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Lighting and Compositing for QA-ARM-A

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LIGHTING AND COMPOSITING FOR *QA-ARM-A*

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Master of Fine Arts
Digital Production Arts

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by
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ABSTRACT

This thesis focuses on lighting, rendering, and compositing for the short film, *QA-ARM-A*. The goal of this project was to create a photorealistic short film centered on an interesting story. During this project, aesthetic direction, rendering requirements, and technical challenges arose. Issues of primary importance included: the proper render system to employ, the division of render layers, the selection of render passes, the combination of those layers and passes in compositing, and techniques for lighting each scene. As a result, many of the collaborative techniques and methods can be directly employed in future productions.

ACKNOWLEDGMENTS

I would like to thank the supervisors at DreamWorks Animation for all their help, encouragement, and time. I also want to thank my committee members, Dr. Timothy Davis, Dr. Jerry Tessendorf, Tony Penna, and Ron Grant, for all their hard work, and assistance during my time at Clemson.

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CHAPTER ONE

INTRODUCTION

This thesis focuses on lighting and compositing completed during the production of *QA-ARM-A*. During this time a complete computer-animated 15-second short was created from start to finish. The initial requirements of this project involved the production of a photorealistic professional film with a robot in some calamitous situation. Due to the high-level quality required, this project generated many challenges, specifically in the areas of surfacing and lighting.

In order to create an environment that was considered photo-real, extensive visual research was required. In the initial stages of the project, a setting and time period were chosen based on the inspiration of a tin toy robot. This research led to the creation of an environment that reflected what one might see in an American factory during the 1920's, as shown in Figure 1.1. Based on this established setting, extensive visual research followed, including image collection, antiquing, and location scouting, which provided a foundation for initial lighting set-ups. In addition to these references, DreamWorks Animation also provided artistically inspirational images, one of which is displayed in Figure 1.2. In terms of lighting, initial tests were conducted in order to explore possible lighting schemes, and the types of lights that would work best for the project's purposes. Artistic aspects of lighting were also carefully address, and it was determined that while the lighting needed to be logical with respect to the environment it also needed to reinforce the story. Due to this need, light became a tool that not only illuminated the scenes, but also told a story. Ultimately, a color script was provided and executed with the use of mainly tinted spotlights with quadratic decay rates and mental ray's ray-traced shadows. Compositing also came into play when implementing the final lighting schemes, as several corrections were made in the compositing software, Nuke, after rendering the lighting set-up from the 3D software, Maya. The lighting and compositing processes are further explained in Chapters 3 and 4.

Figure 1.1 Factory Reference Image

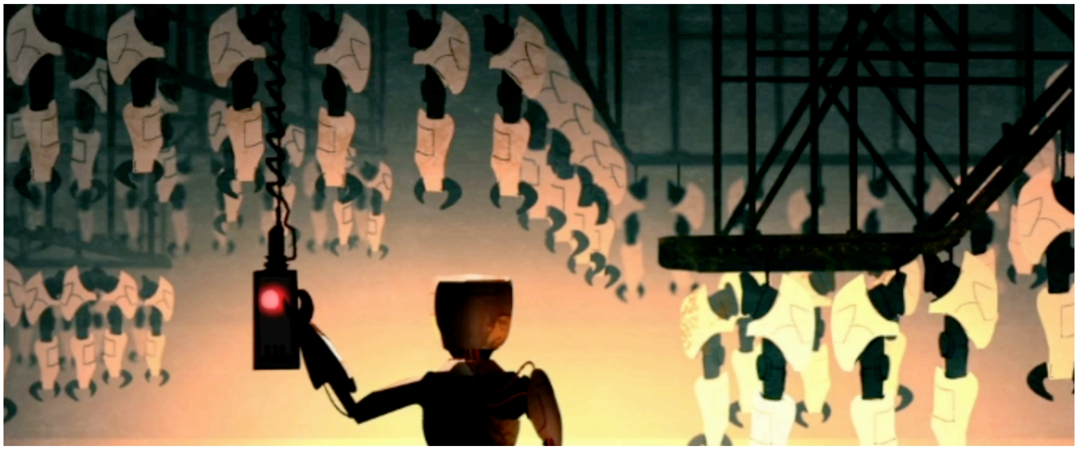

Figure 1.2 DreamWorks Animation Artwork

This thesis explains the lighting, rendering, and compositing challenges of the project and the ways they were addressed. Chapter 2 discusses the specific software and tools that were used in order to create the work, while Chapter 3 focuses on the process and the creation of lighting set-ups and Nuke trees. Chapter 4 describes the final lighting set-ups and the final compositing process, and showcases the final images. Possible future implementations of the techniques and processes used for this project, along with a summary and conclusion of the work, are expanded upon in Chapter 5.

CHAPTER TWO

BACKGROUND

In order to create a photorealistic film, various options and settings were considered, such as the proper rendering system to employ, determination of light quality and decay, subdivision of the scenes into render layers, selection of render passes, and techniques for compositing these layers and passes once rendered. Each area required careful planning and research before a method was chosen for the production.

2.1 Ray Tracing

For this project Maya's mental ray renderer, which implements ray tracing, was used to create realistic lighting with life-like shadows. Ray tracing is the process of rendering three-dimensional graphics with a high level of realism due to the way it traces simulated rays, which mimic light paths throughout an environment [WHIT78]. In forward ray tracing, rays are fired from the camera and pass through a view plane, which is comprised of a specific number of pixels determined by the height and width of the final render's resolution. Figure 2.1 provides a simplified visualization of this procedure and set-up.

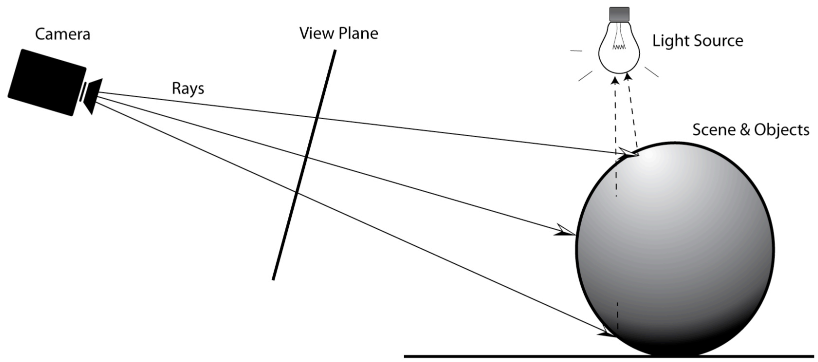

Figure 2.1 Ray tracing illustration

Each ray is shot from the camera through a pixel location on the view plane and is then tracked as it travels throughout the scene. At this time, the ray is tested for intersections with the objects that comprise the scene. When an object is intersected by one of these rays, the material properties determine the light contribution at the point of intersection. For example, if a ray intersects a specularly reflective object in proper alignment with the light source, a specular highlight is rendered at that location. If the object is obstructed from the light by another intersection, a shadow is rendered at that point. If the objects are complex (e.g., numerous reflective objects are in the scene), new rays continue to be generated up to a set number of interactions until the proper light contribution on the object has been found. This process is repeated for each pixel with an initial ray sent from the camera through the view plane, and traced as it travels throughout the scene. Due to this sophisticated system, extremely accurate shadows, specular highlights, and overall lighting is rendered. Because of this high level of realism, ray tracing was used throughout the film.

2.2 Light Decay

After the rendering technique and shadowing methods were chosen, the properties of the light sources in the scene were determined. Due to the fact that light in the real world decays over distances, a decay rate for simulated lights in the scene was selected. The decay rate most closely approximating that of the natural world is "Quadratic Decay" in Maya software. This type of decay decreases the light's intensity proportionally with the square of the distance to the object as it moves away from the light [AUTO13]. Under this scheme, objects or parts of objects that are closer to the light source will receive more illumination than parts that are farther away. If no light decay is present, the light will travel throughout the scene in a less realistic manner, and will illuminate objects in the scene that are both close and much farther away with the same intensity. Figure 2.2 provides an illustrated example. Since the film approximated natural lighting conditions as closely as possible, quadratic decay was employed when lighting the scenes.

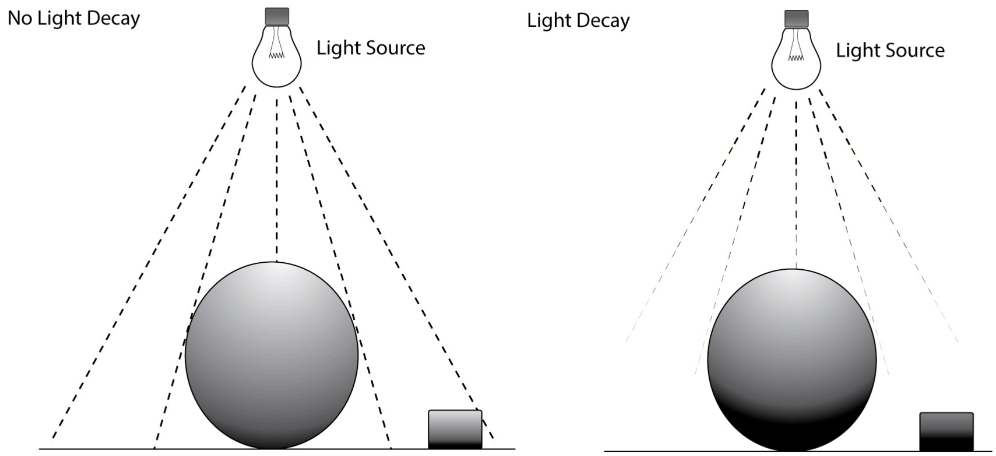

Figure 2.2 Decay rate illustration

2.3 Render Layers and Render Passes

The use of render layers was extremely important to the final creation of this project. These layers allow optimization of render times and potentially lower re-rendering needs by limiting only selected objects to each layer. These layers can then be rendered separately in parallel, and composited to create the final scene. Along with these objects, render masks for each layer are also needed to provide the alpha, or transparency, needed later in compositing. Along with rendering fully lit objects and masks, render layers can also be used to render selected types of renders, such as ambient occlusion, which creates additional shadowing information for a scene. Figure 2.3 shows a list of render layers in Maya.

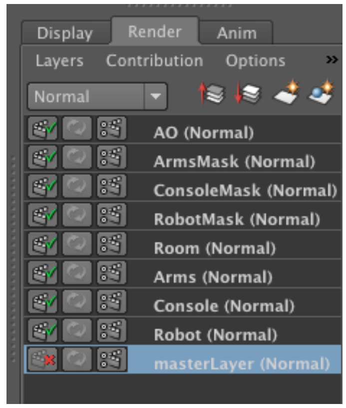

Figure 2.3 Renders layers in Maya

One of the advantages of rendering objects on different layers is that selected objects can be easily re-rendered in a scene or shot without re-rendering the entire scene. If a scene has five render layers, each containing one object or a portion of the object, and that scene requires selective correction or displays some kind of artifact, only that object on the select layer could be re-rendered, while leaving the renders of the remainder of the scene with all objects from each layer intact. This approach saves countless hours of computing and rendering time, which can then be used for other tasks. Additionally, these layers can hold various render settings and unique render passes associated with them without affecting other layers. Render passes are different from render layers because they determine the type of information rendered for the elements on a render layer. For example, diffuse, specular, reflective, refractive, shadow, and various other lighting characteristics can be rendered separately and composited in order to re-create a final render of a scene, as shown in Figure 2.4.

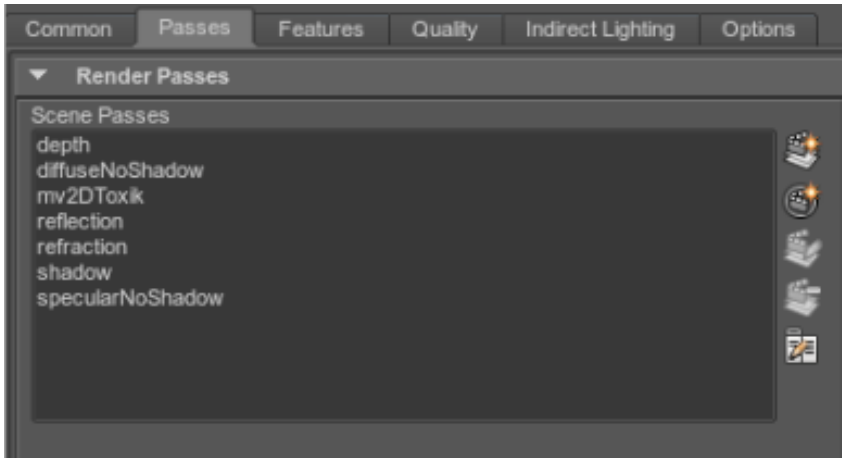

Figure 2.4 Render passes example in Maya

This process allows the user a great amount of control over each pass and facilitates adjustment of those areas without necessarily re-rendering. For example, if a reflective surface is rendered using passes, and its reflective contribution is too high when composited, the rendered reflective pass can be adjusted in the compositing software. This method requires no re-rendering, and can be completed fairly simply and efficiently, and at a much lower cost than updating shaders and re-rendering the scene.

2.4 Basic Compositing and Nuke

Once renders were completed, they were reassembled in Nuke to create the final frames. Each of the passes, i.e., diffuse, specular, reflection, refraction, etc., was rendered as a sequence of images, which was either contained within a single file, such as a multiple-pass *exr* file, or in several sequences of separate files. In the former case, each pass must be extracted from the file and recombined in Nuke to allow individual control over each pass. If the passes were rendered to separate files, all files must be loaded in

Nuke and recombined to create the final images. After these passes have been reassembled, color correction, brightness, intensity, and the application of other filters can be added and manipulated. This approach allows for the artist to manipulate the images without consuming valuable time and resources with additional rendering. Furthermore, other elements or renders can be added to the scene in Nuke, such as ambient occlusion, depth of field, certain types of motion blur, and numerous renders, filters, or additions as necessary.

Nuke also allows for advanced visual editing, such as roto-painting. This feature provides the artist with the ability to paint on multiple frames simultaneously. Sometimes painting frames individually in a sequence is necessary, and Nuke provides a key-framing system that can help with this process. These features provide many opportunities to conserve time, energy, and re-rendering needs while providing the artist with a high level of control over visual aspects to create the desired look for the final images. Figure 2.5 gives an example of a basic Nuke tree.

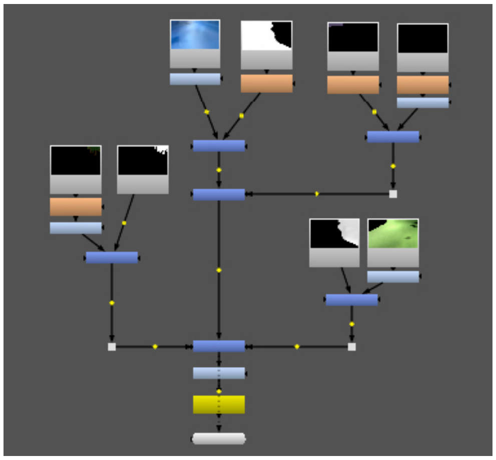

Figure 2.5 Simple Nuke tree

CHAPTER THREE

IMPLEMENTATION, WORKFLOW, AND PROCESSES

Creating photorealistic renders can generate heavy scenes, which inevitably lead to impractical render times. In this particular production, render-farming equipment was limited; thus, the scenes needed to be as efficient to render as possible without sacrificing quality. This requirement necessitated a variety of approaches to reduce render time, as discussed in the following sections.

3.1 Scene Optimization

After the initial scenes were created, and light testing and rendering configuration were begun, the resulting scenes were quite heavy and required unreasonable computational time. Due to this heaviness and the limited resources available, several workarounds were required to create efficient and reasonable render times in mental ray. While rendering with mental ray provides realistic results, its sophistication can generate long render times. As scenes became heavier with polygons, complex texture and shading networks, and advanced render settings, longer render times necessitated scene optimization. Initially, selected textures were reduced in resolution, and render layers were used more intensively; however, render times remained longer than was desired.

3.2 Implementation of Approximate Shaders

To further optimize all levels of rendering, "approximate shaders" for selected objects on render layers were employed. Using this approach, an object needed on a layer only for reflection or shadow purposes, but not visible otherwise, received simple shaders. These simple shaders consisted of lambert materials using only basic colors that most generally mimicked the color of the original object. This technique greatly reduced the computing demands during render time on objects without visibility, but with blurred reflective or shadow contributions. As shown in Figures 3.1 and 3.2, these shaders greatly reduced the complexity of the corresponding shading network, eliminating the need to compute displacement, bump, specular, and heavy diffuse properties for these objects.

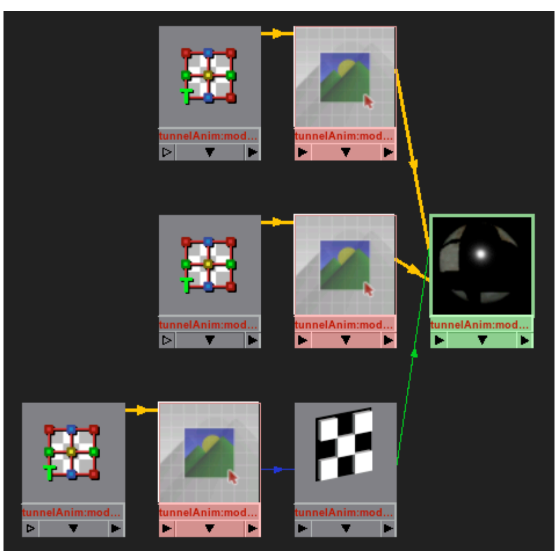

Figure 3.1 Mia material x passes network

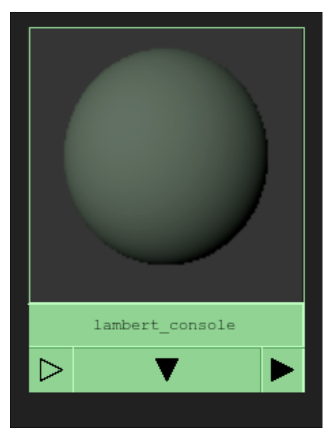

Figure 3.2 Approximate lambert network

Because of these optimizations, render times were greatly reduced without compromising the quality of the final result. This method was therefore implemented repeatedly and consistently throughout the entire film to further optimize computing and render times.

3.3 Render Setting Optimization

Once lighting commenced more intensively, various render settings were optimized as well. Originally, Final Gather and Global Illumination were in use, two processes that are intensive and require a significant amount of render time. As stated in the Maya manual,

> Final gathering is a technique for estimating global illumination for a given point by either sampling a number of directions in the hemisphere over that point (such a sample set is called a *final gather point*), or by averaging a number of final gather points nearby since final gather points are too expensive to compute for every illuminated point… Global illumination is the technique used to capture indirect illumination, the natural phenomenon where light bounces off anything in its path until it is completely absorbed [MAYA13].

Since these calculations are complex and require a great amount of render time, these options were deactivated to reduce computation costs; however, these two settings contribute to the bounce light and color bleeding in a scene, and without those settings active, these characteristics of light require manual implementation in the lighting plot.

3.4 The Lighting Process

After the scenes were optimized and appropriate render settings were chosen, the task of lighting could get fully underway. Initially, lighting was based on references to old American factories with relatively efficient lighting. The results of this initial lighting scheme is displayed in Figure 3.3.

Figure 3.3 Initial lighting tests

These initial tests provided selective lighting, but did not provide much intrigue or reveal the scene in a flattering or narrative way. More lighting reference material was therefore needed. This task was accomplished with a mock lighting photo shoot, as shown in Figure 3.4.

Figure 3.4 Lighting reference and re-enactment

These studies assisted in the further development of digital lighting plots and provided insight into certain types of light contributions and their locations within the scenes. Since completely recreating the desired scene was impossible with our limited equipment, some of the light placement was approximated to create a more precise and visually directed look.

3.5 Render Layers and Render Passes

As previously mentioned, render layers and render passes are of great importance when creating easily manipulated imagery for compositing. Since the scope of this project necessitated optimization, select objects were chosen to be placed on separate render layers, and later composited down the pipeline. Since the robot and his accessories were the main elements of the film, these objects were rendered on separate layers. Also, the background elements were partitioned into a layering system in which the console and its elements were on one layer, the conveyor belt of arms and their respective hangers were on a second layer, and the ground plane, ceiling track, tunnels, and walls were placed on a third layer.

Each of the layers, except the layer with the room elements, included an accompanying mask layer consisting of all scene geometry with either a white or black surface shader, depending on the layer and the objects to be masked. The white shaders allowed objects in the layer to be visible, while the black shader covered any unwanted objects that would otherwise eclipse the layer objects. This scheme enabled certain elements to be re-rendered without including superfluous objects, and eliminated potential layering issues.

As the project continued, new render layers were created with further partitioning. For example, during the rendering process, the robot's headlight produced rendering artifacts within its glass. Instead of re-rendering the entire robot, a new layer along with its accompanying mask layer, were created for the affected object and composited into the scene. This process was implemented again when rendering the legs of the robot produced issues. New layers were created so that only the lower portion of the robot was re-rendered and composited.

Render passes were implemented also for reducing render time. Due to the large amount of complex render information in this short, passes were chosen carefully, and unnecessary information was eliminated. Of course, the primary render passes must be produced: diffuse, specular, shadow, reflections, and refractions. A separate pass containing only shadows was used to allow complete control over the effects of shadowing in the environment. In addition to these passes, other separate renders were needed such as those for depth of field and 2D motion vector blur. All of these passes were then rendered and combined in the compositing stage, which is further discussed later in this chapter. For a complete list of chosen render passes, see Figure 3.5.

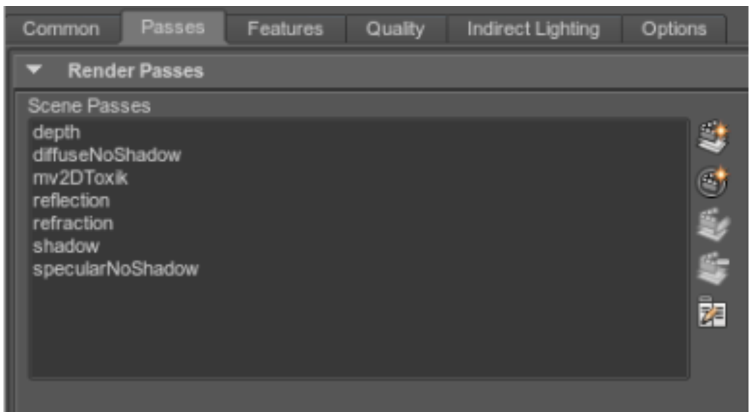

Figure 3.5 Complete list of render passes chosen

3.6 Lighting Plots and Images

Because the goal of the film was photorealism, lighting was implemented in a naturalistic way. Information from the live-action lighting studies, factory reference images, and the team's artistic vision, was used to direct the light to behave in a natural way while maintaining a sense of curiosity and the ability to direct the viewer's eye to desired areas. Any updates to the light plot were therefore made carefully to maintain realistic locations of lights if the space depicted in the film were a real room in the physical world.

Lights were subsequently arranged in a way that mimicked old factories with a series of main lights in a row to illuminate the workspace and some sparse lighting in the background. Because our inspiration stemmed from the 1920’s, the surroundings were made to look old and worn, which was reinforced by the lighting choices as well as the surrounding textures. Originally, each light contributed only a fair amount of light to the scene, with the main light source located directly above the robot’s head. This plan, however, did not direct the viewer’s attention in a sophisticated way, and at some points led the viewer's attention away from the main point of action. Originally, light linking was employed to various lights in order to prohibit certain objects from being affected by specified light sources. This scheme, however, did not produce realistic results, and was therefore removed to maintain realism. Figure 3.6 shows the initial lighting plot for Shot 02, and Figure 3.7 shows the corresponding render.

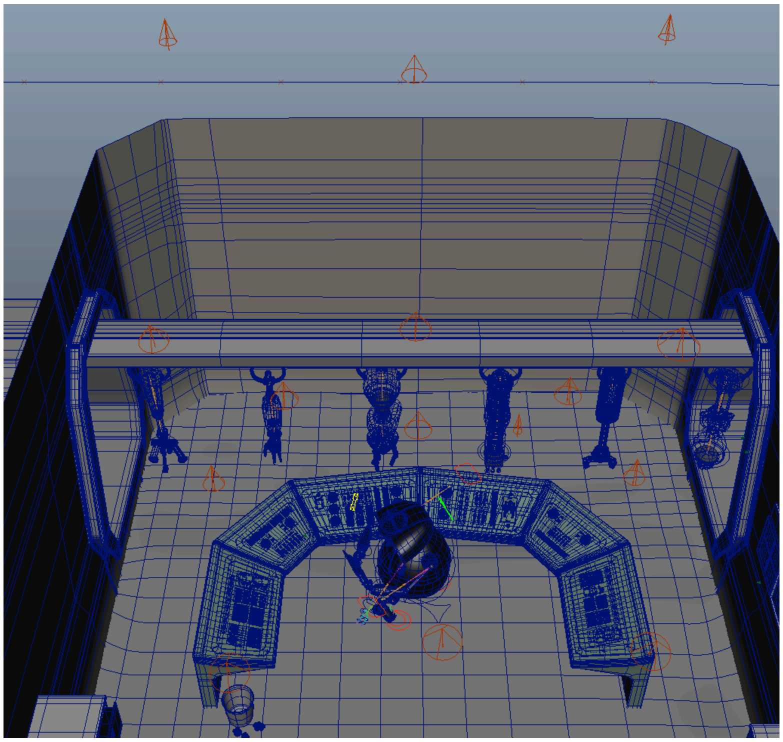

Figure 3.6 Initial light plot for Shot 02

Figure 3.7 Initial render using light plot for Shot 02

This initial light plot was replicated for the other shots, and altered based on the needs of the shots. For example, all of the shots were created with the basic light plot shown in Figure 3.6. Figures 3.8 through 3.10 display images of initial lighting for Shots 01, 03, and 04. During review with DreamWorks Animation supervisors, the issues discussed were isolated and a new iteration of the lighting plot was implemented, as shown in Figure 3.11.

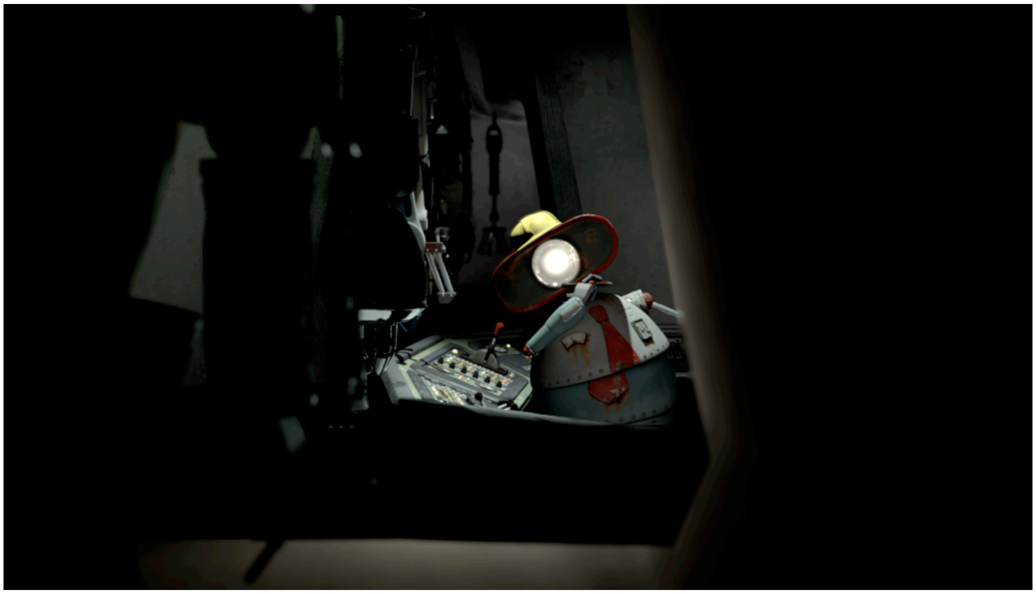

Figure 3.8 Initial render for Shot 01

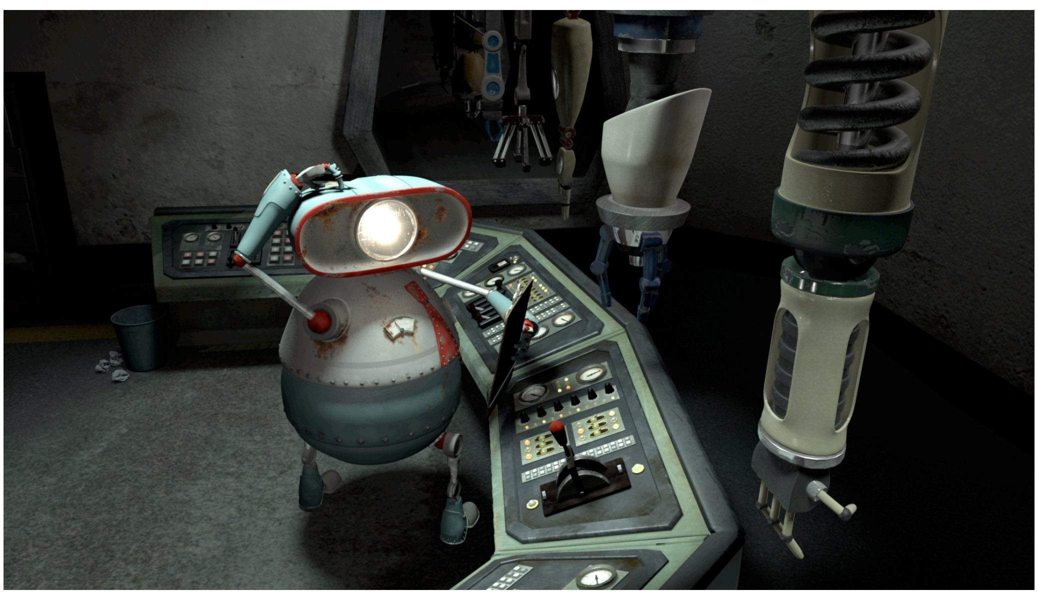

Figure 3.9 Initial render for Shot 03

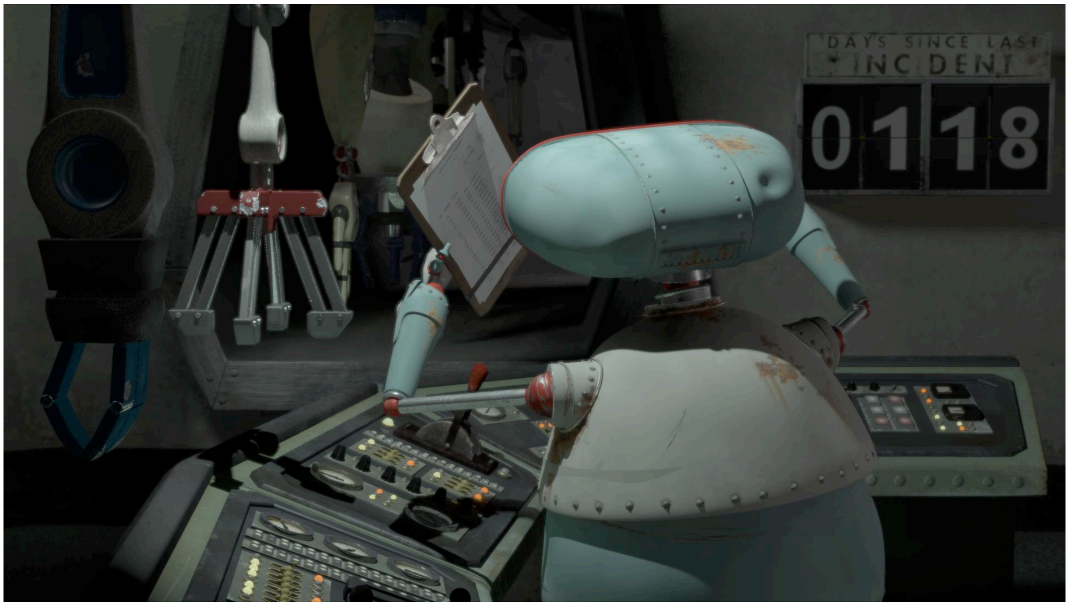

Figure 3.10 Initial render for Shot 04

Figure 3.11 Render of incremental light plot for Shot 02

In this plot, lights that once illuminated the sides of the console and lower area of the ground were greatly reduced in intensity, along with the intensities of the original three main lights, allowing the source of light above the robot's head to have the greatest intensity. This set-up created a ring of importance around the robot, and helped direct the viewer's attention toward the story elements highlighted in this short.

Since Global Illumination and Final Gather were not implemented for this project, bounce light and color bleeding were manually addressed. The need for such indirect light became apparent in lighting the lower half of the robot. Originally, this area was too dark and lacked definition because of the lack of bounce light; additional lighting was needed to produce a naturalistic rendering. To aid in lighting and art direction, Bert Poole from DreamWorks Animation, painted over a scene render to create a color script, as shown in Figure 3.12. This image provided useful guidelines for the placement of bounce and colored lights. The script indicated more directed lighting, with a high intensity on the center portion of the console, head of the robot, and central arms, while highlighting certain environmental areas of the scene.

Figure 3.12 Color script with suggestions from Bert Poole

Other shots from the short received similar updates in order to create a cohesive look for the film. The updated light plot for Shot 01, however, could not be replicated across all shots simply because each shot required specific modifications to keep the composition visually interesting, aesthetically pleasing, and properly illuminated. The process of incorporating the information gathered from this new color script in the final render for each shot is discussed in Chapter 4.

3.7 The Compositing Process

As explained previously, compositing was another large part of the production process since each render layer needed to be combined with other layers to produce the final shot. Due to the use of masks, the order in which the elements were combined was flexible; however, the elements required some standardization to facilitate their use. For example, because the background did not require masking, the renders containing the ground, walls, tunnels, and ceiling track were placed at the highest level of the Nuke tree; therefore, all of the other elements, such as the robot, arms, and console, were masked and placed on top of the background base layer. Other rendered elements were combined in their Nuke trees in similar ways, with the room as the base layer, followed by the console layer, the arms, and finally the robot. These layers included all rendered objects, but were not the only elements that were added to the Nuke trees.

To facilitate these layers, multiple-pass *exr* images were created. Each *exr* file held multiple passes, which were separated and combined with passes from the other layers of the *exr* file. This process required the implementation of techniques to provide control over each pass of the renders. Initial experiments led to the use of Shuffle nodes, but recombining those passes required additional research and work. Figure 3.13 demonstrates the initial Nuke tree that was generated.

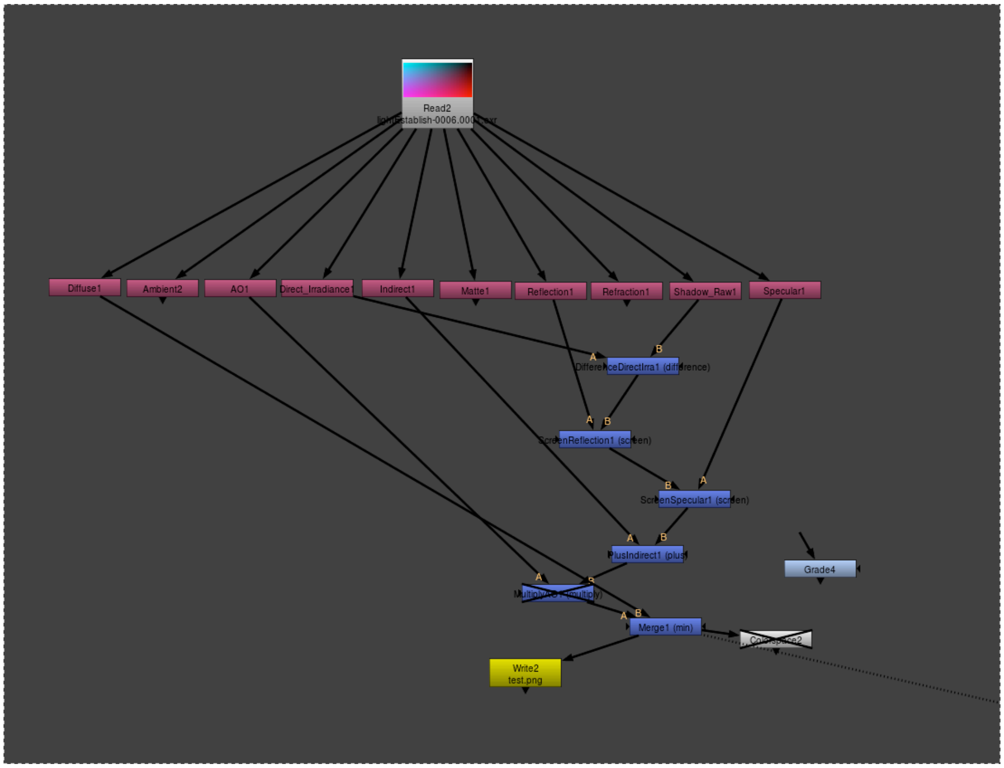

Figure 3.13 Initial attempt at combining passes

As shown in the figure, these rendering networks quickly became complex and cluttered, necessitating organization and visual management of the Nuke tree. While addressing the technical needs of combining these passes, the Nuke trees were therefore carefully ordered. This combining process facilitated simple updates that were easily identifiable.

On the more technical side of completing these networks, extensive research relied heavily on books featuring compositing, such as [LANI10] and [GANB11], along with information from the Internet. Furthermore, [GANB11] included a section that directly dealt with the topic of deconstructing and reconstructing these passes in Nuke.

This discussion provided great insight through a node-by-node breakdown of efficient ways to create this portion of the network structure. In addition to this research, one of the DreamWorks Animation supervisors, Jeff Budsberg, provided assistance during his visit, and perpetually throughout the following scheduled critiques, that led to adding a Shuffle node for each pass, which took the Read node's information and simply returned the desired pass [GANB11]. For example, in Figure 3.14, a Shuffle node is receiving the information from the Read node, but only returning information about the specular layer.

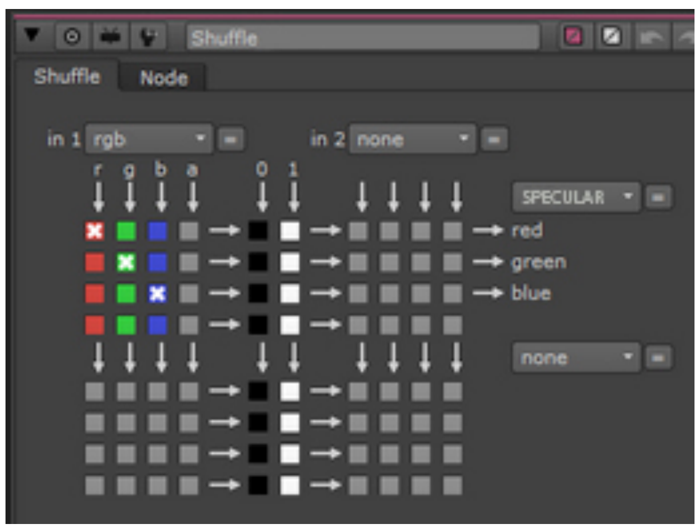

Figure 3.14 Shuffle node for specular layer

After the passes were separated, each received a color correction node for possible future use, and was then merged together with the other passes. The correct type of merge for each connection required some experimentation, but with the help of Jeff Budsberg, proper layering was determined.

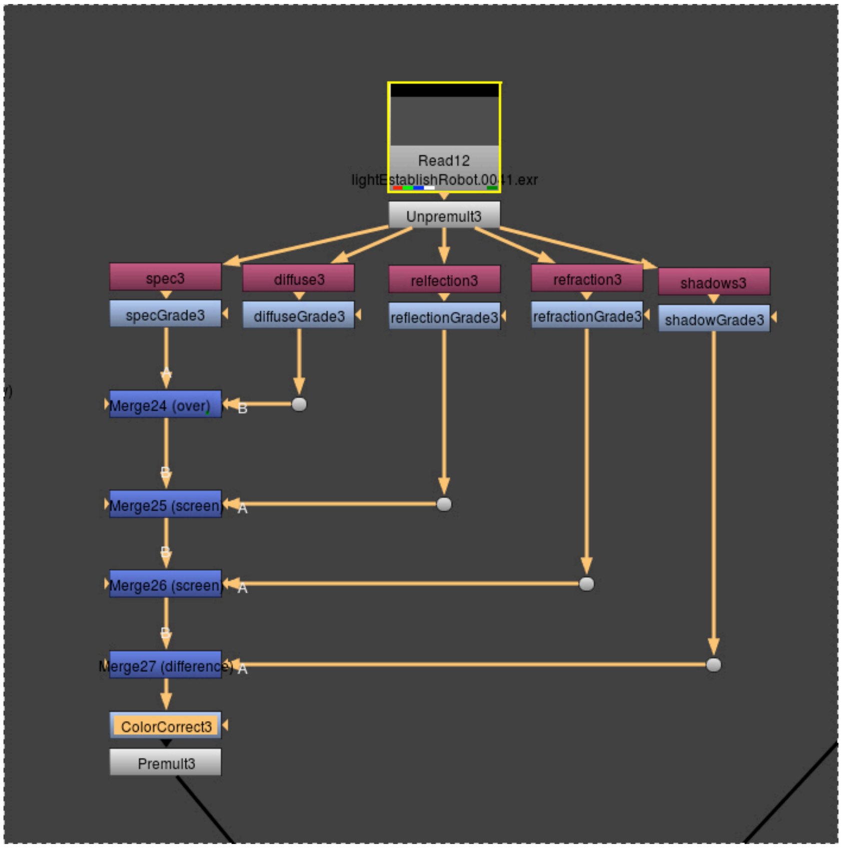

Figure 3.15 Intermediate stage of Nuke tree and network system

As shown in Figure 3.15, an "over" operation, which simply layers the foreground elements on top of the background based on the determined alpha, merged the specular over the diffuse layer. Following the integration of the diffuse and specular, the reflection pass was merged using the "screen" operation, which lightens an image based on the foreground elements. Afterward the refraction layer was merged into the tree also using a "screen" operation. Finally the shadows were merged, implementing a "difference" operation, which provides the pixel difference between the foreground and background colors. This method combined all of the desired passes, with an additional color correction node added at the base of the system to facilitate possible color modification needs.

With this new information in place and duplicated for each element created by individual render layers in the scene, more complex Nuke trees were created for each shot and combined with other layers correctly. The trees functioned properly and neatly, and were ready for more complex integrations, such as color corrections of specific elements, masking of necessary layers/elements, roto-painting, etc. These topics led to the creation of the final images, which are discussed in Chapter 4.

CHAPTER FOUR

FINAL RESULTS

Since each scene in the production retained its own challenges, light plots could not be simply duplicated. Due to similarities across shots, however, similar light plot set-ups and compositing strategies could be employed. These strategies resulted in high-quality final images, which are included in this chapter.

4.1 Final Lighting Plots

As previously explained, the new color scripts and regular critiques with the DreamWorks personnel, especially lighting supervisor Bert Poole, resulted in updates and refinements while maintaining consistency throughout the film. The main elements of lighting were conserved, such as a strong central key light which illuminated the robot, arms, lever, and console, along with rim and fill lights on selected scene elements. Additionally, dimmer colored lights on the walls of the room were added, along with sources to emanate light from the tunnels. The artistic goal behind these visual decisions was to create environmental lighting such that all elements, including the traveling assembly line of arms, were either illuminated over a dark background or darkened over a bright background. This concept remained a central focus while refining light placement and light contributions, and was highly emphasized and integrated into each scene. As shown in the light plots in Figures 4.1 through 4.4, each scene required specific alterations in order to create interesting compositions, prohibiting a simple copy of the lighting scheme across shots. Due to the fact that the entire film took place in a single room, a certain degree of light consistency was immensely important to keep each shot visually connected. Figures 4.1 through 4.4 shows the final lighting plots of Shot 01 through Shot 04.

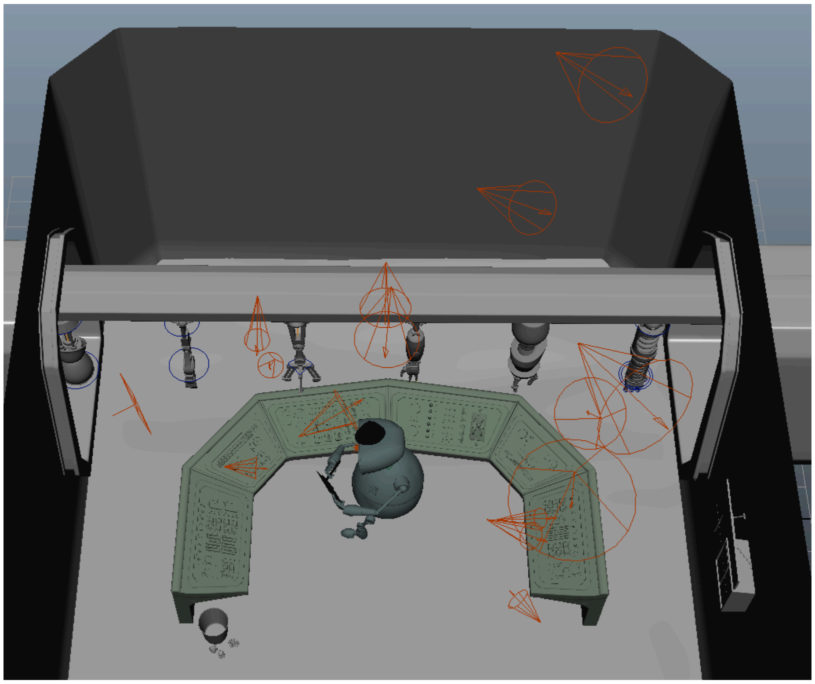

Figure 4.1 Final light plot for Shot 01

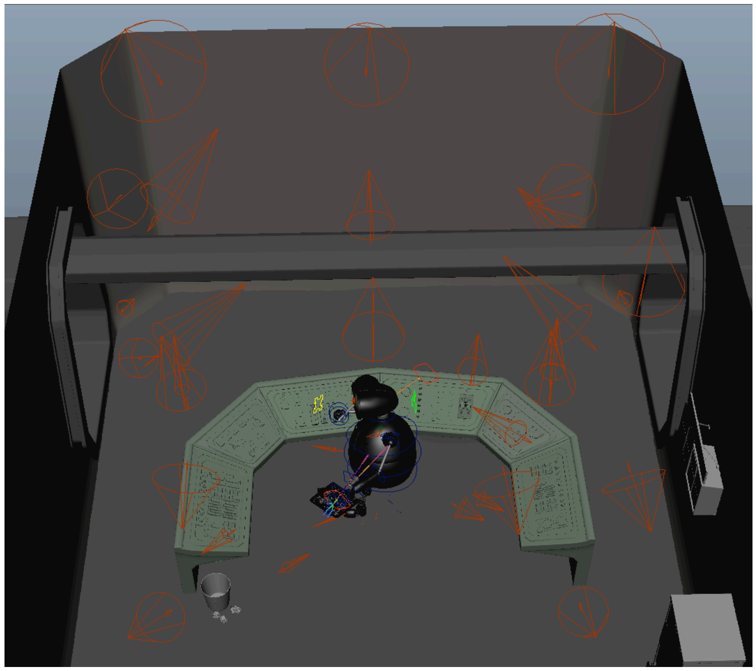

Figure 4.2 Final light plot for Shot 02

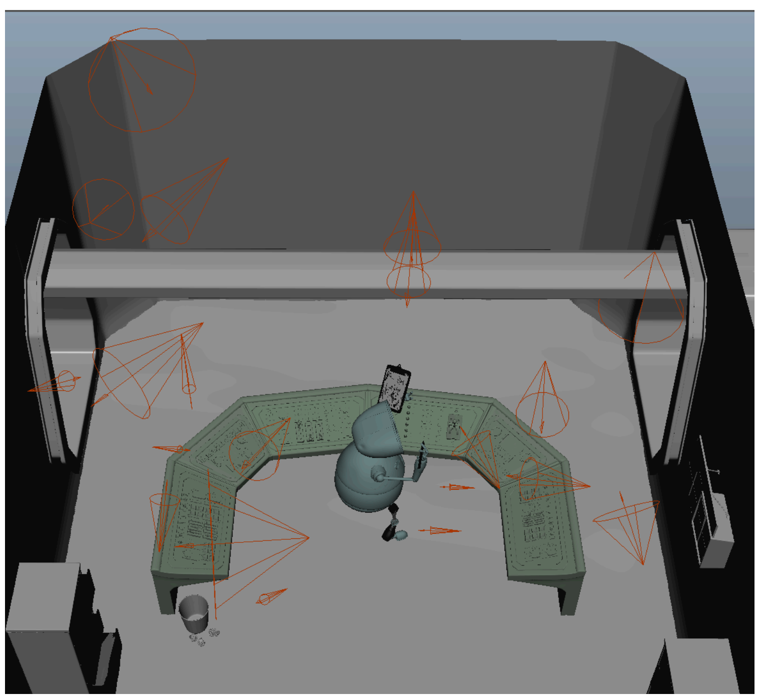

Figure 4.3 Final light plot for Shot 03

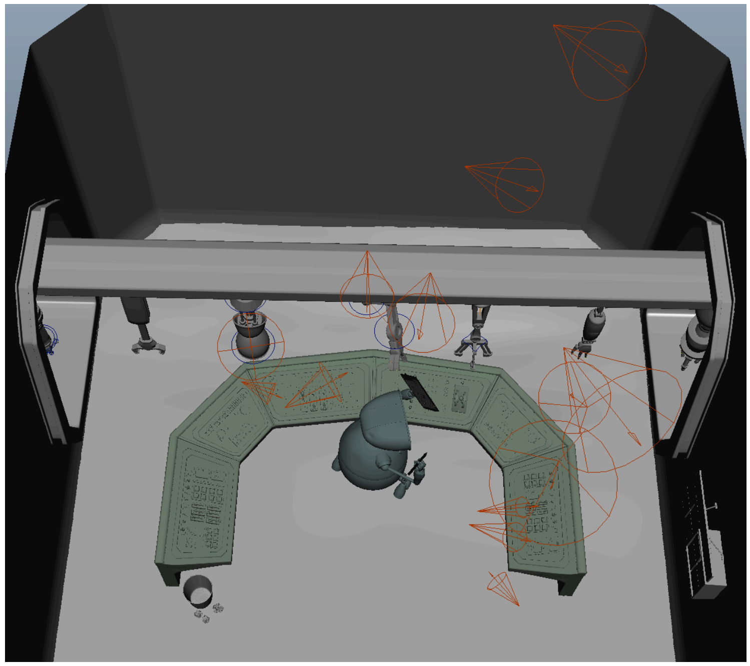

Figure 4.4 Final light plot for Shot 04

4.2 Final Nuke Trees and Compositing

At this point, several elements needed to be integrated into the Nuke tree to create the final images. In order to create the illusion of motion-blurred imaging without using Maya's expensive motion-blur features during render time, 2D Motion Vector blur in Nuke was employed. One issue with this approach, however, was that shadows were not motion-blurred since 2D Motion Vector Blur only affects objects in motion, and not necessarily their shadows. In order to circumvent this issue, the shadow passes were separated in a unique way. Due to an issue with the mia material x passes shaders, which had been employed to surface many of the metallic elements, shadows were inherited on the diffuse layer of those elements. Under normal conditions, the shadow pass could have been separated with the desired type of blur, directional or otherwise, applied to give the illusion of motion-blurred shadows. Due to the issues with inherited shadowing, however, the problem became larger, and simply separating the shadows and applying a blur was no longer an option. With extensive assistance from the pipeline technical assistant, a method was devised to use the original shadow layer as a base, with shadow information shuffled out, applied as an alpha to a black constant, blurred accordingly, and finally added back through the Nuke tree. This approach gave a slight blur to the shadows without re-rendering them with more costly procedures. Figure 4.5 shows the implementation of this process for the console in Shot 01.

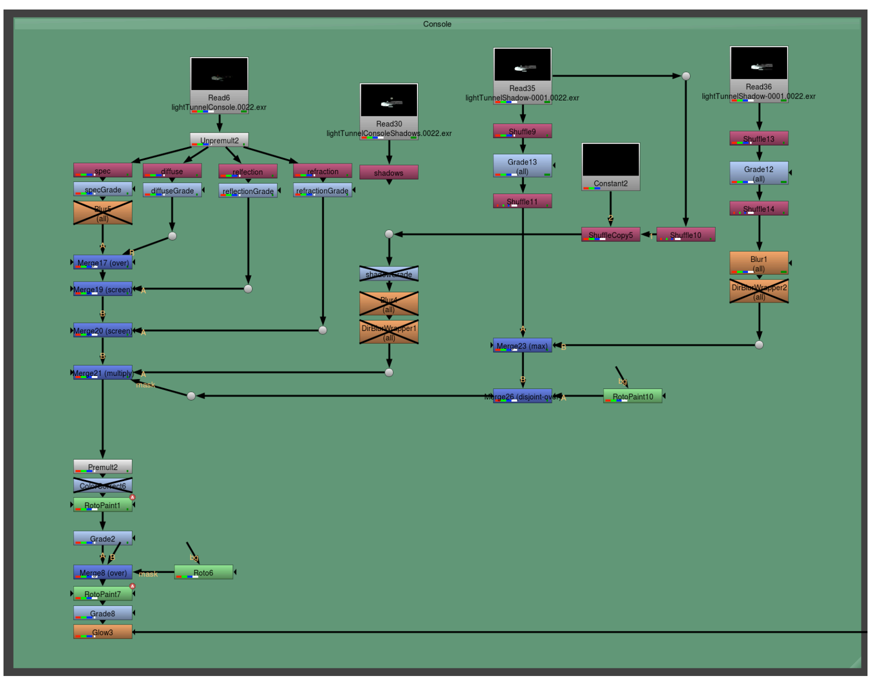

Figure 4.5 Close-up of console portion of final Nuke tree

In addition to these advanced networking techniques, color correction was necessary, along with either adding or painting out selected objects. For example, in Shot 01, the floor behind the console originally received more light than desired. As opposed to correcting the light plot in Maya, an approach which would require re-rendering and re-integration, roto-painting was employed to cover specific areas in a quick and effective way, which saved much time and effort. This process was also implemented in many other shots to handle a large number of changes in an optimized amount of time and resources. In addition to these compositing changes, the lights on the console pulsate, which required selective masking and color manipulation in compositing. Each light on the console was rendered with a mask, and in Nuke the desired lights were selected via a separate masking system. This method further narrowed the alpha information, which was then applied to a color grade node, and animated to create the illusion of pulsating lights.

At this point, some elements within the scenes continued to have rendering issues. For example, the robot's legs used a complex system of both IK and FK handles which activated depending on the needs of the animator. At render time, however, the connections became jumbled, resulting in improper placement of the legs. Although a workaround in Maya was implemented, it necessitated re-rendering. As opposed to re-rendering the entire robot, however, only the affected areas were rendered, along with the accompanying masks. These new layers were then included in the Nuke tree, replacing the old legs, which were removed in compositing. The final result was a properly lit and animated final frame.

A similar issue occurred with the headlight of the robot, which rendered with a variety of artifacts. After the causes for the artifacts were corrected in Maya, the headlight was re-rendered and re-composited into the scene. In a process similar to the corrections to the legs, the headlight required both re-rendering and a mask rendering to provide the necessary alpha. These renders allowed for proper integration into the Nuke tree to cover the old version of the headlight and replace it with the new one. Other adjustments to elements, such as the robot's pencil and chrome pieces, were also easily resolved with this use of selective masking and, when necessary, selective re-rendering. As shown in Figure 4.6, Shot 01 gives an example of the type of network created in Nuke for the robot. In addition to procedures and layers, the network also required the addition of depth of field, FX networks, and the previously mentioned 2D motion-blur, which were implemented directly after the merging of all the elements in the scene. This process continued throughout Shot 01 through Shot04 and created a clean, optimized image creation process.

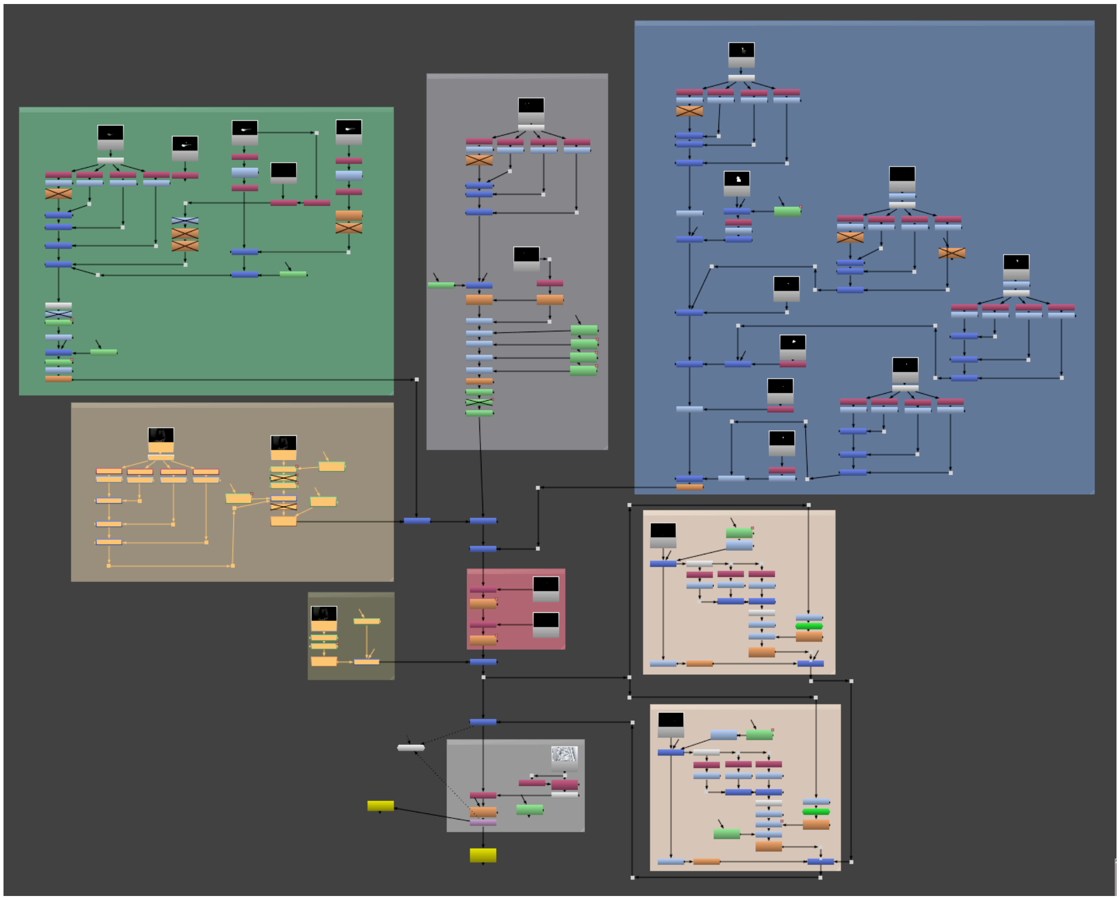

Figure 4.6 Shot 01 final Nuke tree

4.3 Final Images

Because of the high demands of this project, all aspects of the pipeline were rigorously optimized and organized. The images and resulting film were created using this combination of technical processes with creative applications of optimization, lighting, rendering, and compositing techniques previously explained. Figures 4.7 through 4.10, display the final images for each shot of the final film.

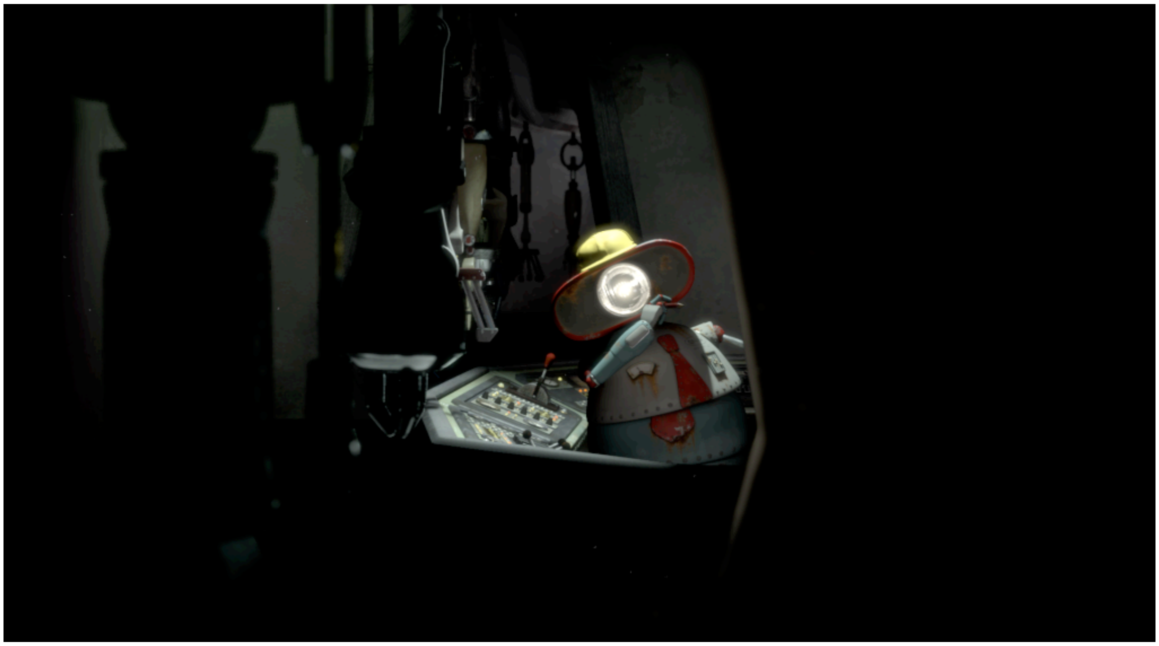

Figure 4.7 Shot 01 final image

Figure 4.8 Shot 02 final image

Figure 4.9 Shot 03 final image

Figure 4.10 Shot 04 final image

CHAPTER FIVE

FUTURE APPLICATIONS AND CONCLUSION

Due to the scope of this project, numerous techniques were employed which could be implemented for future projects. Many of the render settings, Nuke tree organizations, and rendering techniques are potentially useful and can be applied directly to future productions.

5.1 Future Applications

While creating this project, many techniques were created which would be useful in the creation of future films as well. For example, the use of optimization techniques generated here can also be applied and expanded upon for future productions. One such technique is approximate shaders, which can be set up such that their integration is automated, as opposed to manual implementation by repetitive object selection, as was used during this film. Also, approximate shaders could be combined with an environmental sphere and select objects to potentially decrease the geometry used for each render and thus eliminate the need for advanced shading networks for objects only seen in reflections. Additionally, the use of render settings, render layers and render passes could also be used to increase an image's malleability and decrease the need for re-rendering. While lighting needs will be based largely on the desired look of the film, the techniques implemented during this project could be key in the future development and creation of high-quality films. Moreover, the compositing techniques found in the generated Nuke trees can be almost directly employed in future films. For example, the network in which multiple-pass *exr* files were separated and re-combined, merging passes such as diffuse, specular, reflection, refraction, and shadows, will be useful for future films in the same way it has been constructed for this film. Similarly, the selective use of color correction via masking and roto-painting can be executed in future films to achieve a desired look, and to obtain a high level of control of various aspects of a scene with only selective rendering. Moreover, the use of masking selected objects for either compositing manipulation or replacement is another technique that can be directly used in future films to create easy workarounds for situations that could otherwise produce hefty render times and numerous man-hours.

5.2 Summary and Conclusion

In conclusion, this film was created via extensive revisions through the use of both technical and artistic applications. A photorealistic look was required, which generated many challenges in the lighting, rendering, and compositing process. Before these processes could get underway, however, render time optimization and render settings had to be addressed. These pre-rendering challenges, which took time and effort in their development and implementation, included: choosing the render system and settings, employing approximate shaders, determining the types of render passes to use, and organizing render layers.

Beyond the initial set-up stages of the lighting process, the development of efficient and aesthetic-minded light plots became imperative to the success of this film.

After lighting in Maya was completed, all of the elements required recombination in Nuke, which also generated many challenges but offered a variety of answers as well for dealing with updates in a time and resource-efficient way. The high quality of these images is greatly indebted to the assistance and direction of the DPA faculty and DreamWorks Animation supervisors, which resulted in an immersive photorealistic ambience of the final shots.

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