CGI Report

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Concept design

My initial idea for an interior space in Bristol was the Queens Library. At the time, I often visited the area and thought it would be natural to model the space I spent a lot of time focusing on my work. I thought the repetitive booth structure would prove engaging to deconstruct. However, on one of my trips to the library, I passed by the Chemistry building and had a sudden inspiration for a model. The glass dome located in the Chemistry courtyard is an uncommon structure not seen everyday. I thought modelling the dome and the enclosing space surrounding it would evolve into an interesting challenge. I hypothesised the lighting passing through the glass would create an eye-catching combination of colours. I began work after confirming that the courtyard was viable as a model with the unit director.

At the start, the focus was on gathering images of the environment as shown in Figure 1. I took approximate measurements of tiles and created a drawn floor plan of the environment as shown in Figure 2. This would form the image plane that would act as a blueprint for the model later on.

Figure 1: Images of the Chemistry courtyard.

A difficulty in the planning process was determining the height of the pillars and arches, which stood to be a foundation for the complete model. Only after performing multiple extrusions from the image plane was I able to form a more accurate representation of the height of certain objects in the scene. I anticipated modelling the actual dome would involve some complex geometry and cuts, involving separating the glass segments with a wooden frame structure.

A mistake that cost a considerable amount of time would be drawing the pillars to the size of the pre-printed squares on the floor plan paper. The ease of using the size of the pre-printed squares falsely led me to model a scene with pillars that were too large for the scene and restricted the view of the dome and courtyard. I later had to spend time resizing the pillars to allow for a less constricted view.

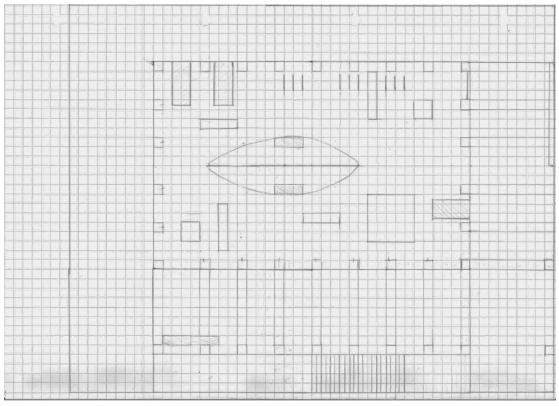

Figure 2: Drawing of the Chemistry Building courtyard floorplan.

Geometry Design

I initially spent time reconstructing the enclosing space by extruding the pillars and making a placeholder dome using a platonic polygon primitive. The start of the enclosure with pillars and arches were relatively straightforward, but I also wanted to include the staircase in my model. I made this using a plane and deleting specific vertices with a final extrude to pull out the steps. I also spent time performing extrudes along the side staircase, paying close attention to detail in the lip of the stairs, as shown in Figure 8.

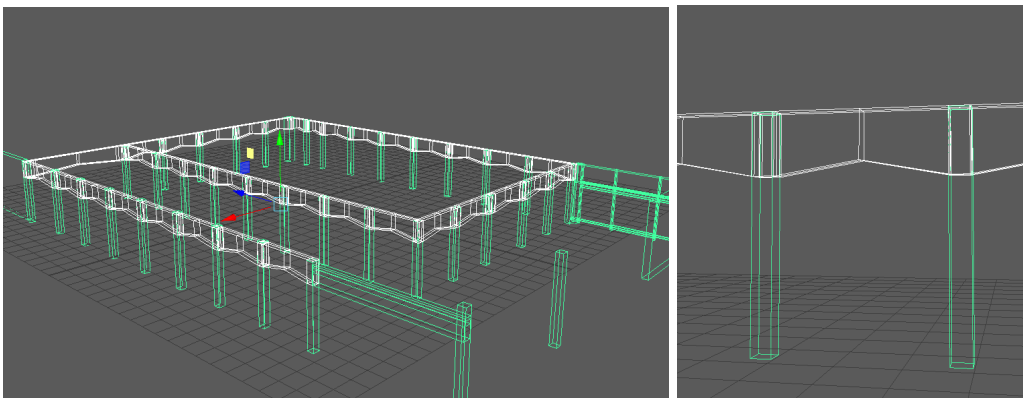

Figure 3: Wireframes of the arches and pillars.

The glass dome in the courtyard required a significant amount of planning and time. The dome proved to be one of the most complex objects to model in the scene. I first experimented using primitives like low polygon platonic solids. I tested changing the number of subdivisions to determine if it was possible to generate the dome in such a way that could let me extrude out the wooden structure. Ultimately, I could not find a way to generate the structure in such a way that accurately represented the actual dome without manually creating at least part of it.

At the outset, it was clear that if I could model one half of the dome, a simple mirror would complete the other half. After some research, I discovered that the dome closely resembled what is generally

known as a geodesic structure [7]. These are spherical structures that are joined by straight edges rather than curved ones. Looking through tutorials [8] made it apparent that these domes are created using what is known as a geodesic face which forms the base for creating the rest of the structure.

Analysing the dome from different angles for an extended duration allowed me to link this to my knowledge from the course of spherical polygon primitives. I evaluated whether or not using a part of the sphere would provide enough base on which to form the rest of the model. Surely enough, I realised using a quarter slice of a sphere and the multicult tool would allow me to meticulously carve each triangle into the side of the dome structure. Once the multicut half sphere had the appropriate mesh, the bevel tool allowed for the creation of the wooden framework that supported the glass panes.

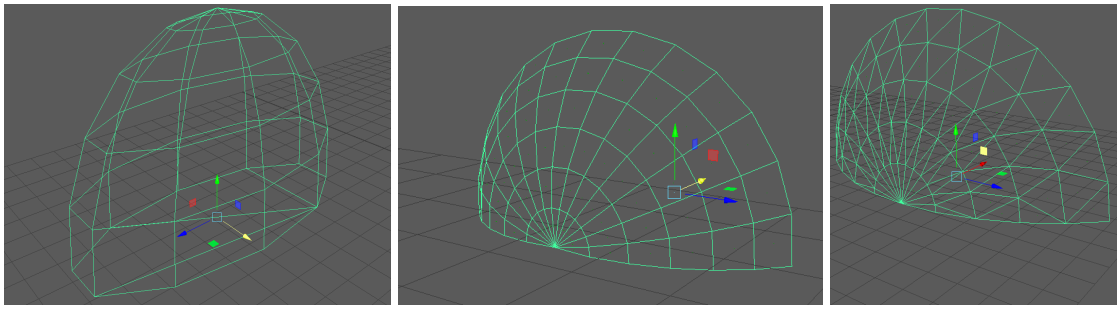

Figure 4: From left to right – Wireframe of initial platonic solid. Centre image shows the stretched quarter of a sphere. Rightmost image shows the face with the cuts inserted.

The base upon which the scene was built included the tiled flooring. This allowed for texturing individual tiles later on to match the colour patterns in the actual courtyard. A minor difficulty in creating this textured flooring included measuring each tile to the approximate size of the real tiles. We scaled the model to 2000 length and width units with gridlines every 100 units, providing a life sized plane to work on. Resizing the floor plane so that the tile squares matched up with these grid lines made scaling the floor an easier task.

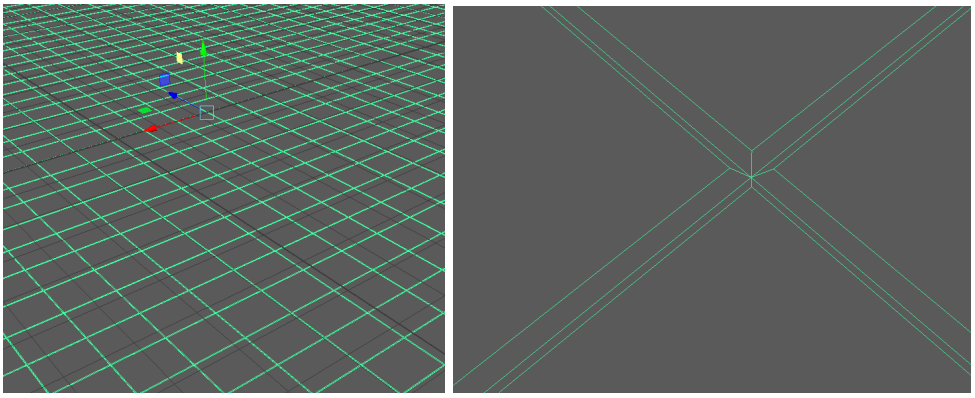

Figure 5: Wireframe showing the tiles and bevelled flooring.

The bike racks inside the courtyard consisted of a simple arrangement of pipes combined with a bridge to complete the object. This also required increasing the divisions of the bridge by a specific amount to achieve a desired curving effect.

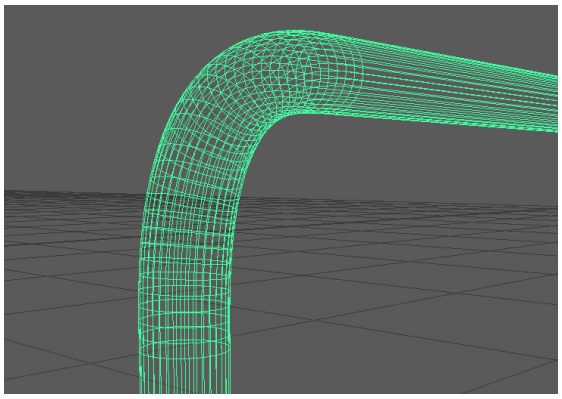

Figure 6: Mesh of the metallic bike racks.

Trees were a complex object to manipulate. Each tree was generated using Maya's inbuilt brush generation tool. An appropriate model had to be chosen and modified so that it closely resembled the trees in the actual scene. Each tree additionally had to be converted to polygons from their Paint Effects. The settings edited in the 'oakWhiteLeafyMedium' attribute included the Tubes and Leaves options which I altered so that the foliage appeared less dense. I also changed the location of the leaves to be on 'Secondary Branches Only' instead of 'All', as leaves occasionally appeared on the trunk which was noticeable from certain angles.

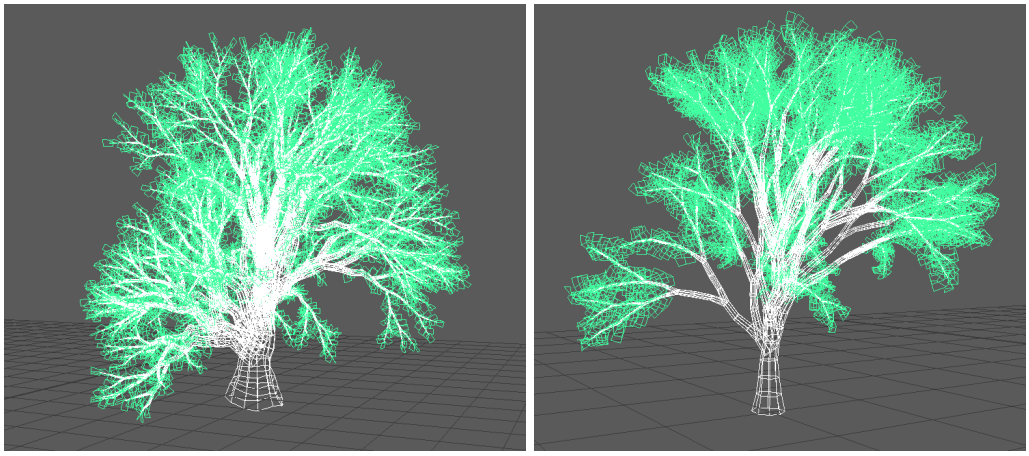

Figure 7: Left – large tree in the courtyard. Right – Zoomed in image of the smaller trees with a thinner trunk.

Railings along the side of the staircase and roof of the courtyard were created using thin pipes and a nearly flat rectangle. On the side of the stairs these railings were not as modular, having a slanted angle along the width of the rectangle. The fastest way to create this railing was by selecting one of the edges and moving it down on the Y-axis so one was below the other. Creating a duplicate placing them next to each other allowed me to quickly judge and adjust how slanted the angle had to be to allow for the further duplications without the railing looking jagged.

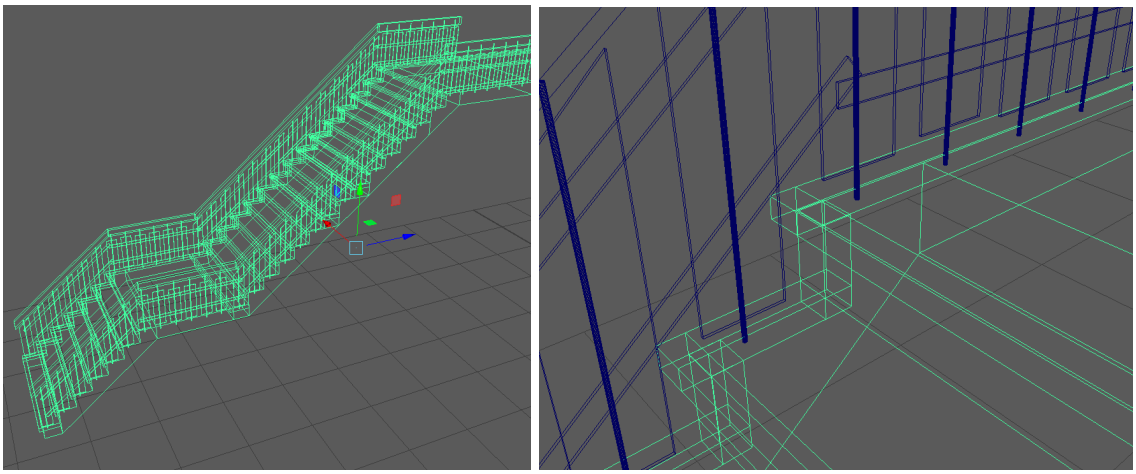

Figure 8: Wireframe mesh of the detail on the staircase and the slanted railings.

A structure I found somehow more troubling to model than expected were the stone seats situated throughout the courtyard. I presumed indenting the rectangular structure of the stone slabs would be easy after using the multicut tool to insert multiple edge loops at appropriate points. However, they did not allow me to easily extrude inwards the areas where the seats had an indent, often giving me broken geometry. If I were to recreate this structure, I would have first created one of the modular centre slabs and end pieces separately before passing the inner rectangle through the centre of each slab afterwards.

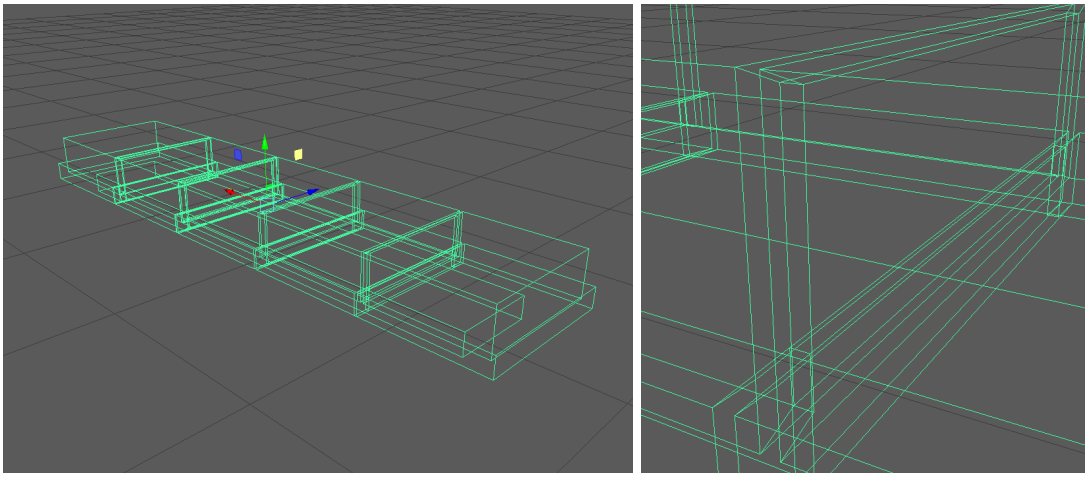

Figure 9: Mesh of the stone slab seating with indented sections.

Creating the lattice pattern across the ceiling of the courtyard initially seemed difficult but realising the poke tool created a subdivision with a central vertex made the process much simpler [12]. I first created a pre-select set of all the edges of a flat plane. Deleting those edges after performing a poke generated a diamond lattice for me to manipulate as required. Using this lattice plane, I performed an extrude with an ‘Offset’ and used the option to not ‘Keep Faces Together’. I finally extruded the face of the lattice cut out to the thickness of the ceiling in the courtyard and scaled it accordingly.

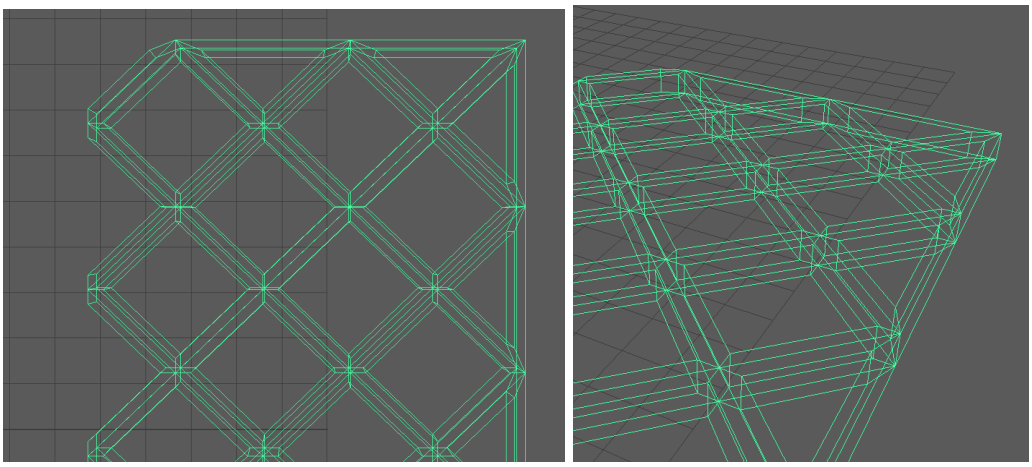

Figure 10 : Lattice ceiling underneath the roof of the courtyard.

Lighting and Texturing

In terms of texturing, a majority of the scene initially consisted of mainly pale and dark grey textures due to the nature of the concrete surroundings. As the scene slowly developed, more textures such as coloured glass for the window panes and metallic surfaces for the railings and flooring of the dome were added to bring life to the scene. Setting my skydome colour to be the default white colour made the scene look flat with washed out colours. I decided on lighting the scene with a sunset skydome imported from Poly Haven [9]. Following this, I adjusted the exposure and then the intensity of the skydome light to prevent the scene from being too bright. The simple change of a skydome with clouds and yellow tinge from the sun immediately gave the scene a more realistic mood. In addition, I planned to use a skydome that was at night to accentuate light passing through the dome in the dark. This is later shown towards the end of the animation.

One of the more intricate processes in texturing the scene was selecting appropriate bark and leaf textures for the tree. At the outset, Maya's default brush tree looked out of place in the scene. Although the tree included a default leaf and bark texture, their alphas did not seem to interact correctly with Arnold renderer, and resulted in semi-transparent square-like leaves. My first attempt at a fix was by creating a maple like leaf from scratch and performing duplications for each branch like in Figure [x]. Quickly realising this process was highly inefficient, I found myself following a tutorial on Maya's Paint FX for trees [3]. I learnt how to use Maya's hypershade graph editor to be able to import my own sourced transparent leaf png files to make the scene appear more life-like.

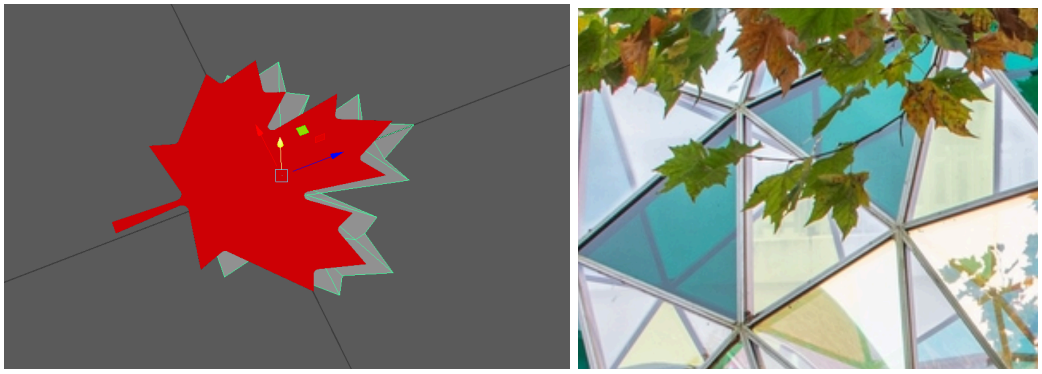

Figure 11: Left: Experimenting with creating a maple leaf from scratch to resemble the leaves in [4].

I passed the leaf images I found online through an alpha mask generator [2] and added them to the graph editor. These determined which areas of my leaf image were transparent and opaque. I also had the option of adding a self-sourced image for the texture of the bark, so I used a normal map as well as inserting an albedo colour map. Both the leaves and bark had the issue of being too reflective at the outset, prompting me to increase their roughness parameters.

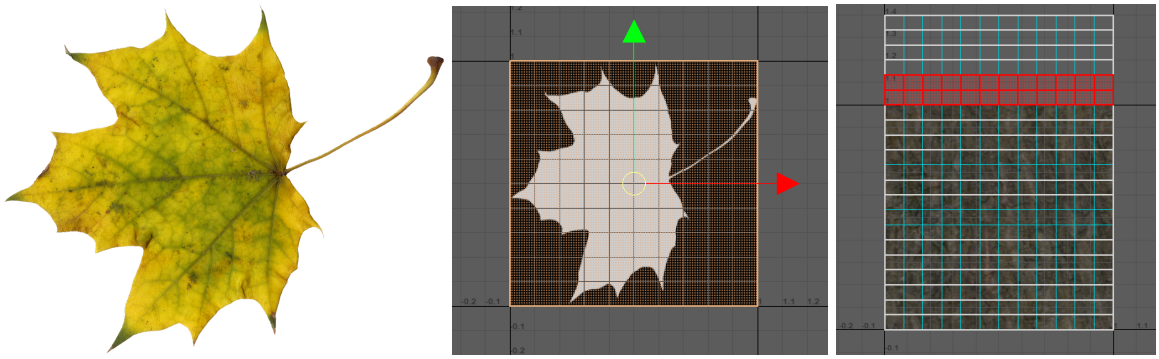

Figure 12: UV maps of the bark and leaf textures [1].

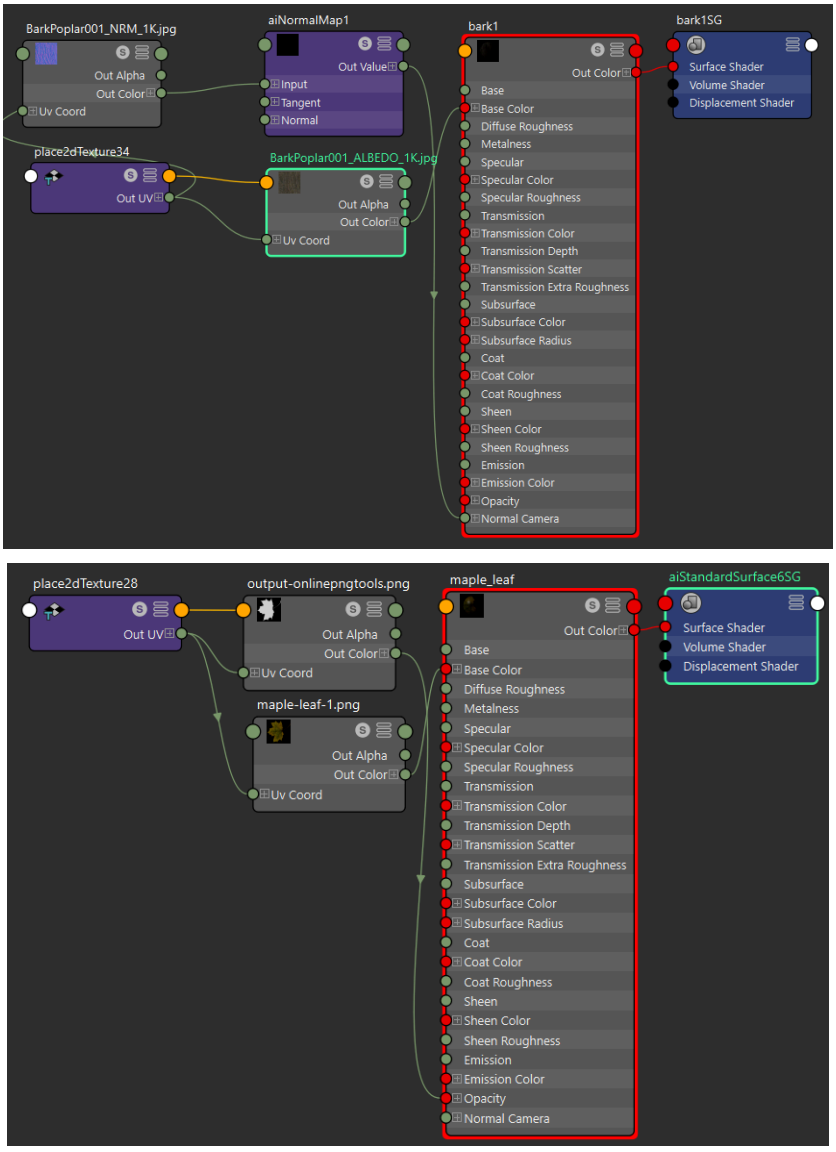

Figure [13a, 13b]: Top shows the hypershade graph network of the bark. Bottom shows also shows the hypergraph of the leaves.

The corridor lamps in the evening added a completely different mood to the scene. I believed it was important to include the addition of the lamps that were lit up and gave more depth to the shadows cast onto the pillars. To create these, I performed a selection of faces on a primitive polygon cylinder and extended these lengthwise. The fastest way I imagined being able to create the half cylinder opening within this structure was by performing a boolean difference. Duplicating the current model I just created then scaling it down and passing it through the original gave me the desired shape of the cutout.

To start lighting the lamp, I first used a centred pointlight to try and achieve the effect of light emitting from both holes. This did not give the desired result, with the light ray being cast having a thinner cone width in comparison to the image in Figure 14c. I then tried using two area lights each pointed in opposite directions at either end of the lamp. The area lights gave a larger width to the ray of light emitted from each end of the lamp, representing the light shone behind pillars more accurately. I additionally adjusted the angle of each area light to ensure a softer and blurred edge to the shadows to depict them in a more authentic manner.

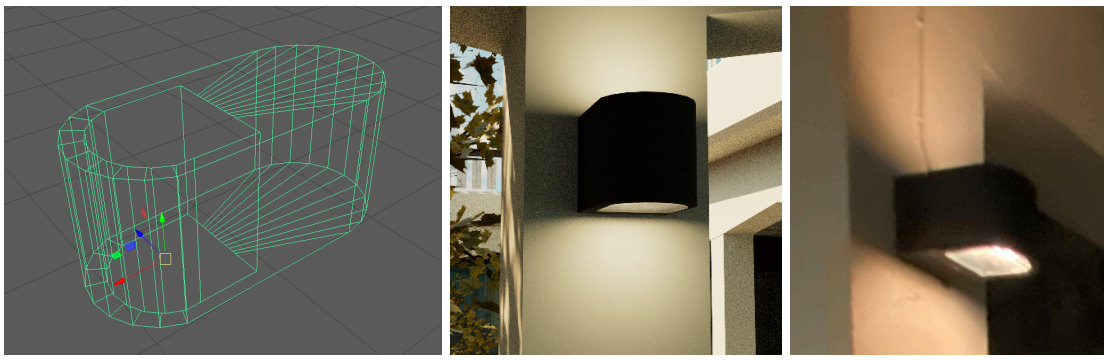

Figure [14a,b,c]: Left shows the lamp mesh created using boolean difference. Centre shows the recreated lamp with lights installed. Right is a real image of the lamp at night.

Alternating between a day and night skydome meant that the dome was difficult to view and fully appreciate without proper lighting in the dark. Despite the dome currently having no lights installed within the structure itself, I decided on creating a pointlight within the dome that lit up on the transition to night in the animation. This served well to light the dome so that the glass panes were visible but in retrospect I would have created area lights in the shape of cylinders which more closely resembled an image of the dome I found online being lit up at night.

Figure 15: Dome lit up at night [10].

Animation

Planning and creating the animation for the scene was likely the most enjoyable part of this project. Even before I started modelling I had a few ideas for how the camera motion should flow throughout the scene. My goal was for the camera to move through the corridor so that the shadows projected onto the floor would seem to move with the panning motion. I also wanted the dome to appear to construct itself while this movement was taking place.

Before beginning on the movement of objects coming into the scene, I had to create a motion path using an EP curve for the camera to follow as a baseline. Simply constraining the camera to the motion path gave the animation a jittery motion that also often resulted in the camera looking in the wrong direction. Following [5] taught me how to use an aim alongside the camera motion path which smoothed out the camera view by providing a focus point. Setting the aim to be the glass dome gave a polished camera motion that allowed me to build the rest of my animation on top of.

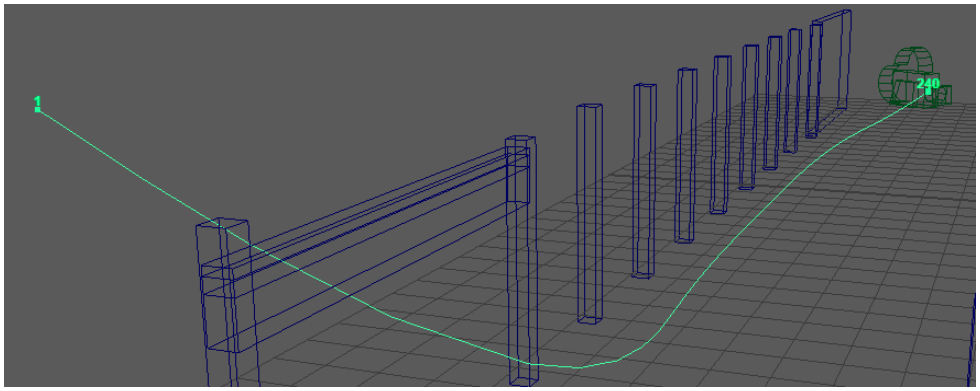

Figure 16: Shows the EP curve used for the motion path of the camera and aim.

One complication that I faced with camera animation was that accidentally moving the camera within the view displaced the motion, and restoring it to its original position was difficult. Ctrl-Z did not work. I had to find that using the left square bracket reverted the camera position but still changed its movement path. To overcome this, I exported a finalised camera motion and curve as a md file to make sure the camera state was recoverable.

I planned for my animation to start from the staircase. I decided on animating the staircase manually so that it seemed to float upwards from the floor. For other models in the scene there were many repeated objects that called for using a script to automate the process. Following [6], I learnt how to use a script to automatically keyframe objects coming into the scene. I applied the script to multiple modular groups in the scene such as the pillars, arches and railings. The animated railings looked most impressive, creating a wave-like motion as they flew down onto the roof. I decided to manually move the objects in the scene I wanted more control over. These included the ceiling and tiles of the roof, as well as smaller objects such as the window panes and stone seats.

Turbulence was incorporated into the tree animation to create the sense of wind passing through the courtyard. These trees also started off bare and quickly grew their leaves as the animation progressed. This detail in the animation served to help anyone watching fully appreciate the complexity of the trees.

Animating the dome was more of a challenge. I first had to separate each glass face from the dome since I combined them into one piece previously. I then tried applying a modified version of the script that I used for other objects, but realised I had to start keyframing at an earlier time than I

expected. This was because the keyframes in the script had to be in at least integer increments, and since I was looping over many objects (all glass panes in the dome) the animation lasted slightly longer than originally planned. Despite this unanticipated extension I am pleased by the final look of the animation.

I decided to render using the MVB 1.07's lab machines with the NVIDIA RTX 3080 graphics cards. Luckily, I was able to find any major mistakes early, such as the ceiling pillars that came into the scene being out of place, before doing the complete higher quality render. If I had to render again, I would take the precaution to do a full render at lower graphics settings before starting the higher quality version. I finished off by compiling the output images into an mp4 video using ffmpeg. Rendering 270 frames at a Camera (AA) of 3 and adaptive sampling at 20 (AA) ended up taking nearly 40 hours of background render time, but I believed the resulting animation quality was worth the time spent.

References

[1] Maple Leaf Image https://www.onlygfx.com/wp-content/uploads/2016/10/maple-leaf-1.png
[2] Alpha Mask Generator https://onlinepngtools.com/generate-png-alpha-mask
[3] Paint FX Tree https://www.youtube.com/watch?v=i03vpu2vDJU
[4] Palm Temple Source Images https://artuk.org/discover/artworks/palm-temple-312991
[5] Maya Camera Aim and Motion https://www.youtube.com/watch?v=OYjYhb87rwo
[6] Maya Python Scripting https://www.youtube.com/watch?v=ijMyo-6T8Ow&list=PLGggcRBH1cXbsLCjxs49a9RBkP3NMKa8g&index=7
[7] Maya Geodesic Domes https://www.youtube.com/watch?v=Z_6IX_QNFGg
[8] Geodesic Domes https://exhibits.stanford.edu/bucky/feature/what-is-a-geodesic-dome/
[9] Poly Haven https://polyhaven.com/
[10] Palm Temple Night Images https://structuralsolutions.co.uk/portfolio-item/luke-jerram-palm-temple/
[11] Bark Texture https://www.poliigon.com/texture/poplar-bark-texture/2985
[12] Lattice Fence https://www.youtube.com/watch?v=gqEmStDUM4U