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Surfacing and Rendering Informed by Photorealism

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SURFACING AND RENDERING INFORMED BY PHOTOREALISM

A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Master of Fine Arts
Digital Production Arts

by
Jennifer M Thompson
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Accepted by:
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Abstract

The focus of this work is in drawing inspiration from the work of Photorealism painters in order to inform the approaches to surfacing and rendering a computer-generated still-life scene. In Photorealism painting and photoreal CG rendering, the goal of the artist is to create an image that resembles a photograph. Much of the preparation is the same, however, the 2D and 3D aspects of each style create different challenges for the artist. Using paintings from the Photorealism period as a reference, a real still-life scene was assembled and photographed for the purpose of recreating in CG. Consequently, the modeling, surfacing, lighting, rendering, and compositing stages of the CG pipeline were explored with an emphasis on surfacing and its relationship to lighting.
Acknowledgments

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Chapter 1

Introduction

Photorealistic paintings have always captivated me. The precise recreation of a photograph in a completely different medium is a skill that I admire because it demonstrates the artist’s ability to analyze hue, value, and proportion with incredible accuracy. With my primary medium being computer-generated (CG) art, I decided to create my own photorealistic painting in the form of a render. Traditional painting and computer-generated renders may seem vastly different, but there are similarities that are worth noting. Like the painter, the CG Artist must also analyze hue, value, and proportion. In painting, the artist must pay careful attention to an object’s scale in relation to other objects in the scene, although as a 2-D representation, the proportion is viewer-dependent. The final render in CG is also 2D and viewer-dependent, however, the process of creating this 2D image begins in 3-D space, and therefore proportion is dependent on correct measurements of the object being modelled. In terms of hue and value, the painter must determine the correct color on their palette. The color that they see is an interaction between the light sources and the wavelength of color that the object reflects - this provides one final color and value, and the painter must match it. In CG, the artist takes note of the final color from a reference photo, and must determine the right combination of texture hues and lighting controls to match this final color.

Many photoreal paintings are based on photographic still-lifes. In any still-life work of art, subject matter often plays a key role and makes the image more interesting. For this reason, I began my project by reviewing Photorealism paintings from when the movement officially began in 1972.

I noticed a theme in these paintings - that of consumerism and self-indulgence. As an American I am familiar with these themes and find these paintings to be an interesting reflection
Figure 1.1: Toyota Showroom Window, Don Eddy, 1972, Acrylic on canvas.

Figure 1.2: Chanel, Audrey Flack, 1974, 60x84
of our culture. I felt particularly drawn to Ralph Goings’ paintings of food, perhaps because I can identify with the pleasure of indulging in sweets and other unhealthy food.

In terms of choosing my own subject matter, I had to keep my goals in mind. My first goal was to achieve a render that resembled a photograph, and my second goal was to texture and surface a variety of materials. This meant I needed to find a location where I could take my own photograph and reference photos and find a variety of different materials that would fit within the context of the location. Since there were diners near my house, and the objects in diners had varying material properties, I thought this would be the best location.

Once the location was decided, I went there and took HDR panorama photos of the inside and outside of the diner so that I could later use this for image-based lighting (IBL) in my CG scene. Taking two HDR panormas would give me more to work with. The interior HDR panorama would provide the exposure values and color from the interior, and the exterior HDR panorama would provide the exposure values and color from the exterior. This meant the objects in my scene would reflect the interior and exterior of the diner. In addition, I took a photo that I would use to match my CG scene to. I also took close-up photos of the different objects in the scene that I could later
use to help with texturing.

The next and longest step was re-creating the photo in CG. I began by modelling the objects in my scene in Autodesk Maya, and when that was done, I brought them into Mari for texturing. While I was texturing and surfacing, I used my HDR panorama photos for IBL so that I could get an idea of how my material properties were behaving under semi-final lighting conditions. Once I was satisfied with the surfacing, I concentrated on refining the lighting and setting up different render layers for compositing.
Chapter 2

Aesthetics of Photorealism

This work is informed by the painters of the Photorealism movement. The photorealism movement was first introduced at the Documenta 5 exhibition in Europe in 1972. ([6], page 11) The paintings at this exhibition were partly a reaction to abstract art and partly an experiment in reconstructing reality. Similar to the pop art movement, photorealism was “a turn toward reality, of copying pre-existing images, and, at least in part, the manipulation and use of photography.” ([6], page 11) However, pop artists tended to use photographs as a starting point and would then change the color scheme, alter the perceived depth of the image, or manipulate it in other ways. The goal of Photorealist painters on the other hand, was to use a photograph as a starting point as well as an end goal. They wanted to recreate the image to the best of their ability with the intention of creating their own visual reality. In other words, “by reproducing the image of a photograph on canvas, the Photorealists were indirectly questioning the claim of this type of image to be a faithful, immediate, and objective reproduction of reality.” ([6], page 11) My interpretation of this statement is that if the individual with subjective views can recreate an image taken by an objective camera, then it is perhaps possible for a handmade work of art to convey reality better than a photograph. Or, perhaps capturing a moment in time can never portray reality because reality is constantly changing as time progresses. The artists at the Documenta 5 exhibition comprised the first generation of photorealism painters and were mostly American. Their paintings “depicted consumer goods or seemingly inconsequential scenes of everyday life, reflecting cliches of American culture.” ([6], page 9) The second movement of painters were not as interested in reconstructing the idea of reality, but were more keen on making their paintings even more detailed and convincing. The third generation
is comprised of today’s Photorealists, who use state-of-the-art digital cameras to help make their work even more photoreal. In each movement of Photorealism, the process remains more or less the same, and can be divided into five steps: observing, seeing, photographing, selecting, and painting. The observing stage begins with identifying the countless photographic images we see everyday and contemplating their ability to communicate and convey reality. The seeing stage involves being aware of rather forgettable moments in everyday life. The photographing stage involves taking photos of the scene. In the early days, the Photorealists photographed their work “with analog 35mm cameras, [and] today with high-resolution digital cameras.” ([6], page 12) The selecting stage involves selecting the source material, and taking many photographs from which they can reference in the painting stage. “They do this either by selecting details from among the many photographs they have already taken, or by combining several pictures together to compose a single image, which provides a uniform depth of field across the foreground, middleground, and background, and which is now generally done by computer.” ([6], page 12) The painting stage involves transferring the image to a canvas with the use of a grid system or a projector. Most artists spend months layering oil or acrylic paint in glazes in order to achieve their desired result.

I am inspired by many Photorealism painters, but I had to narrow my focus to painters with still-life work for the purpose of this project. Don Eddy is “one of the earliest, most prolific, and best known of the original group of thirteen Photorealists.” ([8], page 91) Much of his early work includes still-lifes of cars. One of my favorite car-paintings of his is “Toyota Showroom Window.” (Figure 1.1) As I mentioned earlier, the Photorealist’s were interested in creating their “own visual reality,” and this painting is a prime example of that. Eddy’s painting looks very close to a photograph - the detailed car and the reflections in the window are very convincing - however, there is something about it that disguishes it from a photograph. I am not sure what the original photograph looked like, but I imagine that his painting is more appealing than the photograph. The teal color of the floor at the bottom of the painting does not seem like a typical floor color, so perhaps he enhanced the palette to harmonize better than the photograph. Perhaps this painting describes the feeling of looking at this brand new car from a shop window in a way that a photograph cannot. Audrey Flack is another Photorealism painter whom I admire. She calls attention to herself as the only female Photorealism painter at the beginning of the movement by including feminine subject matter in her paintings. In her artist statement, she explains, “Cool, unemotional and banal were the terms used to describe the movement. My work, however, was humanist, emotional and filled with referential
symbolic imagery." ([1]) Her painting “Chanel,” (figure 1.2) includes a perfume bottle, makeup, a necklace, and nailpolish - all of which are very feminine objects. Similar to Don Eddy’s “Toyota Showroom Window,” the reflections in this painting are superb, but not quite convincing enough to be a photograph. Although I can tell she worked from a rather blurry photograph. Ralph Goings pushes the hyperreal quality of Photorealism to new heights. He “reminds us of the simple, nostalgic pleasures of the American diner.” ([8], page 131) His painting, “Donut,” (figure 1.3) inspired me to choose a diner scene for my project.

I chose a diner scene because it is a distinctly American type of restaurant, with American food and decor. It represents Americans’ obsession with food that favors speed and cost over health. In terms of process, there are a few similarities in how the third movement of photorealism painters approach a painting and how a 3D artist approaches surfacing and lighting. The similarities include the use of digital cameras to take reference photos. For both the painter and the 3D artist, it is essential to have photo reference of the lighting information. It is important to know which direction the light is coming from, how many light sources there are, the color and intensity of the lights, and how the lights interact with the different objects in the scene. For the 3D Artist, taking close-up, high resolution photos of the objects in the scene will help with texturing. The selecting stage of Photorealism painting is an important stage for the 3D Artist, as well. Much like the painter, the 3D Artist must identify where to take the photographs, which objects to include, and how to arrange the composition. In addition, the painting stage of the Photorealism movement takes many months, and is painstaking work with great attention to small detail. Creating a CG still life from scratch also takes months. Aside from creating the models, the texturing, lighting, and compositing stages require much trial and error.
Chapter 3

Physically Based Rendering

The goal of physically-based renderers (PBR) is to depict accurately the way in which light behaves. “They use principles of physics to model the interaction of light and matter.” ([9]) In order for us to understand fully the science behind light, we must begin by studying light rays. Light is reflected in different ways depending on the material. Specular reflection is light that has been reflected at the surface, and it follows the Law of Reflection, which states that on a perfectly planar surface, the Angle of Incidence is equal to the Angle of Reflection (Figure 3.1). ([7], page 2) However, surfaces that are not perfectly smooth will cause the Angle of Reflection to differ from the Angle of Incidence. ([7], page 2) The degree of surface irregularity, or roughness, affects the appearance of the reflection. As mentioned earlier, the light intensity will remain constant but spread will vary. Smoother surfaces give the perception of a brighter highlight because the rays are reflected less randomly than rougher surfaces, where reflections appear broader and dimmer (Figure 3.2). Diffuse reflection is light that is passed from one medium to another, scatters inside that medium, and then refracts (Figure 3.3) out of the medium slightly apart from the incident point and in a different direction. (Figure 3.4). The degree of roughness and the angle of incidence do not affect diffuse reflection as much as specular reflection because of the scattering of the light ray inside the material. Materials that are very diffuse, or rough, tend to be fairly absorbent. If refracted light travels for too long inside the material, it could be absorbed completely.

The color that we see is a combination of the wavelengths of the light source, the wavelengths that are absorbed by the object, and the wavelengths that are reflected via surface interaction (Figure 3.5). Physically-based renderers (PBRs) apply the same principles of energy conservation and the
Figure 3.1: Law of Reflection.[7]

Figure 3.2: Roughness.[7]
Figure 3.3: Refraction. [2]

Figure 3.4: Path of a Light Ray. [7]
Fresnel effect. Energy conservation states that the total amount of light reflected by a surface is less than the total amount it received. The Fresnel Effect states that the amount of light you see reflected from a surface depends on the viewing angle at which you perceive it. ([7], page 7) When light hits a surface perpendicularly (0 degree angle), a percentage of that light is reflected back as specular. Using the Index of Refraction (IOR) for a surface, you can derive the amount that is reflected back and this is referred to as F0 (Fresnel 0), because it gives the percentage of specular light that is reflected back when the light ray hits at a 0 degree angle. (Figure 3.6) When viewing a smooth surface like water from a grazing angle (more parallel to the surface), and if the angle of incidence is 90 degrees, the surface will be almost 100 percent reflective. If viewing the surface from the angle of incidence, the surface will be much less reflective.

In the Sebastian Lagarde equation (Figure 3.7), the reflectivity of a surface is determined by its index of refraction (IOR). The F0 range for most common dielectrics (wood, rubber) will be from 0.02 - 0.05 and for conductors (metals) the F0 range will be 0.5-1.0. The F0 value of the material is an important factor when creating texture maps. Dielectrics will usually have a grayscale value for the specular color map, and conductors will have an RGB value. In most metal materials, refracted light is absorbed, and the color tint comes from the reflected light. Therefore, we don’t give metals a diffuse color map. Instead, we set it to pure black, or 0. Another important thing to keep in mind when surfacing metal objects is its ability to rust. Rust is not a conductor, and should be considered a dielectric material. The texture maps should adhere to the dielectric and conductor...
rules mentioned earlier.

True physically based shaders apply the principles of energy conservation and the Fresnel Effect automatically, while others allow for more user control at the expense of physical correctness. Arnold’s aiStandard shaders are physically based when the artist controls for it. For example, the weight and color of material components should never exceed 1 in order to be energy-conserving. If the user sets the weight or color higher than 1, then the results will not be physically plausible. Arnold also allows the user to apply the Fresnel Effect with a checkbox. In order to maintain physical correctness, the Fresnel effect should be turned on in diffuse, specular, and refraction. 

Since Solid Angles Arnold Renderer is the renderer of choice for this project, its functions will be discussed specifically. Arnold is a physically-based renderer, so it follows the principles of other PBRs as mentioned previously. Its standard material, aiStandard, can mimic a wide variety of surfaces with astounding realism. The Subsurface scattering component of the aiStandard material is used to describe materials where light rays can scatter relatively far under the surface giving a very soft appearance. Good examples of materials that include subsurface scattering are skin, grapes, and other fleshy organic materials. In the aiStandard material, a single light ray can only participate in one of the diffuse, subsurface scattering and backlighting components. As mentioned earlier, in
order for light interaction to be physically correct, it cannot have more exitant radiance than incident radiance. For aiStandard, the sum of diffuse, subsurface scattering and backlighting weights should not exceed 1. As mentioned before briefly, refraction is the changing direction of a light ray as it passes from one material to another, depending on that materials index of refraction. Refraction is most noticeable when light passes from air to glass or water. A good example of refraction is the way a spoon appears to bend when you place it in a glass of water. Another important thing to remember about refraction is that if the interior of the surface is transparent, such as for clear glass, then light rays can pass through the object and exit on the other side. For mixing diffuse, specular reflection and refraction components in a physically plausible way, it’s best to use Fresnel. Their color weights can be anywhere in the range from 0 to 1, and the shader will mix them in a way that’s energy conserving. ([4]) Linear space in computer graphics provides a way to calculate light as it behaves in the real world. These computations are corrected to sRGB space at final output as a means to display these renders on a screen. For this reason, any color texture maps that are created in sRGB space will need to be identified as such so that the renderer will know to convert the values stored in these maps to linear when doing calculations (Figure 3.8).
Figure 3.8: Linear Workflow. [3]
Chapter 4

Preparing the Scene

4.1 Setting Up A Composition

One of the most important things you can do when starting a still life project is to set up a good composition. A composition that follows the rule of thirds is a good place to start. The rule of thirds is “merely a 3x3 grid that suggest layout placement in order to create visually interesting asymmetrical designs.” ([5] page 72) The key is asymmetry versus symmetry - as long as you have balance in each, then you have a good composition. Choosing a mood or story to convey is also important. Since this project was inspired by the photorealist painter, Ralph Goings still lifes, the intention was to recreate the feeling that you are in the scene, looking down at your meal. In his paintings, the horizon line is relatively high, meaning that the viewer is looking down. Therefore, when photographing this image, I made sure that my horizon line was high, as well. The photo in Figure 4.1 does not follow the rule of thirds exactly. The coffee mug is close to the upper left intersection, and the spoon is close enough to the lower left intersection, but the donut and sugar-holder do not meet at an intersecting point. Of course, having the four objects at the four points would look set-up, which is not the feeling he was going for. I think the intention was to capture a moment in time, with the objects placed with the idea that they were not placed carefully. I think Goings did a good job at accomplishing a balanced composition, as well as the feeling of a random moment in time.

I tried to create a similar composition in my photograph (Figure 4.2), however, it was harder to follow the rule of thirds because I had more objects in my scene. The syrup jar is close enough
to the upper-right intersecting point, but none of the other objects meet at an intersection. Like Goings painting, I chose to have the objects centered. I could have raised my horizon line further in order to make the composition more interesting, but I still think I created a similar mood to Ralph Goings painting, which is what I wanted.

4.2 Shooting an HDR Panorama

Before photographing the scene, it is important to plan. It is important to consider these things: 1) What time of day do you want to convey? 2) Will there be a lot of people at this location? 3) Will I be allowed to photograph at this location? 4) How long will it take to photograph everything, and will the lighting change much? 5) Do you want to take an HDR Panorama? In this project, the time of day that I wished to convey was simply daytime – I did not have a specific time in mind. The plan was also to use image-based lighting (IBL) for my CG scene, and since the location was a diner, I was worried that people would get in the way of my HDR panorama shots. For this reason, I chose to arrive at an in-between hour of 4pm. In terms of the lighting changing, I was a little worried because there were some clouds in the sky, but I chose to proceed anyways. I arrived at 4pm, and since it was early Fall at the time, I didn't need to worry about it getting darker for a while. However, I did not realize how long it would take to take two HDR panorama
images (one inside the diner and one outside the diner). I do not think the change in lighting in my photographs was very noticeable, but if I were to photograph everything all over again, I would do it at a time when the lighting doesn’t change much - perhaps around 12pm. HDR panoramas are often used for image-based-lighting (IBL) in 3D art and film because it provides a good starting point to achieve realistic lighting, especially if you are trying to match a live-action scene in CG for compositing purposes. My notes for shooting the HDR panorama are in Figures 4.3-4.6.

4.3 3D Modeling

The modeling of the simpler objects was mainly done in Maya, with the exception of the syrup jar, coffee mug, and condiments caddy, which were completed by Philip Hatfield in Blender. The waffle and sunny-side-up egg required more work. I thought I could speed the process along by modeling one quarter of the waffle, and duplicating, and rotating the other 3 pieces into place. When I first started modeling the waffle, I thought I could get a good base in Maya, and then start sculpting the details in ZBrush. However, it was hard for me to get the perfect squares within a circle, so I decided to use the alpha to mesh feature in ZBrush. I made a black and white alpha by painting over my reference image in Photoshop and used this to make a mesh in ZBrush. With a little bit of smoothing, and after pulling out the edges, it started to look like a waffle (Figure 4.9).

However, the model was very lumpy, too high-poly, and the topology was terrible (as most
Figure 4.3: Shooting an HDR Panorama, Step 1.

Figure 4.4: Shooting an HDR Panorama, Step 2.
Figure 4.5: Shooting an HDR Panorama, Step 3.

Figure 4.6: Shooting an HDR Panorama, Step 4.
Figure 4.7: Inside HDR Panorama.

Figure 4.8: Outside HDR Panorama.
non-UVd, sculpted ZBrush meshes are). This could be easily fixed in Topogun, so I exported my waffle obj file from ZBrush, and imported it into Topogun. In Topogun, I was able to re-topologize my model, and draw clean, even squares in order to get rid of the lumpiness (Figure 4.10).

After this was done, I exported the new, low-poly obj from Topogun, and imported it into Maya to do the UVs. When the UVs were laid out, I exported this obj from Maya, and imported it into ZBrush (Figure 4.11).

I duplicated this mesh in ZBrush, mirrored and rotated it in order to make one half of the waffle. However, there are several bites taken out of the waffle. Pretty much the only way to get these bites in ZBrush is to use the clip curve brush. Unfortunately, this brush destroys your mesh, and so I had to dynamesh in order to fix the broken geometry. Even worse, dynameshing gets rid of your UVs, and so I had to go back to Topogun, and re-topologize all over again (Figure 4.12). I also had to re-topologize the third quarter of the waffle, which also had a unique bite taken out of it.

For the fourth quarter of the waffle, I used the first quarter I had done in Topogun, and mirrored the mesh. Since I retopologized the three parts of the waffle separately, the squares looked slightly different in each one. Looking back, it probably would have been easier to get a clean, low-poly mesh with perfect squares in Maya, and modeled the bites in Maya, as well. But in the end, I was satisfied with my low-poly results. When all three meshes were UVd, I brought them
Figure 4.10: Modelling the Waffle, Step 2.

Figure 4.11: Modelling the Waffle, Step 3.
back into ZBrush, divided up, and started sculpting the details, until I was satisfied (Figure 4.13).

For the egg model, I took a similar approach to that of the waffle. I started by making a low-poly model in Maya, laying out the UVs, exporting an obj, and bringing that into ZBrush to sculpt the details. The egg is divided into three separate meshes (Figure 4.14).
Figure 4.13: Modelling the Waffle, Step 5.

Figure 4.14: Egg Model in ZBrush.
Chapter 5

Surfacing

5.1 Surfacing the Waffle

In addition to being the most challenging models, the egg and waffle also proved to be the most challenging objects to surface. For painting the texture maps, I used The Foundry’s 3D paint software package called Mari. The renderer I used was Arnold for Maya 2014 by Solid Angle. The diffuse map for the waffle was easier to create than I expected. The waffle being fairly flat meant that I did not have to worry as much about painting out shadows.

I used the paint-through tool to paint my photo reference directly on top of the model. Since I did a fairly good job matching my model to the reference (Figure 5.1), things lined up pretty well, although I did have to use the clone-stamp tool in some areas. I also had to paint out highlights that were mainly found in the syrup parts of the image. For this task, I also used the clone-stamp tool. The biggest challenge of surfacing the waffle was creating the soggy look on the areas where the syrup soaked into the bread. I forgot to take reference photos of the cut parts of the waffle, so I had to re-create the soggy look and feel in more creative ways. The color of the scattered light changes in the soggy areas because it passes through a watery material, causing it to refract at a different angle than the scattered light rays that do not come into contact with the water material i.e. syrup. Therefore, changing the color of the soggy areas in my subsurface scattering (SSS) color map helped create this effect (Figure 5.3).

The amount of SSS was also crucial to differentiating the dry areas from the soggy areas. Because of the waffle’s shape, in addition to the direction of the light sources, the SSS radius amount
Figure 5.1: Photo of Waffle from Photo Shoot.

Figure 5.2: Waffle Diffuse Map in Mari.
did change the amount of scattering. The only method to change the amount of scattering then, was to create a SSS weight map (Figure 5.4).

The lighter areas in the map call for a greater SSS contribution, and the darker areas call for less SSS. As you can see, I added more SSS where the syrup was concentrated, but also along the sides, where the tears in the waffle material were more affected by SSS. In order to account for energy conservation, Arnold requires that when specular fresnel is turned on, the combined values of diffuse weight and SSS weight are less than or equal to 1. In order to account for this energy conservation in my maps, I did the following: for the SSS weight map, I applied a solid grayscale color of .8 to the entire waffle in the bottom layer. In a new layer, I applied a solid grayscale color of .2. I masked out the area in this layer where I wanted the lighter color to show. For each layer, I used a mask to vary the color values. In the diffuse weight map, I applied a solid grayscale color of .2 to the entire waffle. In the second layer, I applied a solid grayscale color of .8. I copied the masks from the SSS weight map, and applied them to the SSS diffuse map. In that way, the grayscale values in each area added up to 1.

Although I modeled the syrup separately from the waffle, I only modeled the cubes sepa-
Figure 5.4: Waffle SSS Weight Map in Mari.

Figure 5.5: Waffle Diffuse Weight Map in Mari.
rately. I applied a separate shader to these cubes. However, there are still very thin layers of syrup on the waffle that I did not model, and therefore, I needed to create a specular roughness map (Figure 5.6) in order to make these areas appear shinier than the areas that did not have syrup.

The dark areas have a roughness value of .2, which means the surface is very smooth, and therefore produces sharp specular highlights. The lighter areas have a roughness value of .8, which means the surface is very rough, and produces a broad specular highlight. Because the specularity is not as visible on the dry parts of the waffle, I decided to also use a specular weight map (Figure 5.7).

The lighter areas call for the specular highlight to be brighter, and the darker areas call for the specular highlights to be less bright.

## 5.2 Surfacing the Egg

The egg had similar challenges, but I did not have to worry about achieving a dry vs. wet look. I spent more time painting out highlights and shadows than I did for the waffle.

The most problematic part of applying the texture map to the egg was painting out the
Figure 5.7: Waffle Specular Weight Map in Mari.

Figure 5.8: Photo of Eggs from Photo Shoot.
Figure 5.9: Egg Diffuse Map in Mari.

Figure 5.10: Egg Diffuse Weight Map in Mari.
Figure 5.11: Egg SSS Color Map in Mari.

 highlights and shadows from my reference photo (Figure 5.9). However, I managed to do this by color-correcting and painting in Photoshop. I then brought the image into Mari to project onto the model. I got rid of most of the yellow, oily parts because I modeled those separately, and applied a separate oily shader to them.

SSS was essential to achieving a realistic egg - especially on the yolks. Because my diffuse map (Figure 5.10) was so white, and because the SSS contribution on the white part was only 50 per cent, I made the white part in my SSS map (Figure 5.12) extra yellow. From looking at reference photos, I noticed that the SSS color of egg yolks tends to be orange, so I used a hue adjustment layer to change the yellow yolks to a more orange-yellow color.

In the SSS weight map (Figure 5.13), I painted the values so that the edges of the yolk would receive more SSS than the top of the yolk. This would mimic real-world SSS characteristics of light rays penetrating at different depths depending on the thickness of the object. In order to comply with energy conservation, I used the same techniques in my egg diffuse weight map (Figure 5.11) as I did in my waffle diffuse weight map.
The majority of the surface detail came from the displacement map (Figure 5.14) generated from my high subdivision model in ZBrush, however, I also created a bump map (Figure 5.15) in Mari to give the surface a more realistic bump texture. I did this by layering and masking perlin noise, and squiggle noise.
Figure 5.13: Egg SSS Displacement Map Exported From ZBrush.

Figure 5.14: Egg Bump Map in Mari.
Figure 5.15: Egg Specular Roughness Map in Mari.

Figure 5.16: Egg Specular Weight Map in Mari.
Chapter 6

Lighting

Lighting was a very important aspect of this project. Matching the lighting was vital to matching the final render to the photograph.

The AiSkyDome light that Arnold provides is an easy and excellent way to match CG lighting to a real-world location. It ensures that the same range of intensity and color will be available in your scene. The inside panorama contributed the most to my scene since my reference photo was shot indoors. I was pleased with the reflections that showed up on the objects in my scene, particularly on the syrup jar. However, I also rendered a separate pass of the outside panorama in order to enhance the sunlight coming through the windows. The main problem with the inside panorama was that it wasn’t contributing the amount of green light on the right side of the table as is present in the photograph. This green light was coming from a green piece of paper in the upper-right window. To fix this problem, I created a Maya directional light, which mimics sunlight, and set it to green at a 60 degree angle. I also created another white-blue directional light in order to get more of sunlight on the left side of the table.

After iterating for a long time on the lighting and surfacing, there were still certain issues that I could not fix in the master layer. For instance, the green light on the table was not noticeable enough. However, when I increased the contribution of this light, other objects in my scene would get too green, such as the egg. In order to fix these issues, I decided to break up my scene into different render layers. The render layers are as follows: 1) The walls and the seat, 2) the table, 3) the salt and pepper, ketchup, caddy, napkin tin, sugar container, and syrup jar, 4) the coffee mug and spoon, 5) the plates, 6) the egg, 7) two out of 3 sections of the waffle, 8) one out of three
Figure 6.1: Inside HDR Panorama attached to AiSkyDome in Maya.
Figure 6.2: Outside HDR Panorama attached to AiSkyDome in Maya.

Figure 6.3: Directional Lights in Maya Scene.
sections of the waffle. I used each layer for all 4 lights, making 32 layers total to use for compositing the final image (Figure 5.4).

Although I was able to fix the issues I mentioned, I felt like the lighting now looked less natural. I decided to try rendering out the master layer for each light separately, and then layer them on top of each other (Figure 5.5). I think the lighting in this render looks more natural, and the image overall looks better.
Figure 6.5: Final Render Version 2.

Figure 6.6: Reference Photo.
Conclusions

It is easy to look back at a project and see what you could have done differently. If I were to start all over again, the first thing I would do would be to assemble a team to help at the photoshoot. I was slightly overwhelmed when I went by myself because I had too many things to do, and the light was changing. If I had a few more people, I would have assigned one person to take the outdoor HDR panorama while I did the indoor panorama. I would also have someone take measurements of the objects while I took close-up photographs for texturing. This would decrease the amount of time it would take to take all of the photographs, and I would have more time to focus on getting a better composition, and making sure I did not forget anything.

I think it would have been easier to achieve a photoreal render if I had fewer objects in my scene. In that way, I could spend more time on fewer objects, instead of trying to balance too many objects. It also would have been helpful to measure all of the objects on the same day that I took the photographs – this would have helped me match the camera. I realize now that it would have been helpful to have more modellers help me with this project. I thought that most of the objects in the scene would be easy to model, so I didn’t spend as much time on them or pay careful attention to the details in each. This hindered the photoreal quality of my final render.

That being said, there are many things that worked well. The HDR panorama photographs were a success, and they matched the lighting in the reference photo fairly well. I am especially pleased with the way the syrup jar reflects the objects in the interior HDR panorama. The reference photos that I took for texturing purposes also worked well, particularly for the waffle.

I would like to focus for a moment on one of the core goals of the Photorealism movement -
the notion that a handmade work of art can portray reality better than a photograph. When painting from a photograph or from life, the artist must interpret color and value, and the subjective nature of the human mind will have a different interpretation than a camera. Just like the Photorealism painter’s strove to create their own visual reality through their own interpretation of a photograph, I also interpreted color and value to create my own reality. In doing so, my final render looked very similar to my reference photo, but not exactly the same. In fact, many of the Photorealism paintings don’t look completely photoreal and the reason is the subjectivity involved in our decision-making about how to re-create an image.

Overall, I am satisfied with the results. In terms of my goal to match the reference photo, I believe I did a fairly good job, but the differences are still there. I believe I was more successful at achieving my secondary goal of surfacing a variety of objects well. Although the deadline for this project has passed, I would like to continue to make improvements to several of the objects in my scene. I would add more contrast to the seat cushion, more grunge to the plates and table, and make the metals less dark. In addition, I would like to render short sequences of camera movements in order to emphasize that my project is three-dimensional. By contrast, I would also like to print a high-resolution poster to show that my project is also a two-dimensional work of art.

This project can be applied to my future work. I have learned a lot about the process of rendering photoreal still-lifes in CG. I plan on continuing to refine my photoreal skillset in new photoreal renders with varying themes.
Bibliography


