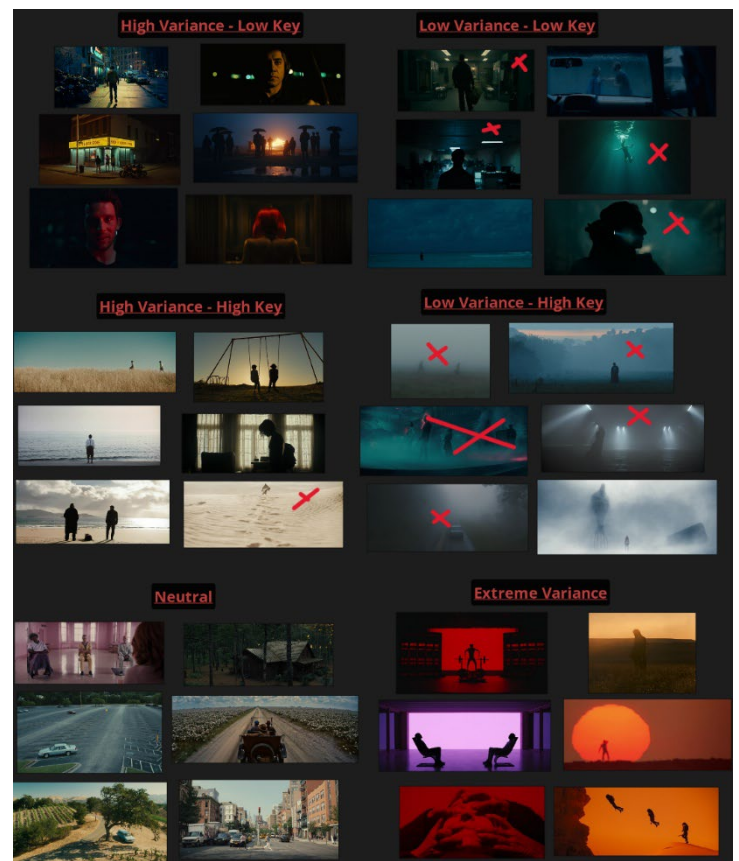
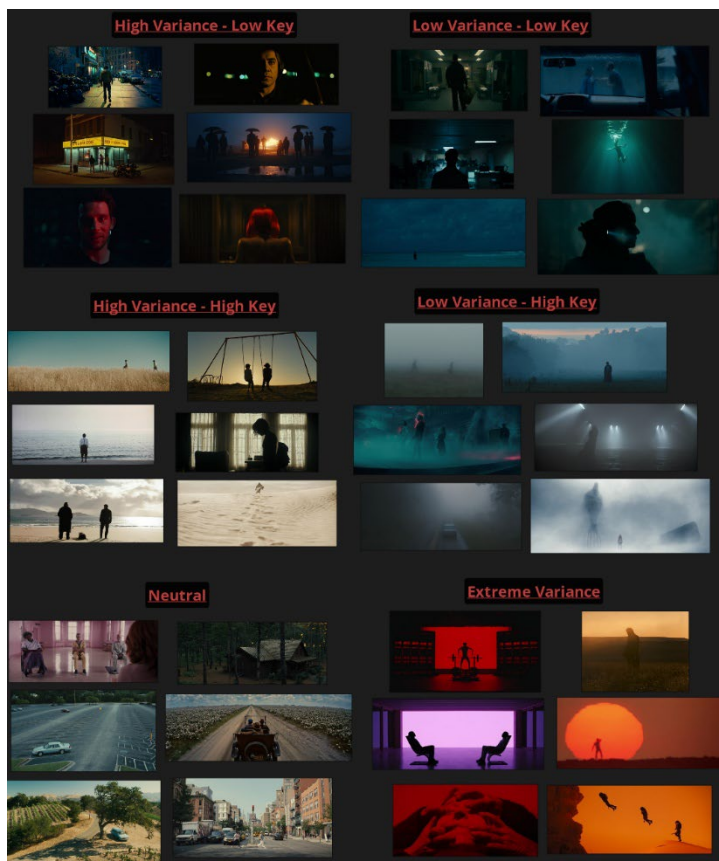


Value

To further my cinematic understanding I decided to take a closer look at value itself. How is contrast used in a scene. I started an exercise where I gathered shot references from films and TV, I then categorised these images into the following:

- Low Key – High Variance
- Low Key – Low Variance
- High Key - High Variance
- High Key - Low Variance
- Neutral
- Extreme

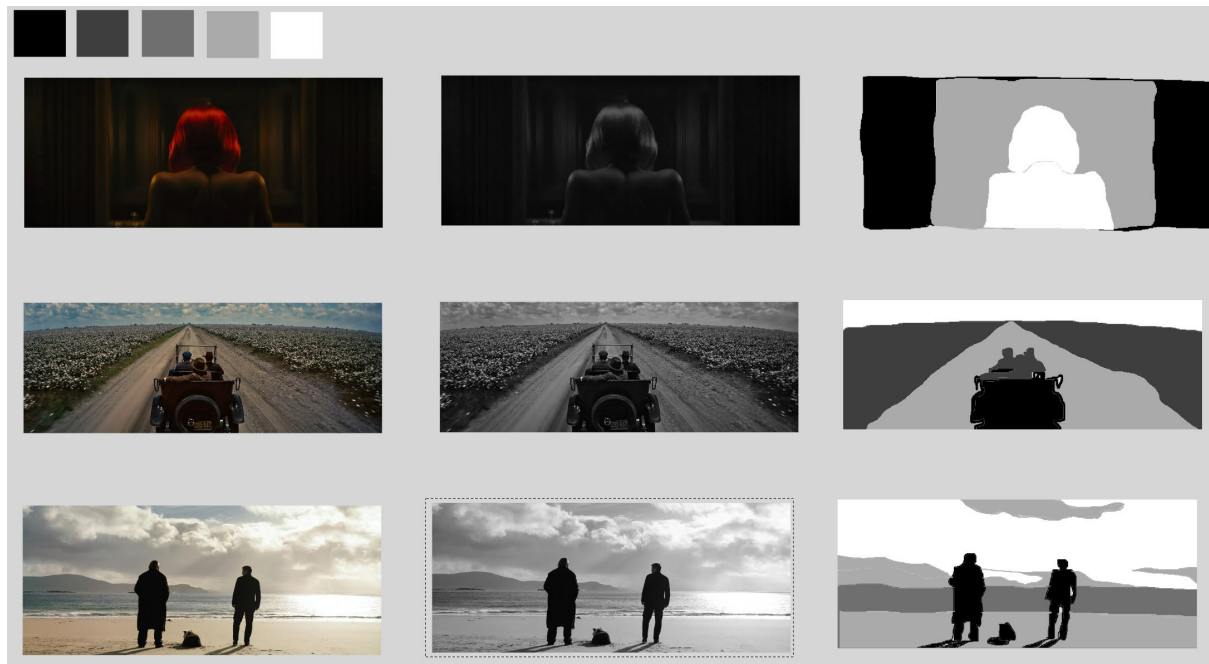
These are the typical combinations we can see in media and can analyse, not just its technical applications but its meaning and how it can impact the story within the context. Below you can see my examples, that I categorised at first glance to start to build and improve my eye on recognising value in shots.



After adding lots of references in these categories I got some feedback from Masha Bazueva, a 3D artist, and Blender Instructor via CG Boost. I learnt that a lot of the images I chose in LVLK were more suited for HVLK due to having too much contrast between the low and dark tones. I will revisit this exercise later in the year to further practice at training my eye in recognising value and contrast in a shot and know how to use it as second nature.

Value Deconstruction:

After looking at many shots from films, I started to think about the contrasts from a desaturated point of view, I want to train the eye to be able to recreate scenes by just using their grey scale values while visually being recognisable as that shot.



As you can see, the first image was a bit rough, I used only three colour values to be as simple as possible, black, grey and white, however I soon realised that the reason the outcome did not look accurate is because there are more than just 3 values that I need to use to be able to recreate the same image. For example, the fall off from the light to darker tones were far too sharp in my version and needed an extra colour or two to accurately depict this on the grey scale as seen with the middle images.

The way carried out this exercise is by just having the image of the shot on its own, then using this I would draw over using the different values and then comparing this afterwards to a copied and desaturated version to see how accurate I was. Training like this is effective because it trains your eye to deconstruct a shot in a more technical

approach, helping me to better understand to build my own shots, and ultimately bringing in, depth, lighting, and contrast that all plays a big part in how visually striking a shot will be, and being able to see this in a single still. It's easily teaching me how to build a shot to draw the eye to the subject or another way of putting it, how to use contrast and value to create a certain mood.

With the second image, showing the car driving down a dirt road, I certainly improved. This time around I decided to use 4 colours instead of 3. After comparing it I have managed to get it quite accurate especially with the darker tones, however with the sky I was working with white as one of the colour values, when in actual fact it was closer to the road value I used, so this should be a slightly lighter grey instead of white.

Moving onto the third and final image, showing 2 men and a dog looking out to sea I used 5 colours as I could already detect that this scene had more complexity in terms of depth, so I would need to expand the greyscale to accurately depict and separate aspects of the scene. Because of how light interacts with the clouds here, it was harder to recreate the sky using simplicity, so I had to break it down and simplify it the best I could.

With this in mind I think the final outcome is fairly accurate and an improvement. However, I would note, that I could use more subtle values to create a less harsh transition between aspects of the shot, perhaps even expanding the grey scale again. I also want to note the sea value could be lighter, as related to my previous observation.

Colour

In this section I will research and analyse how colour can be used in terms of creating a cinematic shot, both linked to this module and my independent project as well as being valuable to learn that can improve all my work and how I approach lighting.

More specifically I will look at:

- Colour Temperature
- Hue
- Saturation
- Tint
- Shade
- Colour Relativity
- Colour Harmony

One way to put this and what my main goal in this section is all about is that value gives my composition's meaning, while colour gives it emotion.

4.0 Part 3: Reflective Report

Outline and Key Points

In this report it not only serves as reflection but as a culmination of my work and gained knowledge over the course of this module. The below is what I plan to cover.

- Reflection on the planning vs. execution of the practical projects.
- Detailed discussion of challenges encountered and how I solved them.
- Critical analysis of how effective my chosen techniques were in achieving the desired look.
- Summary of key lessons learned and how this module has deepened my understanding of lighting and rendering.

4.1. Introduction & Project Scope

To reiterate my personal aim, was to primarily learn how techniques like Global Illumination (GI) and Ray Tracing, both areas I have researched in depth can be used to create photorealism and atmosphere in the context 3D environments in my case but to also understand it's other applications in the wider industry.

When choosing my scenes to light I avoided picking at random, instead I thoroughly thought in terms of the how I would benefit the most from which lighting scenarios would help me grow technically, artistically and creatively as well as choosing two that may use similar lighting methods but a varied range of different techniques and versatility in the approach, this not excluding post production however, including colour grading with LUT's for the final tweaks and desirable looks/vision for example.

In reflection, I chose the sc-fi scene for a small enclosed indoor environment with a focus point of the robot, creating depth within the shot and a lighting subject, its use of burnt edges and soft glow of the ceiling lights, the brightness, reflectivity and multitude of varied lights and light sources.

For example, I liked the challenge, thinking critically, how to create many panel lights (experimenting with point lights but later deciding to use mesh lights for their ability to encompass the object and more well suited for many smaller objects in the scene, that emit light and be able to their control bloom effects in the Arnold renderer). This created not just the same look as the image I was recreating but allowed me to learn the same processes throughout the production pipeline without any handholding and using my own intuition and problem solving skills as expected at this level, being on my own

career path to enhance and create more chance of varied possibilities for job types/positions down the line.

On the other hand, I chose the natural museum for its contrast, in its darker areas, its shadows and moonlight. Being able to effectively recreate a night scene, and one that looks realistic from multiple angles was the challenge here. I particularly enjoyed learning how to create volume (volumetric lighting) and have it affect lighting in its intricacies as subtly as I wanted in the scene. For example, how the light source from the area lights and spotlights, differently scattered through a volume and onto the surrounding surfaces below, creating a denser atmosphere and depth within the shot.

In effect it did not matter that there were no materials used as the principle was the same, learning how lighting and rendering can be used most effectively to create my chosen style of realism that I was going for opposed to the more stylistic image options that had largely different techniques involved which would deviate from my long term goals.

However, I did in fact learn and was open to these ideas of more stylistic images in how they may influence a certain look for a more realistic image as seen in my extracurricular studies posted in this document that was extremely relevant to the module at hand, as unlikely as it may be found in other people's work I found it interesting seeing and learning about these differences and how to incorporate these different styles potentially into one and into my work.

In summary to texture every asset from scratch would have inflated the production pipeline significantly, distracting from the module's primary focus: Advanced Lighting and negatively affecting my other module schedules.

The solution, I chose to adopt a slight stylistic approach "Clay/White Box" or simplified PBR workflow that did not divulge from the core principles for certain areas to demonstrate the pure lighting competence instead, ensuring the light itself was the hero of the scene per say.

Ultimately, I chose these two images as I believe I would get the most out of them and utilising the knowledge I learn to advance my other skills, like scene composition and framing as well as 3D modelling in other software like Blender and being able to create realistic renders for my portfolio was the ideal takeaway from this module.

4.2. Theoretical Application: From Research to Render

Another way to explain how not using textures has actually positively impacted my progress on this module is the following. That without heavy textures to hide behind, the GI had to be perfect. In other words, I had to rely on **Indirect Lighting** and **Colour Bleeding** to define the space rather than PBR having a major factor in how the light interacts around the scene as a whole ultimately taking away from the core lighting principles and techniques I am using.

But as a result, it also makes apparent any discrepancies or visual artifacts in the lights be more apparent because of the use of one shader. This was a motivator and why I strived to perfect the lighting to the best of my abilities.

Referencing my research on the "Law of Energy Conservation" I had to implement realistic lighting that adheres to the laws of physics, and though many of these process are automated these days by the renderer, having a understanding of how light works indiscriminately helped in the creative thought process behind placing each light as I knew what I wanted to achieve and to a lot of extent how that works in relation to energy conversion despite not needing memorise the equations myself.

I also ensured my basic materials had correct specular/diffuse ratios comparing them in the same scene with my previously mentioned diagram of comparing light (ray tracing) with 2 spheres, cross checking values and making sure it looked accurate and realistic in the final output allowing me to move forward with the pipeline. This was the first thing I did to ensure success and maximum effect. so, the render engine (Arnold/Lumen) calculated light bounces accurately.

In summary my research in Global illumination and Ray tracing technologies including the various techniques used to implement them effectively were controlled and maintained throughout the pipeline were invaluable to the core of this module.

4.3. The "Materiality vs. Lighting" Strategy

I have already talked a bit about how the lack of preexisting texture (use of grey scale) that came into play but there is another aspect that helped significantly in this regard that came from my value deconstruction exercises. These being some very important tutorials/lessons I have been following from CG Boost, further developing my understanding in, shape, colour theory, composition, value, depth and most importantly, lighting being the overarching topic and focus in the context of creating photo real 3D environments.

By stripping away the "noise" of textures, I were essentially forced to use light intensity and shadow placement to separate the foreground from the background more closer or

at least with less room for error, similar to how I analysed the "Low Variance vs. High Variance" shots.

In that personal exercise, I search Shot Deck, and a software called PureRef to compile and categorise images from various films where I had multiple attempts at training my eye to see the difference of low – high variance and low – high contrast in different combinations and use cases. As well as recreating a few of those images in Krita with a chosen 3-5 shade grey scale to recreate the lighting composition and contrast within the shots, then using another clean plate of the shot I would saturate converting to greyscale and compare how close I indeed was.

From this exercise I was able to train my eye to notice even which techniques or lighting methods would or could be used to recreate said images in a 3D software with the same composition in mind. This made me critically analyse all of my work going forward with this same mindset and new knowledge and intention of improving this skill in the future and one that I certainly implemented and improved on this module.

The above idea is a methodology heavily related to scope management and how I in turn reflect on the decision to prioritize the *lighting pipeline* over the *asset pipeline* and the ability to adapt over time. In a real-world studio, lighting artists often work on grey-shaded models to perfect the mood before textures are final. Likewise, this mirrors industry workflows and is why I chosen this focus, not just to save time but for effectiveness.

4.4. Technical Problem Solving & Troubleshooting

This is my strongest evidence of technical learning overall. **The "Unknown Nodes" Error**, detail the panic and resolution regarding the "Unknown nodes" error that threatened data loss and was an urgent problem to resolve. Which with some external help was resolved swiftly and I then by watching and analysing, understood why it happened and how not to come across the same error in the future.

It is also because of this I must reiterate and was reminded of the importance of scene optimization and cleaning "legacy" data (Mental Ray nodes) from older files before starting work in the early production stages (scene setup within Maya, as well as folder and file optimisation, to regularly create backups and contingency plans).

The key to this error was essentially a software issue and not something I was doing 'wrong'. What we discovered was that the scene which was previously built using an older version of Maya was no longer fully compatible with the latest version of Maya.

To counteract this and for more stability I reverted to Maya 2024 which solved stability issues that I was getting from outdated versions etc that occasionally caused crashes

which were obviously less than ideal which is why I was so happy it was solved quickly using the processes mentioned and was down to the ability to use quick problem solving skills in time sensitive projects that have deadlines as found in most areas of the industry likewise.

Another problem I encountered when working with mesh lights were The Blue Artifacts seen in some of my screenshots that I took through the project.

First, I isolated each area and set of lights including each type, for example, the spotlights, area lights and mesh lights predominantly used to make sure no other assets with interfering with the mesh lights causing any unwanted artifacts.

After this I continued the debugging process: testing materials first making sure there were no conflicts in the basic shaders or experiments with materials I previously used in the scene. Then lights themselves using Arnold's utility light editor to easily control individual lights and sets. Then finally and logically scene optimization which is what it actually came down to.

I clicked on optimize entire scene (not just selected nodes) which resolved the render artefacts, proving that "lighting" is also about "data management" and is always important to prioritise in any project no matter it's scope to ensure its success which was certainly the case here and is a value takeaway.

4.5. Cinematic Analysis & Artistic Growth

One of the major lighting systems I research about was 3-Point Lighting: however, I also learned how this can be limited especially in open larger scale 3D environments and was more suited for when a subject was a focus point, such as the robot from the sci-fi image and as seen in many cinematic shots where a character or subject is to be lit, commonly but not limited to moody or in other words atmospheric shots and images.

Therefore, and mainly for the advancement of the museum scene I moved beyond basic 3-point lighting to more complex environmental setups (e.g., Skydomes and Area lights) that I controlled systemically in the light editor, making small tweaks to get the desired look created different version along the way, an important step in my creative cycle, to iterate.

It is also important to note, how I have expanded on my colour theory: as seen in my other extracurricular activities. I used colour temperature (Warm vs. Cool tests) to create mood in the absence of texture colour which really enhanced the overall image rather than appearing flat or void of colour. So, there was still a lot that could be done in this regard.

In relation to cinematic analysis, spending most probably hours upon hours, watching and analysing footage and images from different genres of movies as well as games and animation learning that the key takeaway in this topic is that **value gives meaning, colour gives emotion**. And that reins true for my other modules, that I have in mind not just in pre-production but in every phase as I strive to refine and iterate each image or shot to be better than the last to have a portfolio, I am proud of and can explain the thought process behind.

4.6. Conclusion

In conclusion I successfully delivered photorealistic lighting solutions despite any asset limitations and learned to adapt this into a positive, driving forward with maximum effort and effectiveness the technical and creative know how, in this case recreating an image to understand light and rendering at an advanced level which I can now say with confidence I have accomplished. That is not to say that this is where it ends however, I will always strive to maintain and improve this understanding as well as with the evolution and unstoppable growth of technology in the future.

In terms of future application, explicitly linking the knowledge and skillsets here to my Independent Project. The ability to also control "Atmosphere" and "Indirect Shadows" is now being directly applied to the "Bunker" project to create narrative presence that I can iterate and gain influence from the basis of this module.

Linking modules in this manner is much more effective than compartmentalising each and not utilising the full effect of the knowledge base and being able to seamlessly integrate that knowledge into other modules as much as it should be required but as a skill to be learned in conjunction with the course.

For example, working at any position in the industry it is extremely likely that I would need to be able to communicate separate or joined ideas to my peer's whiles working on various projects and timelines. So, the previously mentioned skills of data management, time management and other soft skills relating to organisation and communication are vital for me to increase my employability within the very competitive creative industries.

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