

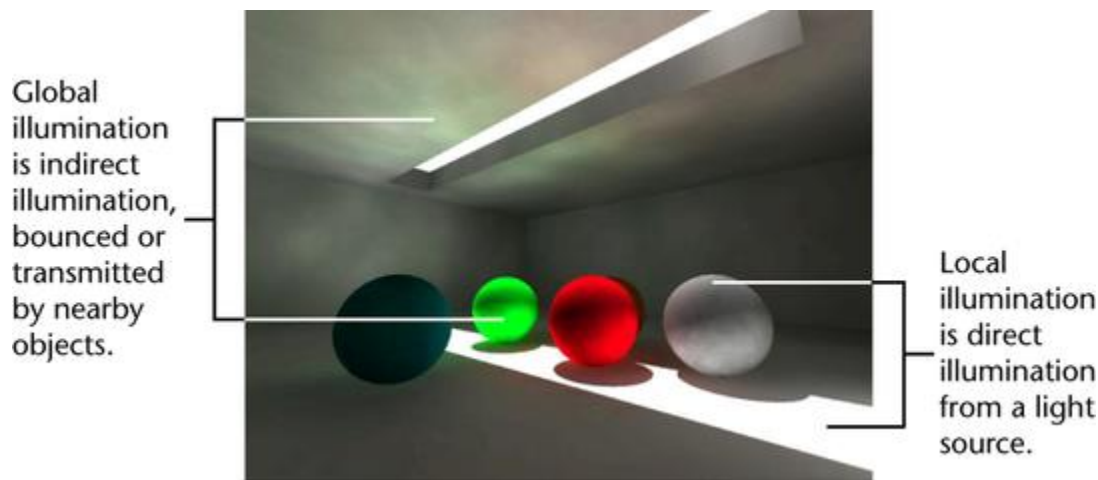
Advanced Lighting and Rendering

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Global illumination:

Global illumination imitates the real world lighting using algorithms to “take into account not only the light that comes directly from a light source (*direct illumination*), but also subsequent cases in which light rays from the same source are reflected by other surfaces in the scene, whether reflective or not (*indirect illumination*).” [2]



Bouncing a certain amount of light rays off different surfaces is the key to global lighting that allows it to recreate how real world lighting is done since in real life light bounces off and has different fall off rates depending on the surface it's bouncing off since darker colours absorb more light along with different textures making the light reflect less or not at all depending on the surface.

Recreating these in 3D is computationally intensive which is why it takes longer to render these scenes but also result in a hyper realistic result in the final product.

Ambient Occlusion:

Ambient Occlusion is more so about the shadows created by a model itself such as folds in the skin or areas where the light isn't strongest where it is occluded from the light source. It is done by casting rays to geometry and ignoring objects with transparency since there won't be any ambient occlusion to add, the shadows created by ambient occlusion

also use the distance of objects to depth to calculate how dark they may be such as in crevasses.



Ray Tracing vs Rasterization:

“Rasterization works by drawing the objects in a scene from back to front, mapping 3D objects to the 2D plane via transformation matrices. It determines the color of each pixel based on information (color, texture, normal) stored on the mesh (model), combined with the lighting in the scene. It is generally much faster than ray tracing, but cannot simulate effects that rely on bounced light, like true reflections, translucency, and ambient occlusion.” [8]

“Ray tracing, on the other hand, works by casting a ray out from the point of view of the camera and tracing its path as it bounces around objects in the scene until it reaches a light source, collecting and depositing colour as it goes. Because it mimics the physical behaviour of light rays, it delivers much higher-quality, more photorealistic results than rasterization, like soft, detailed shadows, ambient occlusion, and accurate refractions and reflections. All these benefits conventionally come at a cost, however: speed.” [8]

Conclusion:

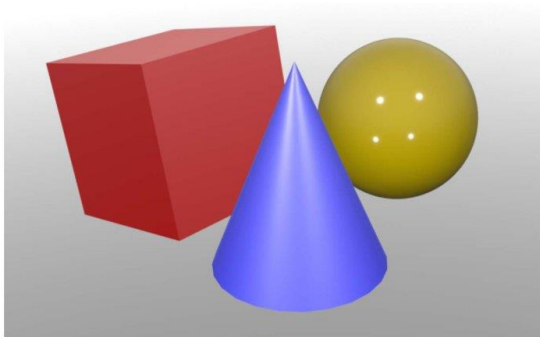
For more realistic scenes & renders that put a heavy focus on lighting would be better suited to ray tracing due to reflection which would play better into metal, water, glass/screens, and other materials that would normally reflect. It brings in better shadows as well ambient occlusion meaning that wrinkles, unlit corners, with small nooks and crannies being better shaded with ray tracing.

The use of rasterization is better put into what it is best used in and what restrictions it has, that being the lower stress and power it takes meaning it is better for a large majority of machines since unlike ray tracing which takes a large amount of computing power rasterization takes a lot less since it doesn't need to calculate all the rays of light paths which require high end hardware & in games requires an RTX card in most cases which runs slow on the lower end RTX cards due to the high processing needed and the high end RTX cards required for smooth use in games are out of reach for a majority of people. The best use for rasterization is in games and in non-realistic animations/scenes due to the low computing power needed.

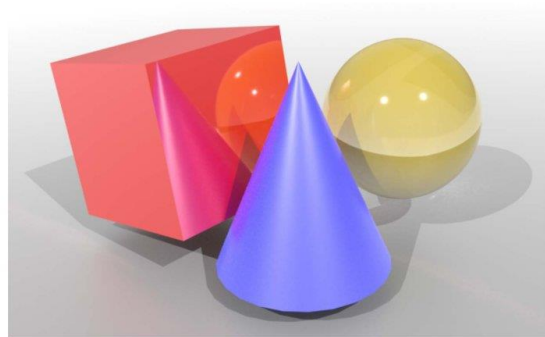
Ray Tracing vs. Rasterization—Illumination

- **More major difference: sophistication of illumination model**
 - **[LOCAL]** rasterizer processes one *primitive* at a time; hard* to determine things like “A is in the shadow of B”
 - **[GLOBAL]** ray tracer processes on *ray* at a time; ray knows about everything it intersects, easy to talk about shadows & other “global” illumination effects

RASTERIZATION



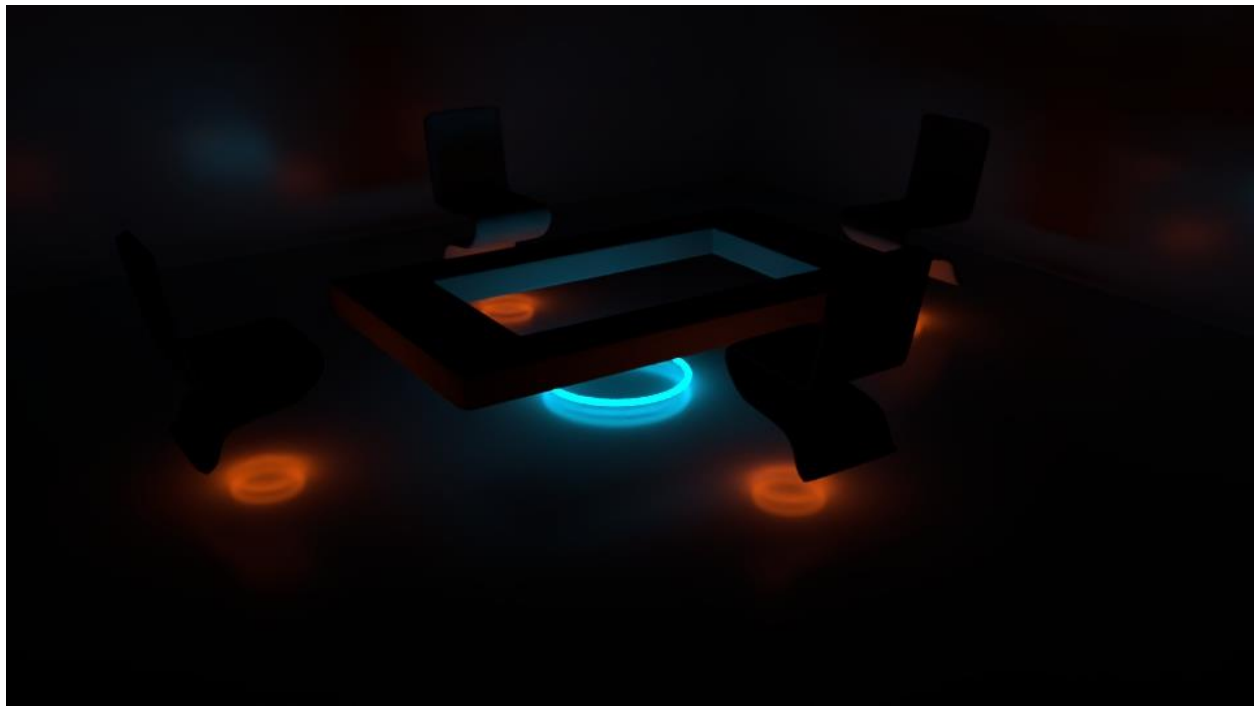
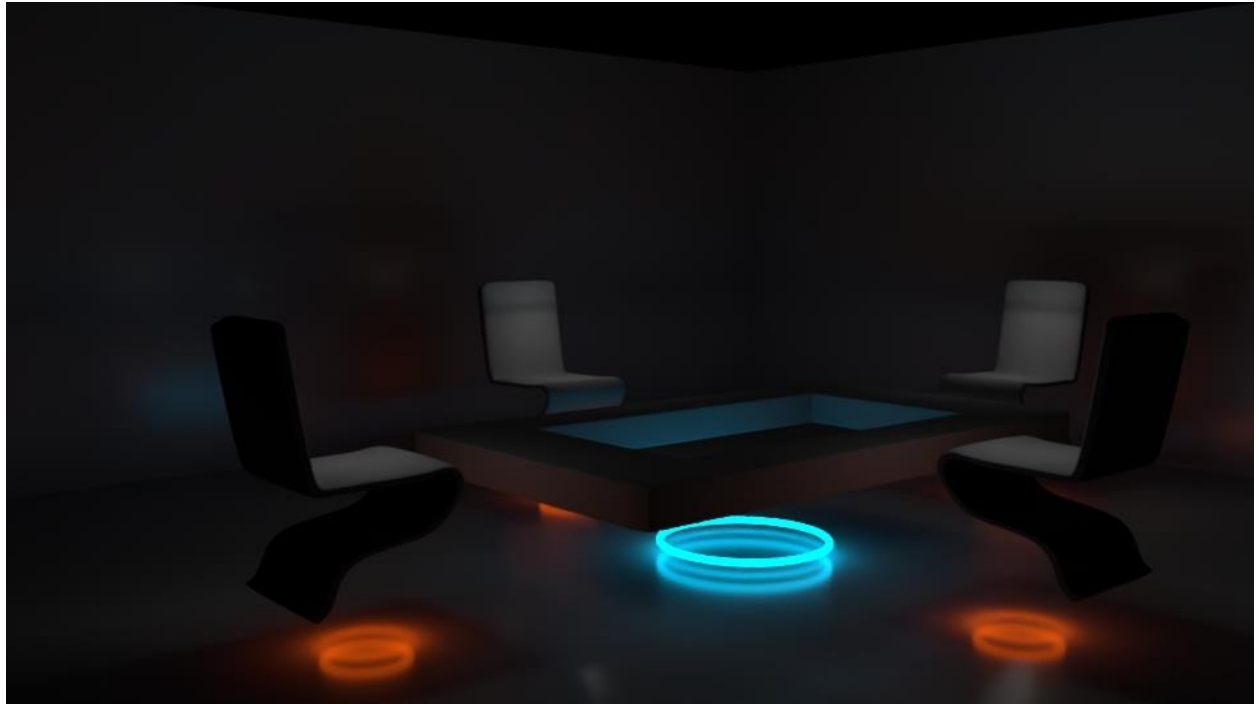
RAY TRACING



Q: What illumination effects are missing from the image on the left?

*But not *impossible* to do some things with rasterization (e.g., shadow maps)... just results in more complexity

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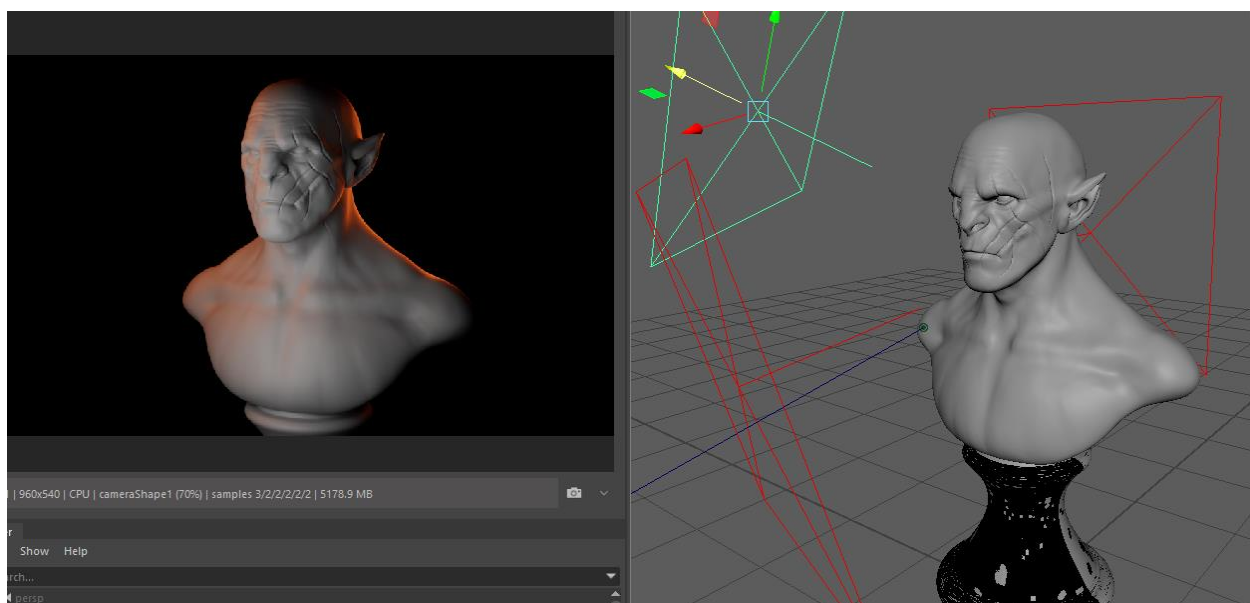
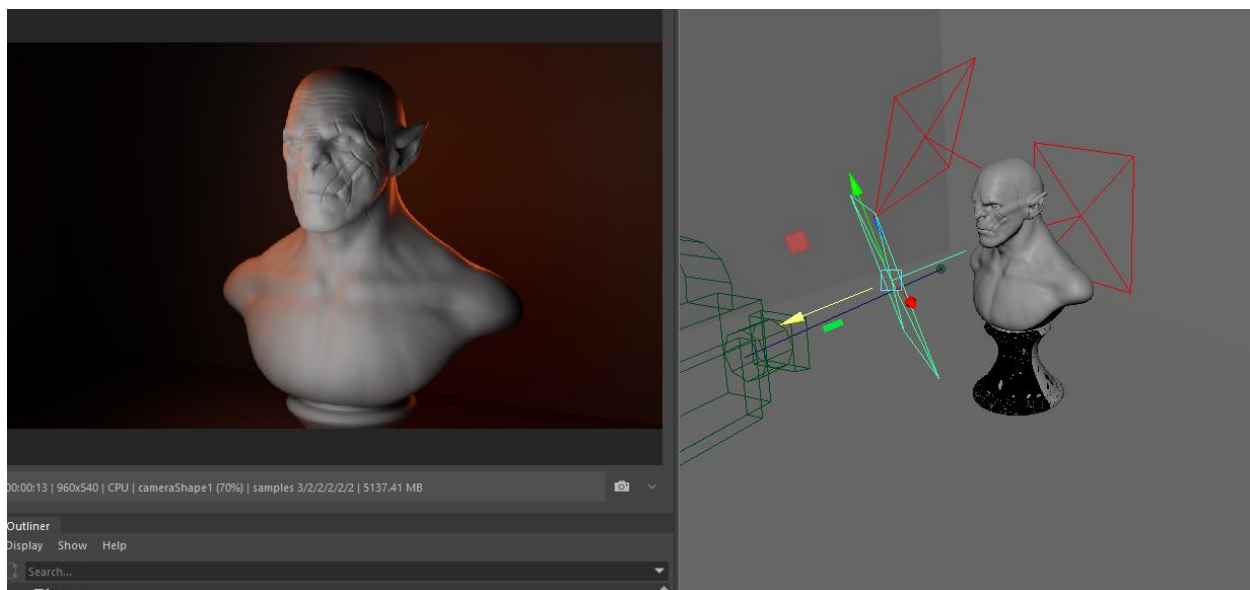


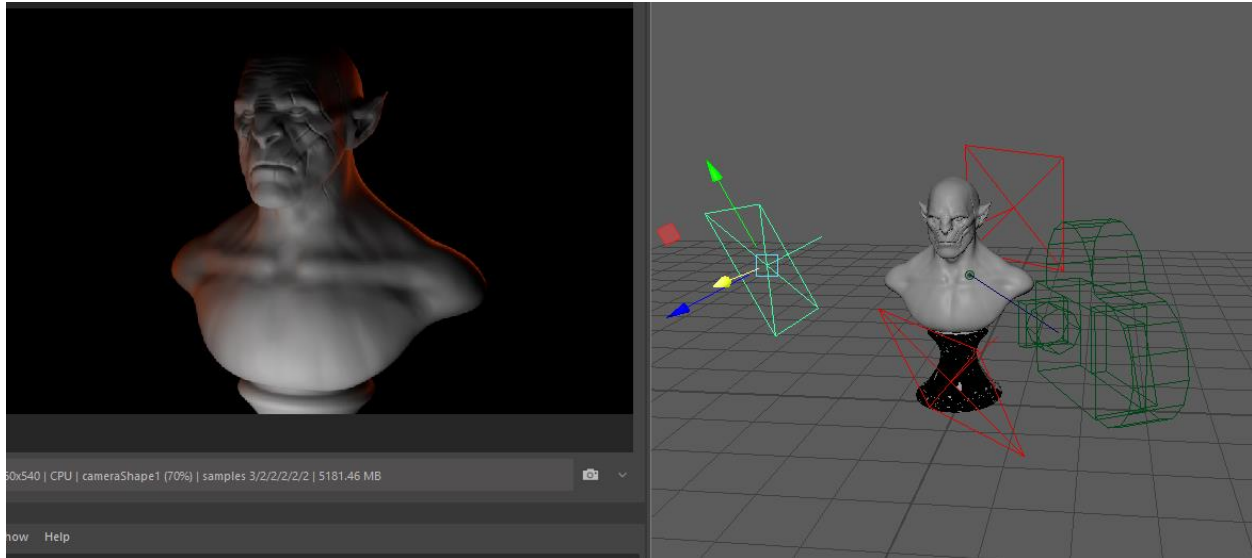
Room lighting

Adding area and mesh lights to the scene and removing normalize from all lights to get a better light as well as changing its size and shape worked well for creating a nice bright scene.

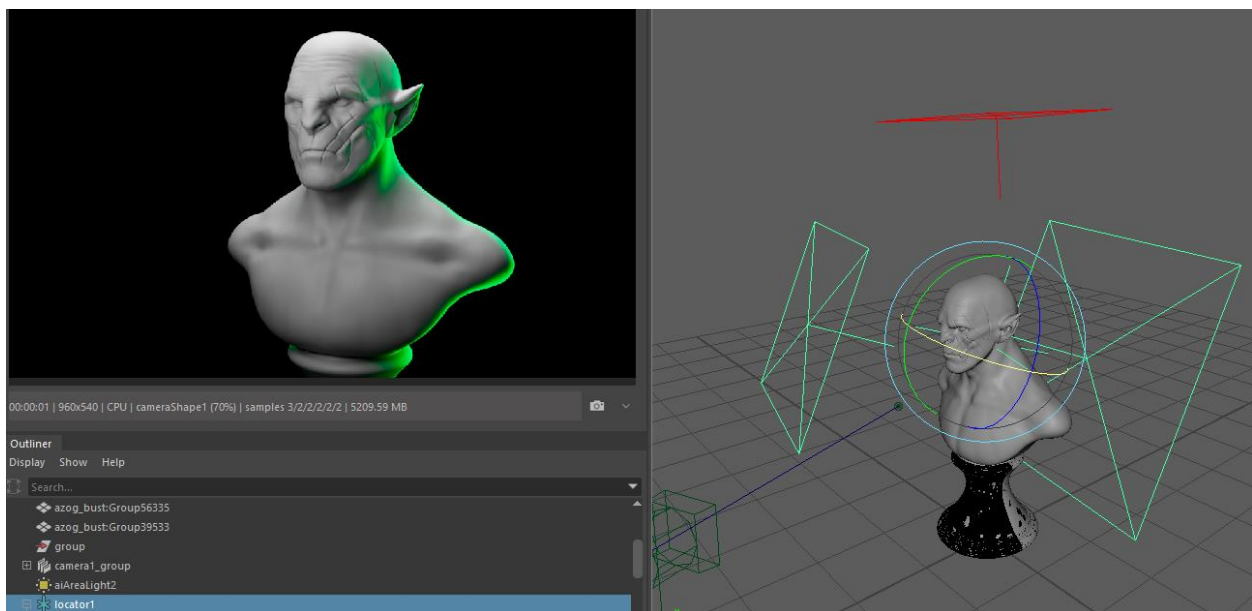
3 point lighting

Using 3 points of lighting via the area lighting to better light up the scene I was able to give the room some depth with the shadows cast and better view of all the models.

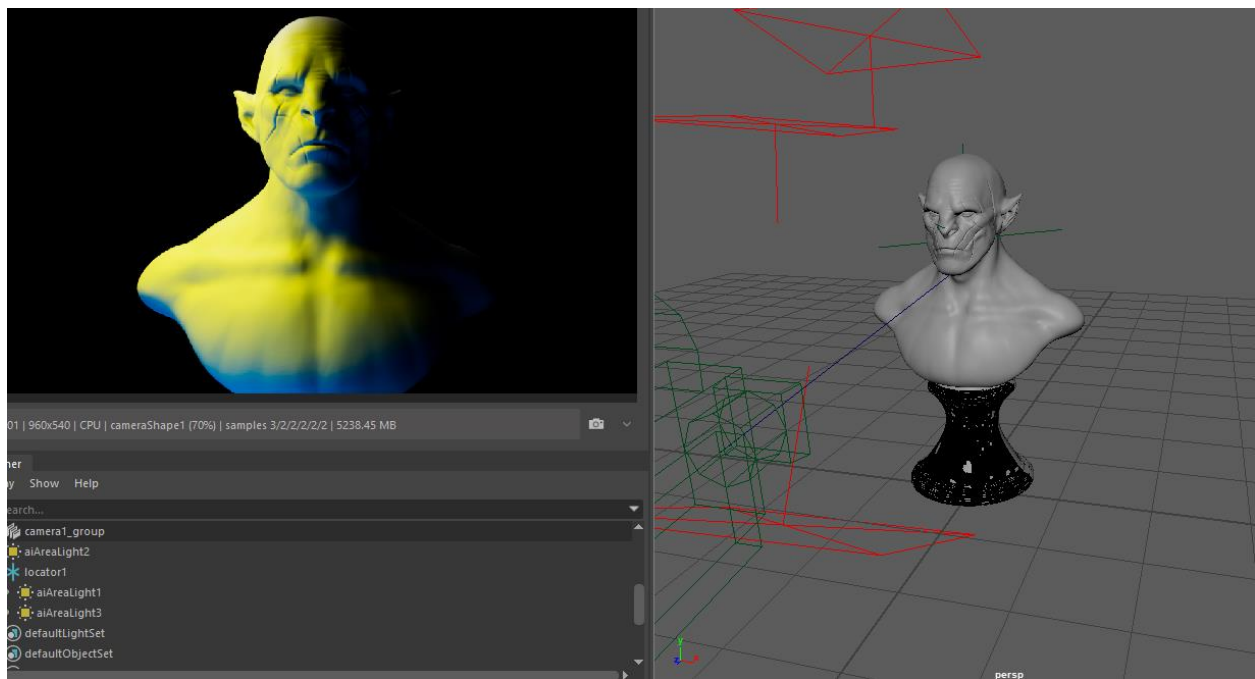
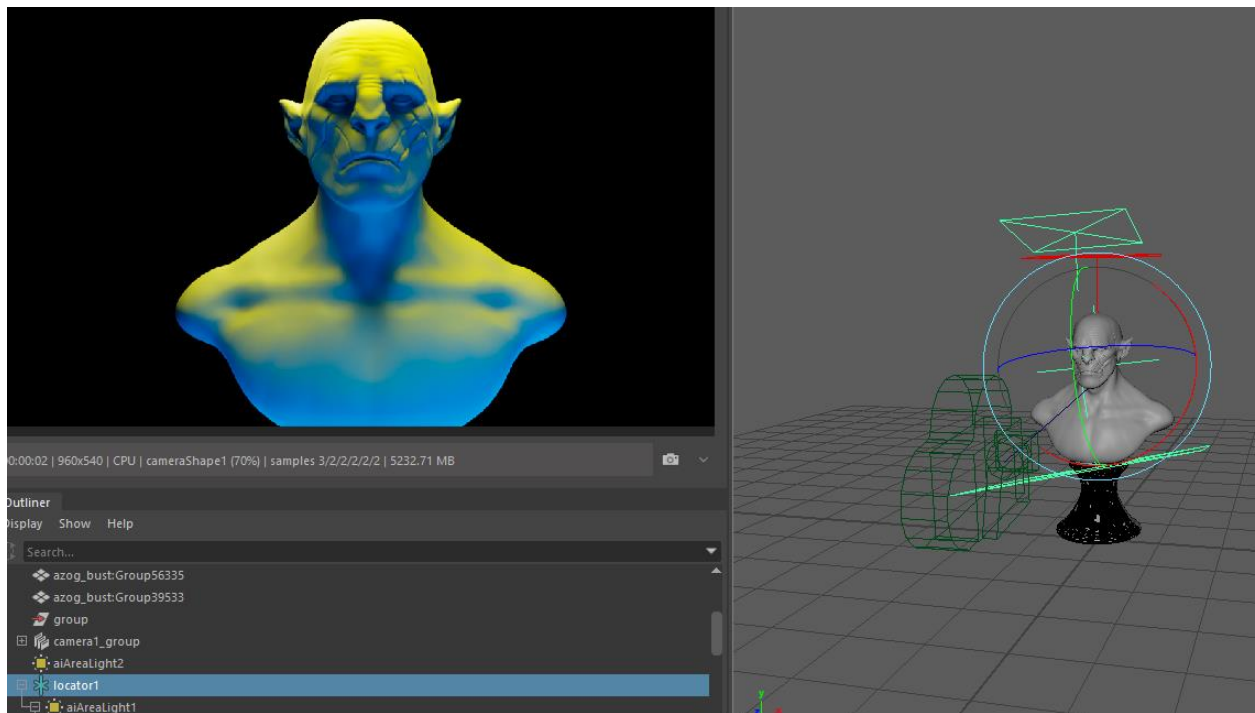


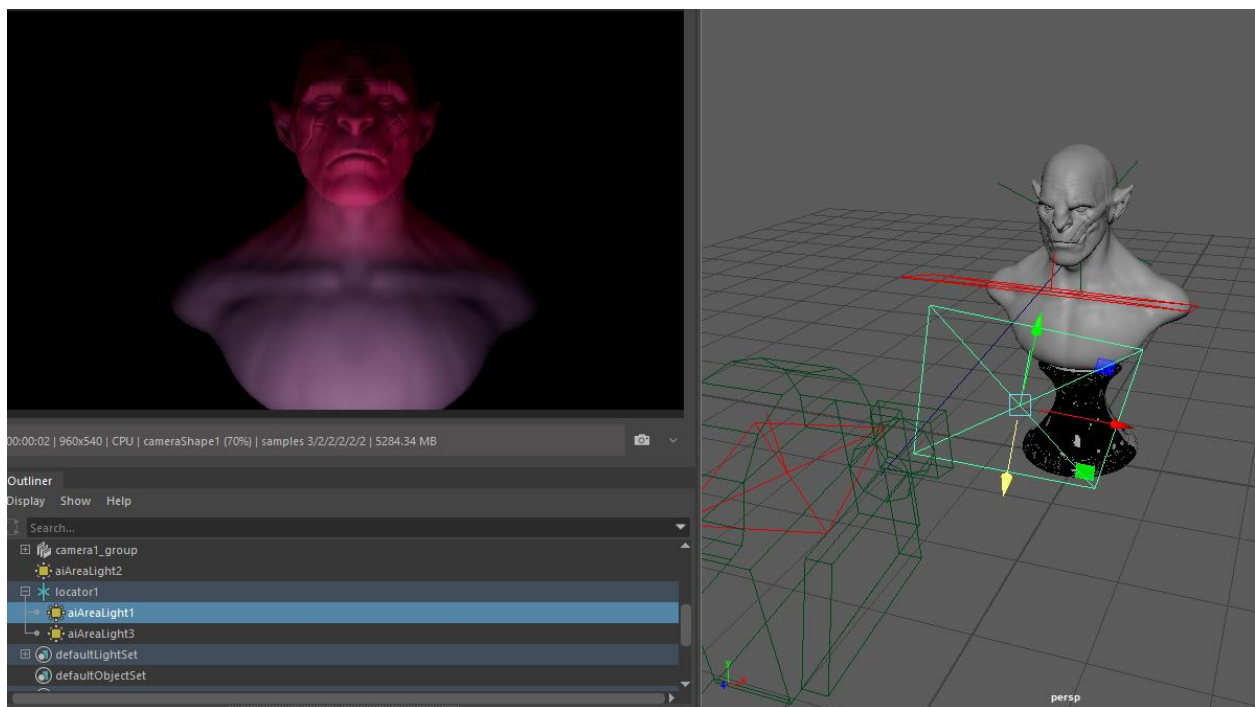
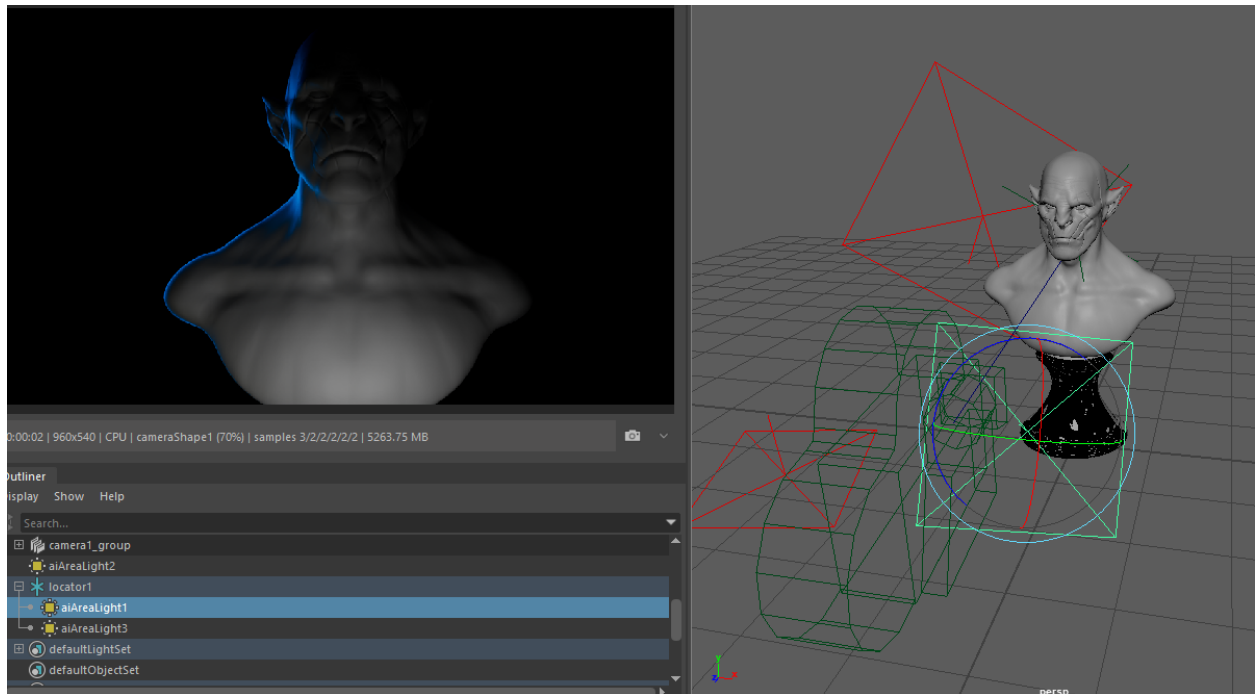


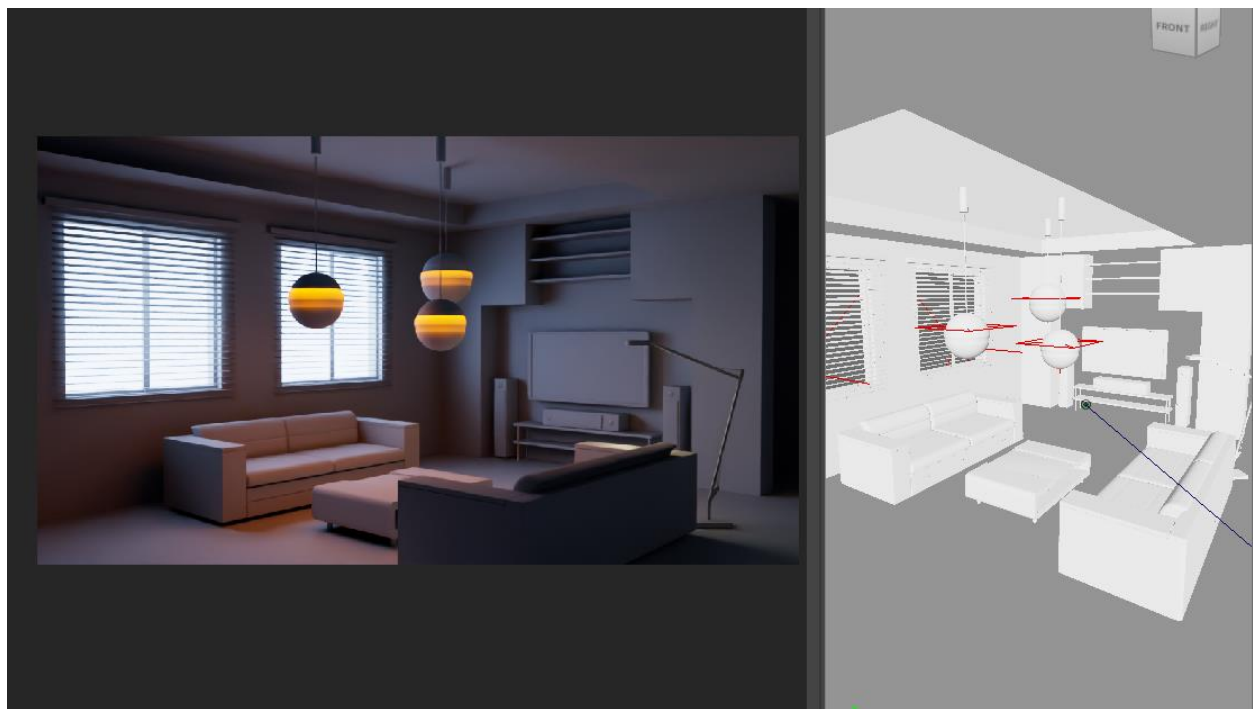
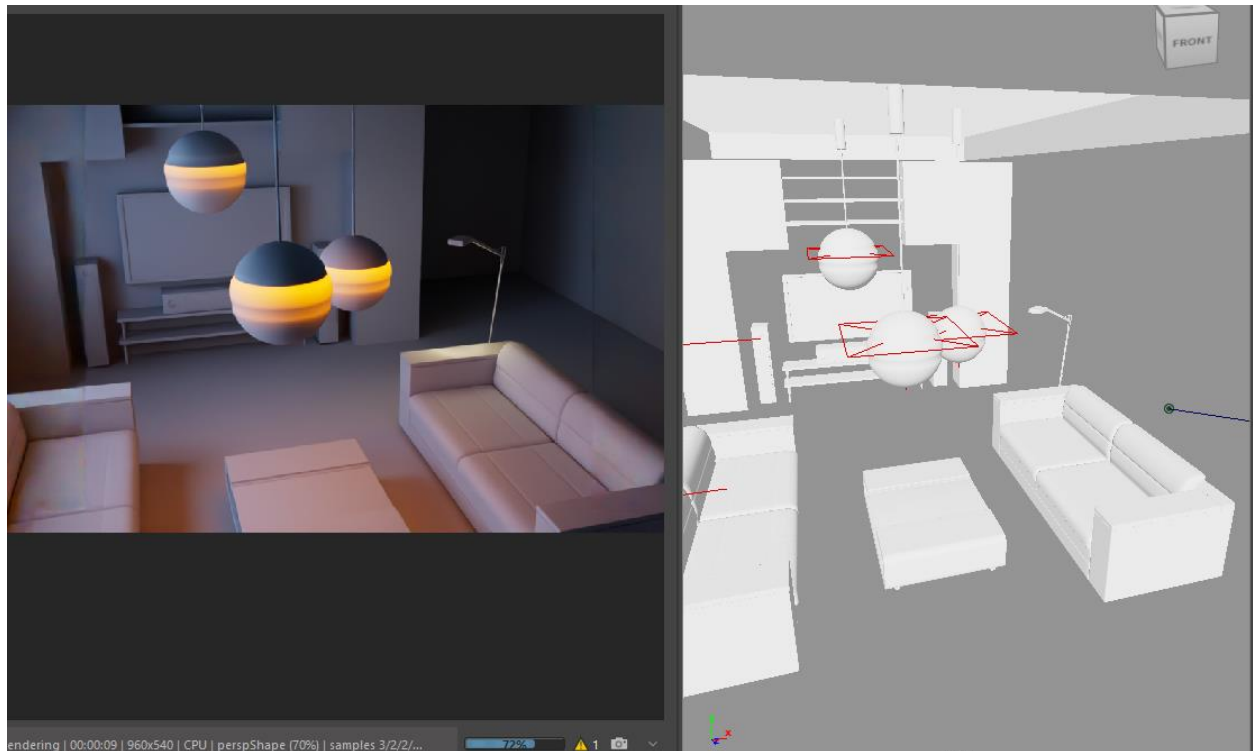
Trying to get a more dramatic lighting by angling the lights up to give a feeling of menace and power, it worked out better than I thought and the back lighting allowed some shadows to better emphasis the body.



2 Point lighting: I attempted to create a nice gradient effect with the light which turned out better than I thought it would, being close made it very strong but being further away made it dramatic which was a much better use of this.







Lightroom

I created a light portal and used it to reduce the noise and direct the world light into my scene without flooding it, for the lights I used an area light stuck into the model which created a nice glow effect. The only light that I had a problem with was the side lamp, I

created a cone that was placed under the lamp mimicking where the light would normally be & made it into a mesh light changing the colour to soften it to match the other light in my scene.

Two scenes

The Carnival

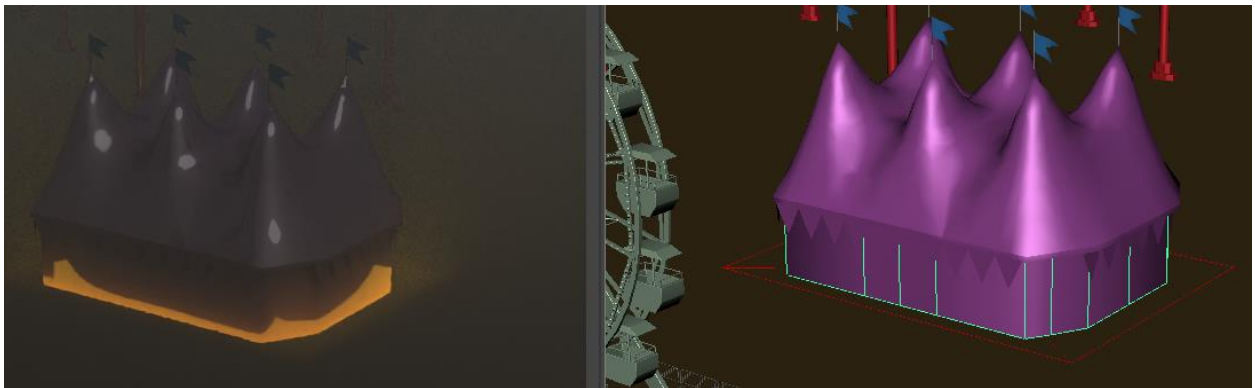


I started with creating area lights to attempt light up the merry-go-round which didn't work out as well as I thought it would so I had to change to copying the lightbulb mesh & creating a mesh light that allowed me to change the size of the mesh light so that I could replicate light bulbs. This turned out to be better than using area lights, I was able to avoid putting multiple area lights behind each lightbulb & was able to completely change the lights from one point instead of multiple which as saved me time.

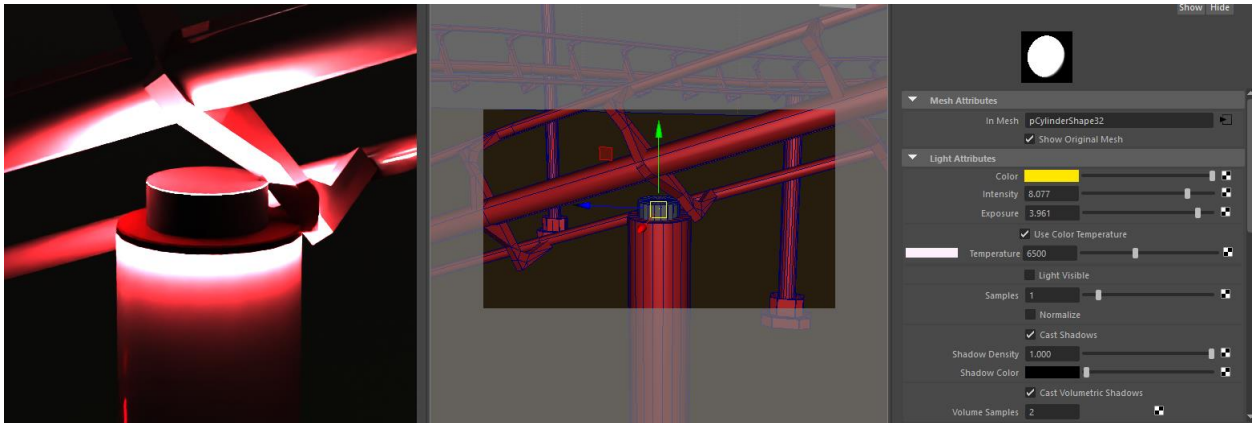


Process: Lights = Copy + Paste + Create Mesh light + Move copy above until it looks right. This worked out well for creating a realistic lightbulbs & making it easy to set up these lights anywhere there were lightbulbs and making sure the exposer was on the higher side let the lights look closer to their real-life counterparts and pop out better.

The Ferris wheel has 3 different light bulb meshes which means I was able to play with the light colours without having mess with the meshes & since the light bulbs where grouped up I didn't have to spend time changing every single light bulb light since there are around 50 to 100+ individual light bulbs.



I have tried to create glow effect like the lights of a circus tent, so I chose a warm colour & this made it look like it's lit by old style light bulbs which helped create the night look I was going for with my lighting, I also noticed that like a few other lights I have created they look fine from my cameras perspective but odd from most angles.





I used a mesh light on each pole using a cylinder a bit bigger the tip of the pole I was able to get the lighting to work in my favour, but it looks a lot better further away than close due to how I have my lighting set up.

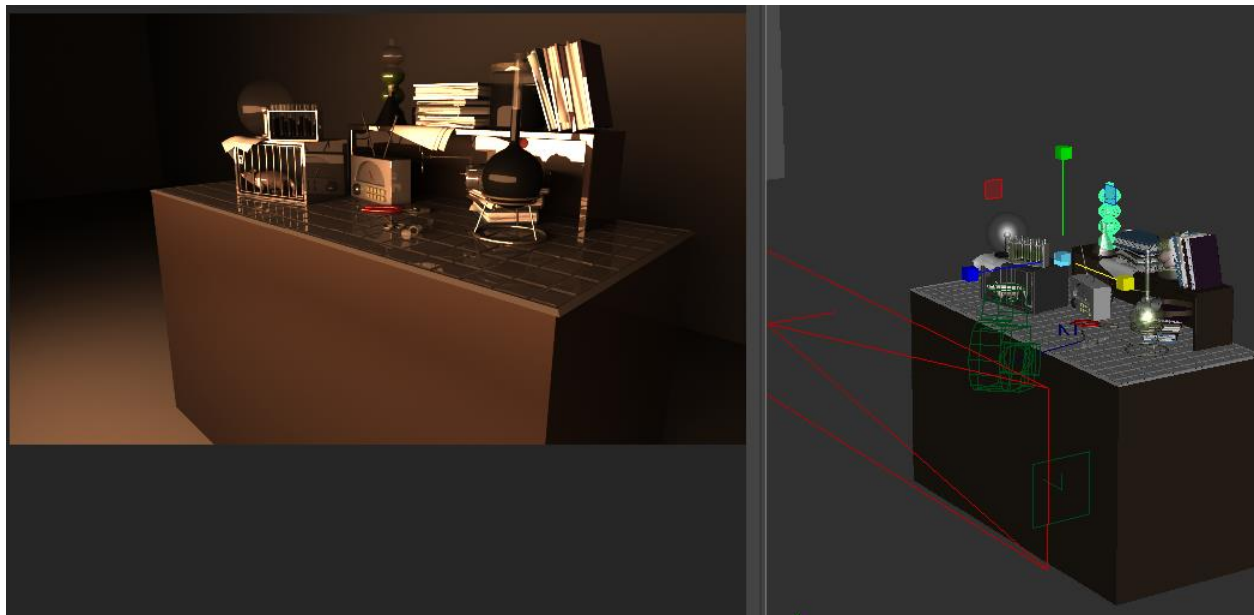


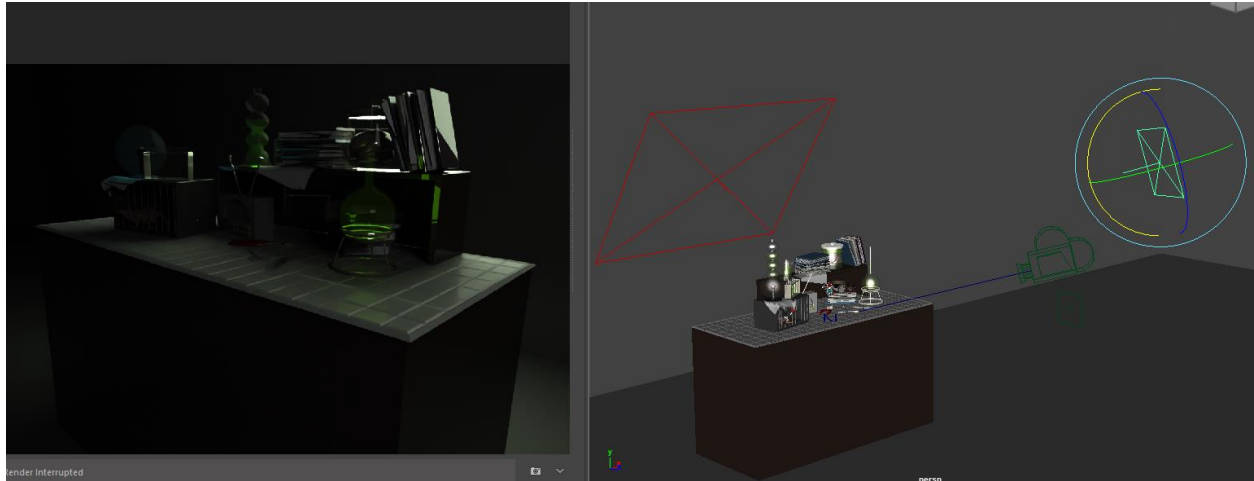
With my final out come here I can say that I like the fog a lot more than without, some of the more subtle lighting is lost the lights in the background pops more & gets much better.

The Carnival conclusion

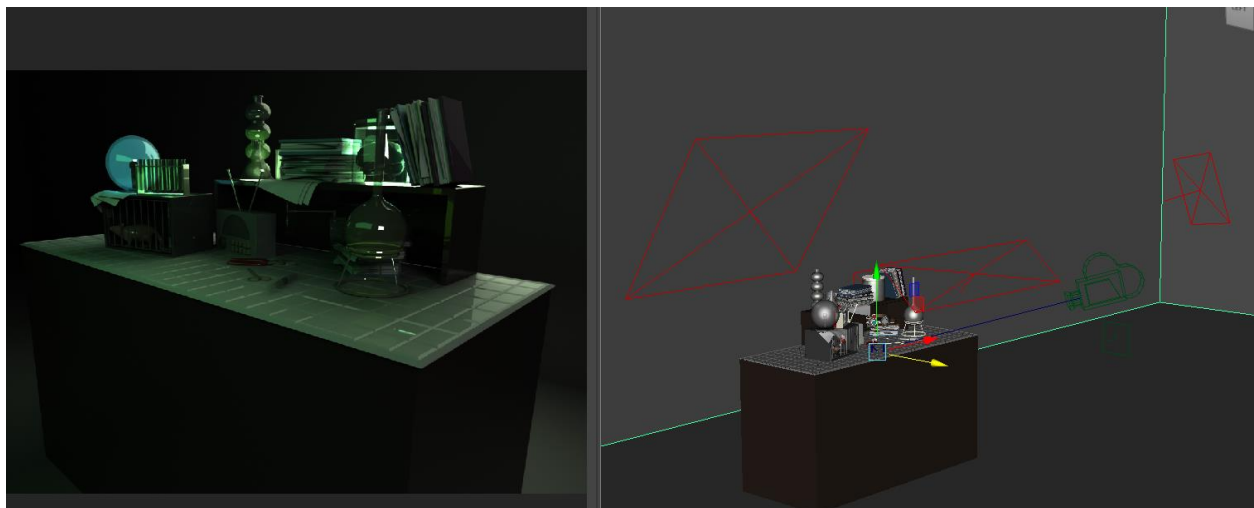
Mesh lights for the light bulbs: I used a lot of mesh lights to create lights & replicate light bulbs since that is all the lights I created mesh lights for, it turned out well & I was able to repeat the same process for each mesh light which saved me time in attempting to tackle each differently since I got to perfect the process by the ferries wheel which was my their mesh lighting of this project which was after I did the merry-go-round.

Area lights: I didn't use as many area lights as compared to mesh lights, but I did use a few such as the light underneath the tent which gave it a warm glow which turned out well, I also used some in the Feris wheel to light up the top.





Changing the opacity and attempting to use multiple light sources for more atmosphere & to highlight the scene better.

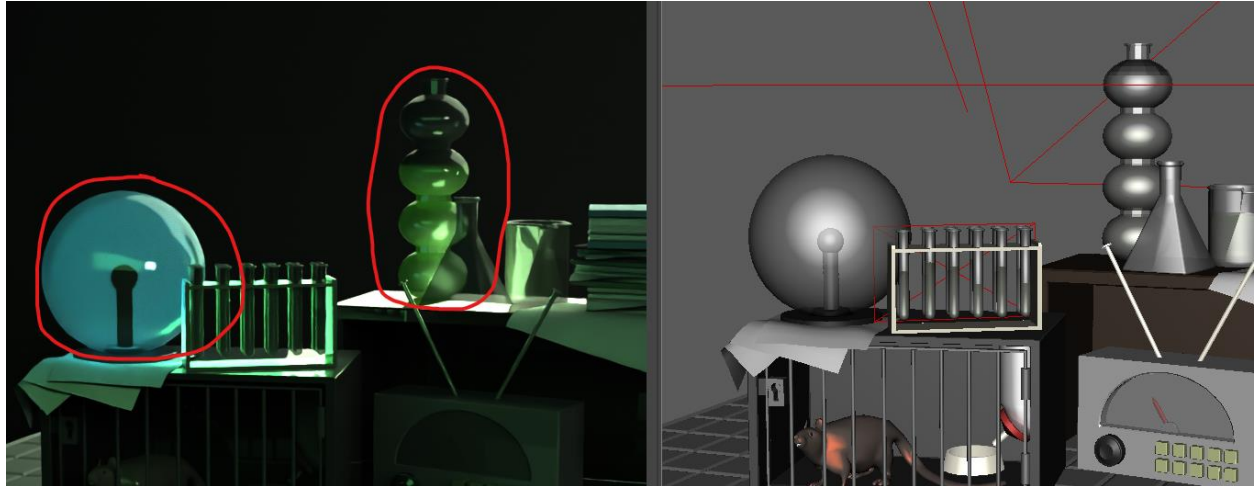


I have added more area lights that gave the scene a glow & better lit up the area since it was too dark before, some of the objects were also too reflective & some were not so I had to change the values. The glow from the area lights helps sell the idea of a mad science lab with the green lights and glow coming through the glass.

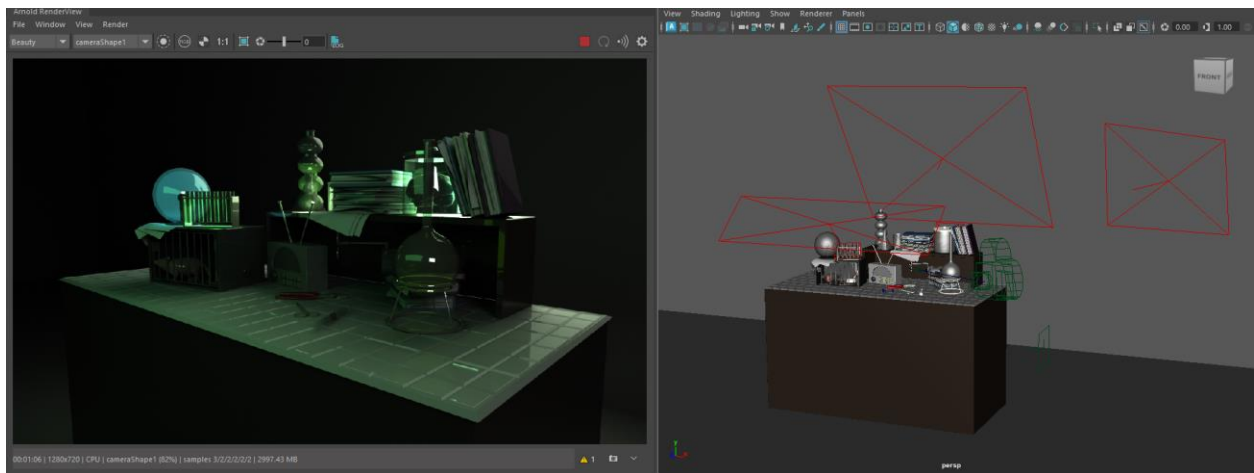
Mesh lights:

The mesh lights are something I did a lot in the carnival scene, but this scene has a lot of nested meshes that means if I want to create a mesh light, I need to do a significant amount of work that wasn't necessary in the carnival scene. Due to this fact I have only created 2 mesh lights for this scene & did attempt to create more but found it to be inefficient as well as extremely time consuming so I lit up what I was going to mesh light

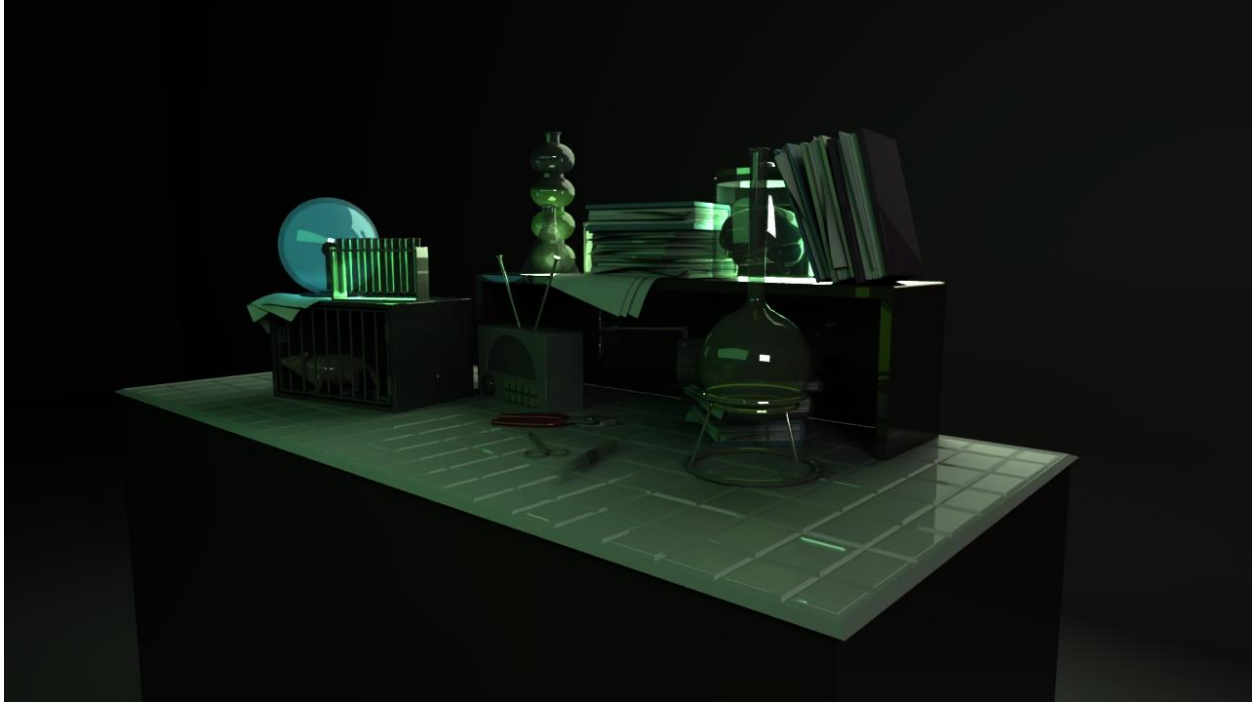
with an area light close up so that I would create a glow like I was aiming for with the mesh light



I changed the reflections on these two objects that made the mesh lights inside stand out & glow more, I want to create more glowing light effects with this to emphasis the mad science aesthetics in the scene.



Coming close to what I had in mind for the final scene with a dark look while highlighting the main subject of the scene, I used 3-point lighting for this with 3 big lights as my main ones with a few smaller lights highlighting some of the glasses to make them stand out.



The reflectiveness of the table & glasses turned out well, I only changed the reflectivity of the glasses which ended up well and since I kept the focus on the table & what's on it the lighting keeps the focus to the middle of the image. Drawing the eyes to the table/middle of the scene wasn't the aim but creating the lights as I did end up doing so, I played into this attempting to keep the surrounding dark & the middle well-lit the focus to the middle of the image.

Reflection

Carnival & Lab

In both cases I ended up using mesh lights since area lights were good at lighting objects from the outside but when it comes to creating glowing objects or anything like lightbulbs it was very difficult to get it to work & this is where the mesh lights came in.

World lighting

For the carnival I wanted to make the lighting dark since I wanted to do a night scene for it, this meant that I had to have a low light world & work around that such as adding fog so that I had less blank space with the fog making my lights stand out more.

The Lab was in a room already, so I started lighting the room to give my scene a dark feel like it's a secret but in doing so some of the objects in the scene became hard to see & I think that takes a little away from the scene but I tried to make up for it with back lighting to better enhance the scene where the dark parts take away from it.

Colours

I was trying to create an atmosphere appropriate of the scenes was something that had to be thought-out since I ended up making the carnival a night scene so the warmer colours stuck out such as the light was leaking out from the tent & other lights that I made brighter to better emphasise the lights in my darker scenes along with picking different colours for the carnival lights to replicate what lights you might see in a carnival. I liked that I was able to use the mesh lights to create the light bulbs that allowed me to play with the colours & change them to create my carnival/circus look but the top lights on the Ferris wheel didn't turn out how I wanted them to with them becoming fainter the closer to the front of the scene which doesn't look how I wanted it to but it ended up good enough so if I was doing this again I would attempt different methods to create the light bulbs on so that I could get a better look for the top lights in that scene since it's the only light source I wasn't happy with in that scene.

For the science lab scene, I aimed to make most things glowing, green, and white clean lights that are contrasted with the forementioned green lights as backing. I used this a bit too much with the green area & mesh lights in some areas but I didn't want to have different colours and keep the colour scheme simple, so I didn't have to deal with different colours bleeding into each other or taking attention away from other parts of the scene.

Different lighting

Using different lighting techniques for this project has been a key piece since I used 3-point lighting along with a good amount of mesh lights for the science lab but with the carnival I created a large area light with the rest of the scene being made up mostly of area lights, there are very few standard lighting techniques since I was aiming for recreating the light bulbs & stick to the theme of a realistic carnival at night with the fog helping to give a darker & real atmosphere. These differences in lighting allowed me to better understand different lighting techniques & how to light a scene fit for the scenario given.

Learning what lighting fits the scene & what lights are appropriate was a key piece since I ended up using a majority of lights with most being mesh lights but that was done to recreate the light bulbs, this was all to recreate the scene as if it was real but even then I needed more to add to the scene & this is where I got to see how other outside lights were

needed since just having those small lights weren't enough to recreate the feel I wanted which helped bring the scene together.

I have leaned heavily into coloured lights with both projects & my practice scenes all had very colourful lighting, I didn't want to create flat white lighting & enjoyed creating very colourful scenes but with some practice scenes I did create plain white lit scenes for practice with it being useful for helping getting used to creating well-lit scenes along with different types of lighting. I found that to me I thought plain lighting doesn't add enough to a scene since in my experience & through the projects a lot of real-life scenes have a large amount of different coloured lighting along with different strengths of lighting.

With all my scenes I could have attempted to add more area lights or used a few different types of lighting techniques since I relied heavily on mesh lighting, for the carnival I could have added more area lights such as more lights in the sky to create a larger area covered with light or changed the lighting like adding a sky dome, creating more area lights to fill in some of the weaker areas of lights that my mesh lights failed such as the front of the carousel since the mesh lights don't work so well there, and changing the roughness of some of the objects in the scene to reduce the reflectivity.

With my lab scene I could have made all glass objects with fluids mesh lights but there were so many embedded into other objects that going into the scene & changing each would of taken up most of my time which would of also mean I would have to repeat most of the process of going through the different layers to make any changes to my scene which would of been too time consuming, it may have created a better looking scene but I didn't want to waste too much time on that & I didn't want to keep using mesh lights for everything, I wanted to try more area lights for this scene but if I could redo this scene I would make all the glasses mesh lights for the glowing effect. I lent very heavy into the green glowing for the lab scene which I fear I leaned too heavily into trying to add more colour into the scene but I think it turned out well but could of been made better if I did lean more into the glowing effect in all the glass objects. Some of the objects in the scene are a bit more hidden by the shadows then I wanted them to be but trying to get them to stand out more ruined some of the lighting, so I left some objects obscured by shadows.

Link to all files: [Light_Work
Advanced Lighting and Rendering.docx](#)

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