EXPLORING FORMAL ISSUES AND
NATURALISTIC IMAGERY
IN 3D COMPUTER GRAPHICS

A Thesis

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By

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ABSTRACT

Utilizing my background as a painter, my current 3D computer graphics work focuses on 2D design issues as realized through surfacing, lighting, and composition. It also has naturalistic imagery as a central issue, and emphasizes command of 2D design concepts and observation of the natural world as a means to achieving this. Information specific to 2D design and lighting are presented both through an exploration of film and animation sources as well as the artist's own work.

While purely formal issues have been of primary concern, this visual development has culminated in a final body of work that creates an environment that acknowledges both the natural and the digital influences of its creation. The work is presented as a series of slide projected stills and video projected animated segments that are viewed as an installation in a large sound stage. Some aspects of naturalism are occasionally subverted by intentional use of artifacts associated with computer graphics in order to acknowledge the medium in which it is created and projected.
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CHAPTER 1: INTRODUCTION

Relatively speaking, computer graphics is a new discipline for academia, especially in terms of its place within traditional art departments. People are entering into it from vastly diverse backgrounds and with specialized banks of knowledge. There are also many avenues to explore in the field - from educational multimedia titles to virtual reality to scientific visualization to special effects for movies. Even within those categories there are subcategories that people can specialize in, such as programmer, character animator, interface designer, and modeler. Not everyone has a specialization, though. Many choose to be generalists and because of their skill sets can switch from the role of software developer to modeler to character animator with ease.

Due to my background and interests, I have chosen to focus on formalistic issues, specializing in the area of lighting. In 3D computer graphics this can include both lighting and determining the surface appearance of objects. Within this specialization I have worked to create naturalistic imagery. This thesis is therefore specific, directed toward those in the field of 3D computer graphics who are interested in the area of lighting and/or interested in creating more naturalistic imagery. The emphasis is not on technical terminology; however, there is an assumption of a basic familiarity with 3D computer software and 3D graphics. Rather the focus is on traditional art training, as I feel this is the strongest contribution I can make to the area, and sorely needed. A grave mistake people
often make who want to enter the field (even from an art background) is that it is primarily about learning hardware and software, and forget the fact that in the end they are making images, and the computer is just another tool. Granted, it is a complicated tool with steep learning curves, and one must invest a large amount of time and effort to gain enough technical command to realize one’s vision. But it is that vision that I am most concerned with, and the primary focus of this thesis.

To that end, I feel it is informative to provide a brief overview of my background leading to my current focus, whereas the remainder of the thesis presents information that I have found through the research that I have completed in developing my visual work, with an analysis of my work provided in that context.
CHAPTER 2: ARTIST'S BACKGROUND

2.1 Undergraduate

My interest in art began not with computer graphics, but with painting. My early work was concerned fundamentally with learning how to see and how to master the medium well enough to reproduce that which I see. While working from the source gave a starting point for gaining technical mastery of the medium, the subject matter seemed to simply provide a framework for other issues. Realistic reproduction of a particular scene was not the end goal. My thinking seemed to revolve around basically formalistic issues: creating a particular color palette, value contrast, line type, etc. This was not for design purposes (i.e. a color scheme to match something), but to make an image I felt to be aesthetically pleasing based on design issues applied therein. I would often conceive of an idea and execute variations of that idea, changing color palettes, color proportions, points of view, scale, etc. Usually I was not satisfied with a single execution of an idea, but needed to work through many variations to feel I had come as close as possible to my intended vision, or found something even better.

As I continued to work, I still followed a basic desire for whatever image I was making to be aesthetically pleasing, and continued to use the source object as the starting point for my images, but more and more wanted to convey not only a certain painterly
way of working with the medium, but also a definite mood or sense of place that those colors/contrast/value/line/form inherently communicated or personal/political expression. While complex and subtle, I wanted the form to exist not for purely aesthetic reasons, but primarily to relay content.

My sophomore year as an undergraduate I was accepted into the B.F.A. painting program at Indiana University, Bloomington. Going into the program, I had no doubt as to my desire to be a painter. As I became more immersed in the medium and the culture of “High Art,” the less I could imagine integrating it into my life. As I matured and gained knowledge about the field, I realized that while there were certainly areas of common interest, many of the things that I wanted and expected out of the field were quite different than what it could offer. I had philosophical problems with general characteristics I found (though there are undoubtedly exceptions to all): intentionally directing work toward a very small audience, relying on the very wealthy for support, the context of the gallery system, intentional separation of art from everyday life and popular culture (unless it was to reprocess it in a derogatory manner), and the trend of confined thinking processing itself in a loop within high art circles, the avant garde often just old-world thinking veiled under different packaging. I felt stifled and constrained, and I needed to reevaluate my relationship to the situation.

This intellectual/philosophical doubt was coupled with a severe and accumulative allergic reaction to the oil paint and turpentine I was working with. Even when I began use of acrylics, pastels, and mixed media, my studio was nevertheless in a poorly ventilated
building with other painters and I continued to have problems. The physical act of painting ceased to be an enjoyable experience, and I found myself working less.

After much thought, I realized that painting/High Art was not working for me due to complicated and interrelated reasons. I chose to leave the BFA painting program, and searched for things that I felt I were missing through several different routes. After a while I came to the realization that although I have a range of interests and capabilities, my strongest passion was with the visual arts, though that did not have to mean painting. With that I went back to the art department to complete a B.A. degree, and tried my hand at other mediums such as textiles and ceramics. While I left painting itself, I maintained an interest in formal issues, aesthetics, visual communication, and the idea of bringing art into life. Textiles and ceramics were both potential routes to realizing the principles I find important, but I could not quite get that click that I had enjoyed at one point with my painting, or that I found inherently exciting enough to commit major amounts of time.

I next tried Adobe Photoshop. At first I was not sure if I wanted to work with it due to my unfounded belief that the interface would be too difficult. This was coupled with my feeling that there was not a lot of work in computer graphics that was impressive or that I felt I could do within my current skill set, because everything I had seen that I liked I knew to be the result of complex mathematics and programming. After not even an hour of working through the tutorials, though, I was amazed. I realized I could work on variations on a theme with wonderful ease, changing color palettes, value contrast, etc., without having to recreate the entire composition. I could get a range of effects applied to the whole image that to create physically would take an inordinate amount of time. I could
easily work on a specific area of an image, controlling it down to the pixel. I could “undo” any accidental marks and even revert to a previously saved version should a sequence of changes take an undesired direction. Not too long after having Photoshop, I started working with Fractal Design Painter, and with the range of painterly effects, and layering options (not available in Photoshop at that point), I became increasingly immersed in 2D image manipulation as a medium.

My last semester as an undergraduate I took a multimedia design class to further explore the digital realm. It was during that semester that I first saw the multimedia game Myst, and in 3D computer graphics found a new world to explore.¹ I pursued a final project that entailed building a 3D environment with Strata Studio Pro, and realized much of what I enjoyed in 2D graphics were expanded to the nth degree in 3D. I could build models, surface them, resurface them to my heart’s content. For different points of view all I had to do was to move the camera around. There were all kinds of alterations to a scene based on lighting and effects too. One of the first models I worked with in this capacity was an architectural structure that is like a temple. I explored numerous vantage points by setting up different cameras, and color schemes through both surfacing and lighting. An example of one image created from this sequence is shown in Figure 1.
Figure 1: Variation on Temple Scene

For the next year I continued to create 3D graphics, built up a portfolio, and gained entrance to the MFA program at The Ohio State University in the Department of Art. I also worked doing graphic design, web design, freelance multimedia design, and in my free time directed my personal energy toward 3D computer graphics/animation.

2.2 Graduate

Those familiar with the realm of 3D computer animation realize that it can be conceptually broken down into three main parts: modeling, animation, and lighting. Modeling concerns the building of the 3D objects and the environments they occupy. Animation entails giving life to the objects you create, whether it be complex character animation complete with bodily gestures and facial expressions, or as simple as making a ball bounce. Lighting encompasses a range of issues - from selecting surface attributes of
the 3D objects such as color, specularity, diffuse reflectivity, bump, displacement, reflectivity, transparency, luminosity, and glow, to setting up lights in your 3D environment by selecting their type, placement, intensity, color, falloff, assignment, and shadow-casting attributes. Lighting usually also involves controlling certain environment parameters such as fog and depth of field.

During my studies through the Department of Art and the Advanced Computing Center of the Arts and Design (ACCAD), I have had the opportunity to study and try my hand at all three aspects of 3D computer animation and gain a deeper understanding of all that goes into creating such work. The importance of such a broad experience cannot be underestimated. However, as I delved deeper into my work I found that my focus kept coming back to issues that concerned me previously as a painter. While I enjoy modeling and animating, they seemed to simply be an armature for what I was most wanting to focus on: the surface attributes and the lighting, and ultimately, the fundamental aspects of design in the final 2D image such as color, value, texture, and composition.

This awareness became more acute as I began teaching my 2D Design course for undergraduates. The more I gave lectures about and discussed the formal issues of line, shape, balance, rhythm, scale, value, and color, the more I realized that these concepts concern me deeply, not as rudimentary exercises, and not separated from issues of content and narrative, but as the essential visual language capable of communicating all forms of meaning from the most didactic to the most subtle. To gain command of these issues would enable a person to establish any setting, convey any feeling, relate any concept visually that one might want to tackle. I had an intuitive understanding of this for some
time, but this experience served to structure it in my mind, and provided a more verbal/intellectual understanding.

It is one thing to approach 2D Design working in two-dimensional media such as pen and paper, collage, or paint on board. The concepts transfer directly from 2D examples to 2D work. The other thing I have come to grapple with is that while my 3D work does inevitably get transferred to the realm of 2D (either stills or animation), and therefore all 2D principles apply, the fact is that I am spending the majority of my time creating that work in virtual 3D space, and there are technical issues that must be recognized and understood to translate whatever set up I have with my 3D models, environment, and lighting to how I wish the final 2D image to appear. They are issues that move considerably beyond training I had as a painter or concepts I teach concerning 2D Design. It has prompted me to pursue the study of traditional lighting from a photographer’s standpoint, who must also contend with translating the 3D into a 2D image. I have also engaged in analyzing lighting in film and animation.

Along with 2D design issues and traditional lighting concepts, there is a perhaps obvious but necessary task of learning the tools of 3D computer graphics. There is an entire world of knowledge that is very specific to this field. While these basic concepts often carry over from package to package and therefore ease the learning curve somewhat, the tools are varied and deep, and it takes a large amount of time to familiarize oneself with the mindset of each and feel comfortable enough to reach a level of expertise to actualize one’s vision as precisely as one might wish.
I outline these aspects to not only give an indication as to the direction of this thesis, but also to provide a bit of reasoning for my personal pursuit of a certain level of naturalism in my work.

I have an awareness of continuing the line of history specific to computer graphics (CG), which has its own branch of development that currently owes as much if not more to computer science and the entertainment industry as to traditional art history. A large part of this history has been a preoccupation with ever-growing realism or naturalism, and it is still a big issue. Even in a fantastic, cartoonish, or improbable scene one may wish for certain naturalistic characteristics of modeling, animation, and/or lighting to make the scene believable. Production houses, military simulations, computer scientists, software developers, and artists are still in a hectic pursuit of the ever more naturalistic image.

Part of my pursuit of naturalistic imagery has to do with technical mastery. Not unlike when I began to paint, I personally feel that if I am to reach a level of artistic expression that I am comfortable with in 3D computer graphics, I must gain a high level of command of the tools with which I work, as well as the concepts that most concern me of traditional lighting and 2D design issues. To do this best, I work with "known" settings: primarily still lives and landscapes, to have a real-world reference to gauge the quality of my work. This is not to say that I do not employ certain aspects of stylization, exaggeration, and artistic license. While I do not strive for pure photorealism, though, I do desire to have a relatively high level of naturalism in my work.

At this point I should clarify my use of the terms "realism" and "naturalism." I have found both similar and dissimilar definitions for the two terms depending on which
source I use. I would define “naturalism” as the attempt to create something that is visually indistinguishable from what it represents in the real world, perhaps synonymous with photorealism. An example would be the seamless integration many Hollywood studios strive for in combining CG with live action. The dinosaurs in Jurassic Park should be as realistic or photorealistic as possible to be believable, especially as we are to believe their interaction with humans.\(^2\) I would define “naturalism” as utilizing characteristics from what one is familiar with in the real world and applying those characteristics to images that do not duplicate reality exactly as we know it, but creates realities that hold true enough to our human experience to be believable or feel “right.” An example would be The Lion King in the wildebeest scene.\(^3\) Close observation of herd behavior and appearance was observed in the real world and applied to the cartoon. The computer generated wildebeests were programmed with proper flocking behavior for the stampede.\(^4\) They were also given naturalistic variations in color, size, and other attributes, and even kick up clouds of dust.\(^5\) While no one would watch the show and think for a second that it is real, it is, however, naturalistic. It feels “right” according to what we are familiar with in the real world.

I realize there may be a point when I wish to work in a completely different manner than I am now, but I strongly believe that whatever vision I wish to actualize can only be done and done well after working through these issues. Even CG imagery that appears hand-drawn, painted, or like claymation, for instance, are duplicating that which we know in the real world, and must have a high level of naturalism to successfully achieve those results, though the images themselves would probably not be what one
would look at and call "naturalistic." The point to keep in mind is that every image you create in the computer is a facsimile of the real thing and it takes careful observation of the original to duplicate it in computer.

Beyond my personal technical mastery, there is an aesthetic decision to use the real world as source material. Part of my avoidance of the medium to begin with was the fact that much of what I saw coming from it consisted of shiny, plastic objects or objects covered with one bright color, etc. There was relatively little I looked at and found inspirational. While practically every month finds new work being put into the world that is more visually rich and complex, I find that the majority of those works are naturalistic on some level and are explicit in their use of the real world as reference.

There is also the issue of the fact that I spend the greater proportion of my days and nights behind a computer. I could easily become completely removed from the world that surrounds me. I do not desire that disconnection, but, similar to what Char Davies strives for in her work, (though approached in a different manner), a connection and a presence in the world.\(^6\) I feel a very good way to maintain that is to continue actively looking at all that surrounds me, using real-world sources for inspiration in the form of scans or general visual references to ground my work in the natural dirt, beauty, detail, and wonder that exists outside the domain of the computer. This should not be read as an anti-computer statement, because mathematically speaking, the computer can be used to recreate objects from the real world much more convincingly than anything that can be done by hand, and provides a different and fascinating way of obtaining those images. But,
to do this, one must first be grounded enough to observe carefully their surroundings. It is also important to be well versed in basic formal issues in visual design.
CHAPTER 3: 2D DESIGN: TEXTURE, VALUE, AND COLOR

The concepts of 2D design should be familiar to most anyone with basic artistic training, whether the field is that of graphic design, industrial design, photography, printmaking, painting, art education, or art history. The reason for reviewing such concepts are threefold. First, I have found as an instructor of 2D Design, (and well remember being one of the only individuals in my undergraduate course to get heavily into the topic), that it is a subject whose importance is sometimes missed. People might mentally sleep through it, because on the surface much of it seems obvious. There is indeed information that intuitively and intellectually makes a lot of sense. There is also the sense of "rules" being put forth, and it is a perhaps understandable reaction from creative individuals to rebel against anything that seems like a rule or restriction. Unfortunately not paying attention under the assumption that the information is simple and basic, or just rejecting it outright as prescription, tends to lead to a lack of command of the subject and an inability to utilize it within one's own work. There are a few too many who manage to come through their art programs without a deep appreciation and understanding of just how greatly these concepts influence the success, or lack thereof, of their work. Second, there are many working in the field of 3D computer graphics who have little to no formal art training. Though there are definite exceptions, there is usually only a basic understanding of visual design issues, and though they have tremendous command over
the technical aspects of the tools, the aesthetic decisions can sometimes reflect a need for
more knowledge in the area. Third, the information provided here is brief, specific, and not
meant to rewrite texts already available on the subject. It provides a basic introduction so
that when I use these concepts to discuss lighting and analysis of my own work, the reader
will have a general understanding of which I speak. It is also given in a different context
than is usually covered in 2D Design courses. The examples provided come from film,
traditional animation, and computer animation sources. This is partially to take into
account the element of time. It is also partially due to the fact that these are the examples I
have looked to more than any other in the past two years to reify my grasp of these
concepts and utilize them in my own work, as I am intending to enter this genre and want
to be more familiar with its distinct visual language and history.

The study of 2D design encompasses a range of topics, which usually include
unity, emphasis, balance, line, shape, texture, scale and proportion, rhythm and pattern,
value, and color. They are all important to understand and utilize for the success of the
final composition. However, I have found I have focused on some aspects more than
others in my own work and analysis of other work. The issues I have chosen to discuss in
this thesis are texture, value, and color. The introductory paragraphs for each topic are
based on the text I used to teach my course in 2D Design, Design Basics 4th Edition, by
David A. Lauer and Stephen Pentak. Another useful source which covers these design
issues in relation to lighting in computer graphics is Storytelling Through Lighting: A
Computer Graphics Perspective by Sharon Calahan. Should you want more detailed
information about these and other design issues, I would recommend referring to these sources.

3.1 Texture

When discussing texture in terms of 2D design, we are not referring to actual texture, but the visual representation thereof. Visual texture stimulates a person's sense of touch. It is created by variations in the surface appearance.

Texture can be used to identify an object. Let's say you are looking at an image of a sphere in black and white. You do not have color to help indicate identity. It is on an infinite plane with nothing to give a sense of scale or proportion, either. In everyday life there are a variety of familiar objects that are spherical in nature. How do you tell if the image is of an orange, a tennis ball, a racket ball, or a golf ball? Texture would be your only indication. The tennis ball might be the easiest, as it would be the only one with surface fuzz broken with that familiar line of plain rubber. A racket ball can be distinguished by what could be perceived as nearly a lack of texture. It is very smooth with the tiniest surface variations that help disperse the light and make it matte. How would you tell if it is a golf ball or an orange? Both have surface indentations that are circular in nature. However, the orange's indentations would be irregular and organic in appearance, whereas the golf ball would have exact, regular indentations. While our minds would reason through this in a fraction of a second if faced with such a situation, as a creator of images in 3D computer graphics, it must be thought about in detail to convey the intended visual information to make sure objects are identified as we wish them to be. Along these lines, visual texture can be employed to give a greater sense of naturalism to an image.
Even if the color and scale of an orange were correct, if the texture was too regular or somehow "off," it could destroy the identity of the object.

Texture is also used to convey narrative. Calahan discusses the importance of texture in this capacity as such: "textures in the image can trigger a sensory reaction. The surface quality of objects can help define the mood of the scene, where soft, fuzzy objects summon a warmer memory than do smooth, polished objects."\(^9\)

Along those lines, texture can also be used to convey a sense of character. An example from the film Star Wars would be to compare the texture associated with Obi Wan Kenobi to that of Darth Vader.\(^10\) Kenobi is seen in a soft, flowing robe that has a strong, earthy, knobby sense of texture. It has frayed edges. The man himself has hair, a beard, and wrinkles. There is a lot of organic texture to him. In stark contrast, Vader is wholly untouchable. He is primarily made of hard shiny metal and plastic. Even his flowing cape has no perceivable texture which lends it a flat, slick, untouchable feeling. The textures alone communicate a great amount about how we should feel about these characters on an unconscious level.

This can be played against as well, as with the case of R2D2 and C3PO. Both are relatively hard metal robots. What they lack in organic texture is made up for with their "animation" and characterization. However, even though the material they're made out of is not organic, for a good part of the movie they do have scuffs, dings, dirt, and different organic traces of inhabiting the same messy existence that we do. This additional texture does make them more comfortable and approachable than the highly polished Vader.
3.2 Value

The term value refers to levels of light and dark. The perception of value is relative to its surroundings. When comparing the relative areas of light and dark, one often uses the term value contrast. High-value contrast is when there are strong differences in the areas of light and dark. Low-value contrast is when there is very little differentiation between the areas of light and dark. Value can be used not only to increase a sense of naturalism, it can also be used to convey content. It is up to the artist to decide where and why to use certain values and value contrasts in their composition.

Value can be used to convey a sense of space. In general, given a field of a certain value, the greater the value contrast of an object from that field, the more it will seem to protrude in space. Likewise, the closer in value it is, the more it will seem to recede into that space. In computer graphics this effect can be easily achieved by use of a fog parameter available in most 3D packages. You can specify the fog color and value or set it to be the same as the background. As objects get further away from the camera, the more their color and value gets blended with the fog parameters, and thus the further away they seem. I used this technique in a snow scene, shown in Figure 2.
Figure 2: Use of Value to Convey a Sense of Space

Value is often used to impart a certain feeling to a composition. Usually compositions that reflect low-value contrast give a calm, relaxed feeling. Those with high-value contrast, in comparison, usually give more of a sense of drama, excitement, or unrest. The overall sense of lightness and darkness also influence the mood of a scene. As in our everyday lives, light is a signifier of life, sun, happiness, warmth, and that which we relate to as “good.” Darkness in turn can feel cold, lifeless, and even scary.

A computer animated film that has a nice example of using both overall value and value contrast to convey emotion is *Toy Story.* The movie opens in Andy’s room, which is an overall light scene, and one which also has low-value contrast. There are no dark shadows anywhere. It is a bright, friendly place that feels happy and secure. Later in the movie we get introduced to Sid’s room. We first see it at night, and it is overall very dark
and scary. Even during the day, though, unlike Andy’s room, there is high-value contrast with dark shadows and it lends the environment an agitated, uncomfortable air.\textsuperscript{12}

### 3.3 Color

Perhaps the first thing to clarify when discussing color is which color system you are using as reference. There are two color systems: additive and subtractive. The additive color system is based on radiant or direct light, and the subtractive system is based on pigments or reflected light. My painting background primarily trained me in the subtractive system. There are different color theories within the subtractive system, each of which has their own version of the color wheel and differing definitions of which colors are primaries, which are complementary, and so on. The color theory I use is based on the most commonly known 12-step color wheel where red, yellow, and blue are considered primary; orange, green, and purple are secondary; and compliments consist of the pairings of green and red, yellow and purple, and orange and blue. When all primaries are mixed it creates a dark neutral close to black. The additive color system is used in the creation of computer graphics, and it has significant differences from the subtractive system when it comes to mixing colors and creating the final color you want. The additive primaries are red, green, and blue. The complementary pairs are: red and cyan, blue and yellow, green and magenta. When all primaries are mixed, they produce white. When looking at images and discussing their use of color for purposes related to giving a sense of place or narrative, however, there are basic similarities between the two systems.

Color can be utilized in a variety of manners. Local color can relate the identity of an object, as the color we intellectually know it to be (grass is green, sky is blue). Optical
color can be used to represent reality as we see it under given lighting conditions. This is the most naturalistic use of color. Heightened color can be used to give a certain sense of exaggeration to seen or known color. Color can also be used in other ways, to serve as emotional signifiers, holders of symbolic content or certain intellectual concepts, and so on. When the color choice is subjective like this, it is sometimes referred to as arbitrary color. Of course local, optical, and arbitrary color can all be chosen by an artist to serve certain functions in a composition. Complementary colors when placed together create an effect called simultaneous contrast, and it makes more colors appear brighter and more intense. Depending on the context, this can be used to make the image seem more exciting, even agitated. Cool colors on the color wheel (yellow-green to purple) tend to feel tranquil and cool, warm colors (yellow to red-violet) feel more sunny, active, and excited. More than one of these concepts can be used in tandem for the desired final effect, or a time-based piece may switch from one mode to another. The other thing to keep in mind, especially when analyzing color for content, is that color must always be understood in context.

The first film I will discuss concerning color was directed by Ridley Scott. Legend is a fairy tale relating the basic concept of the balance between good and evil in the world. Scott pays infinite attention to detail in the scenery and environment, to where they become actively involved with the narrative, to the point of almost being main characters themselves, and therefore one could pick just about any aspect of most of his films and pluck something useful concerning color and communication of narrative. In Legend there is a scene very near the beginning of the film, inside the dark castle. It opens
with a high contrast black and orange color scheme, showing individuals being tortured next to hot and raging fires. When we first see the character, “Darkness,” he is very blue in hue. While his form would seem to indicate that he should be red (he looks very similar to the mythological Satan), and for the rest of the film his local color indeed proves to be a dark red hue, Scott chose to introduce him in as much visual contrast with his surroundings as possible. To do so he chose a strong blue as opposite to the surrounding orange fires. It creates a nice simultaneous contrast, and an intense focus on Darkness as an important character, as opposed to other surrounding characters who in warm neutral tones visually blend in more with the background. This main character speaks to one of his minions, planning a way for darkness to rule the world. It is an intense monologue, and the color scheme supports it. At the end of his discussion, the camera raises above the head of the gremlin, and closes in on the orange light in the background. The light consumes the scene, and the camera pulls out to show that same light as the sun above a beautiful green field with trees and flowers, with petals gently floating in the wind. A princess in a flowing white dress lilts through the landscape, and in this context, the orange light provides life, beauty, and warmth to the scene. I find this to be a wonderful acknowledgment of the symbolic function of color depending on the context and events surrounding it (color is relative), and at the same time communicating with color the intended concept that there is a similarity and interdependency between that which we consider good and evil.

*Lord of the Rings* is a very interesting visual piece that makes varied and creative use of color throughout.¹⁵ One sequence I am fond of in particular takes place in an old wooden lodging at night. The Hobbits and their traveling companions have found out that
the evil characters who pursue them plan to attack at dark. They place their pillows under their bed sheets to serve as decoys and wait elsewhere as the creatures attack. The scene begins with an establishing shot of the street outside at night: wet pavement, blue lighting. We then enter the room through the window, with color use being optical, representing very close to what one would expect to see under cool, low nighttime lighting conditions. The creatures materialize in the room, and as the first one brings down its scythe to attack, the wooden scaffolding and plaster walls of the room are dramatically replaced with intense strokes of orange, red and yellow. During the whole attack scene the background color is used not to represent the actual environment, but instead to give support to the emotion and violence of the scene.

*The Lion King* also makes use of arbitrary color, for different emotional effect. For a good portion of the animation, local and optical color are utilized. The lion cubs are tan, the sky is light blue, the clouds are white, etc. This establishes a certain sense of naturalism, albeit as represented in a cartoon. This color usage shifts dramatically just as the scene changes into the musical number “I Just Can’t Wait to Be King.” The sky becomes yellow, the ground pink, trees purple and orange. Color is used to completely to give a sense of fun and liveliness, and to serve to separate the musical number from the rest of the film.

*Babe* is a movie that, while filmed as live action, is presented more like a fairy tale. Besides the talking animals, the main way in which the fairy-tale feeling is communicated is through use of color. Once we get past the dark and intense scene inside the pig factory, the rest of the film takes place in a joyful and deeply saturated color.
palette. The grass is greener, the sky is bluer, the barn redder than what one would realistically expect to see in everyday life, yet not exaggerated to the point of jarring our sensibilities. It provides the film a visual context that is playful and similar to what we remember from childhood storybooks.

Color has been a very important aspect of my work. Even when I have the basic models and compositions worked out, I will work through many color schemes to get the final look I want. In terms of creating naturalistic imagery, I have tended toward very subdued colors and overall low color contrast, almost to the point of being monochromatic. Though there is a plethora of examples of bright and high-contrast color schemes found in nature, I am in general more attracted to the more delicate. Also, there are a substantial number of CG works that lean to the radically bright and garish color schemes which feel very contrived and unnatural, and I consciously want not to add to that line of work.

An example of the previous concepts of texture, value, and color applied in my work is a scene that uses objects not based on namable items in everyday life to nevertheless create a believable and dramatic scene due its use of texture, value, color (See Figure 3). It shows a furry sphere in the foreground and a spiky object in the background. The furball has a soft fuzzy texture, it has a medium to light value, partially because of the color assigned to it, and partially due to being brightly lit. The spiky object in contrast has a cold, smooth, shiny texture, and is dark in value. The color assigned to it is indeed a dark gray, but it is also shown in silhouette that emphasizes its darkness. All of these attributes together work to make the furball feel like a friendly character, and the
spiky object one which is unfriendly. In terms of feeling naturalistic, the fur is assigned a range of colors to give it natural variation and has a warm light falling on it from one side which corresponds to what we associate with incandescent interior lighting, and we can read it as if it is stepping out from an interior setting into the dark night with a single light and dark character looming in front of it. The green light from outside feels eerie, and adds a sense of narrative, but is not too unlike cold exterior lighting.

Figure 3: Application of Design Concepts
CHAPTER 4: LIGHTING

4.1 Introduction to Lighting

There are multiple objectives when lighting a scene as well as issues specific to lighting in 3D computer graphics, both of which this chapter will address. As 2D design issues such as texture, value, and color are directly determined by lighting, it is important to understand lighting in relation to the previous chapter.

The first and most obvious concern is lighting to see the scene. Without a light source everything would be black, and consequently, you would not be able to see anything. Unfortunately, simply making objects illuminated is often the end goal for many people when lighting in CG, and it tends to happen almost as an afterthought after the bulk of the time is invested in modeling, surfacing and animating. As a result the work is not revealed to its fullest effect. The impact and power of lighting can and should be used to actualize design intentions.

When I first concerned myself with lighting, I began by looking at photography books, as well as what I could get my hands on about cinematography. Sources I referred to frequently were both Matters of Light & Depth\textsuperscript{18} and Photographing in the Studio\textsuperscript{19}, as well as a range of periodicals in the field. Terms I would consistently come across for a basic lighting set-up were “key,” “fill,” and “back.” The naming scheme makes sense in relation to their functions. The key light is the main source of light, the fill helps lighten
the shadows by "filling" them with light, and the back light (not always necessary) is placed at the back of the subject to separate it from the background (See Figure 4).

Though there are numerous ways to approach lighting a subject, the use of key and fill made sense to me as I was starting out, and this became my standard lighting arrangement.

![Image](image_url)

**Figure 4: Use of key and fill**

In "Lighting for Computer Graphics," John Kahrs provides a good discussion of this basic lighting set up. He acknowledges that while this can become a canned, predictable approach if not honed for the particular scene one is lighting, more often than not it is a very effective method to start (and end) with, and discusses it at length specifically in relation to 3D computer graphics.
4.2 Lighting to reveal nature of the object

When lighting, you can determine what aspects of the object you wish to reveal. Do you want to emphasize the surface/texture, the shape, the scale/volume, or full information about the object? You will place the lights differently for each objective, or use a combination, depending on the end goal.

To show just the shape of the object, you can show it in silhouette by not having any light falling on it from the front or sides, but by 1., having the background illuminated or 2. Using a back or rim light. This will provide information about the shape only. In Figure 5, the main information provided about the object is the sense of it being round, along with a suggestion of the material along the edge of the object, which in this case is fur.

Figure 5: Rim Light
To emphasize texture, it helps to have light at a glancing angle, grazing over the surface. Sometimes this can be used in conjunction with a rim light to catch detail such as fur or hair. In Figure 6, both a side light at a glancing angle and a rim light are used to show the fur texture to its full extent.

![Figure 6: Lighting for Texture](image.png)
To give emphasis to the scale or volume of an object, it's good to put light at a severe angle to give a broad area of transition from light to shadow. Often light from above and slightly behind can be used for this purpose, as in Figure 7.

Figure 7: Lighting for Volume
There may be times that you want to provide as much visual information about the subject as possible, not leaving anything in shadow. What photographers traditionally refer to as "butterfly lighting" works well for this. The set up for this is two lights in front and either side of the object being illuminated, coming in at 45 degree angles, one to the right and one to the left. This is illustrated in Figure 8.

Figure 8: Lighting for Information

Of course there are quite a number of variables here and it takes a lot of experimentation on your own to get the right combination of lighting effects. If you have a scene with a number of objects with vastly different surface properties, you’ll want to light the scene on a per-object basis. It is therefore extremely important to have the ability to assign lights in whatever software package you are using. Also, even in a simple 3-light set up, but especially when your lighting situation gets more complicated, it can sometimes be hard to tell which light is causing what effect. It can help to isolate lights by testing them.
one at a time, or turning them off one at a time. Of course the final look is dependent on how all the lights together affect the scene, so you have to remain aware of how the lights act together.

4.3 Lighting for a sense of place/time

It may seem that the objects themselves hold enough information to give a sense of place (i.e. if there is a desk, computer, printer, stapler, pens and pencils, the scene is probably in an office). While objects do provide basic information for where one is, lighting can support or counter the information the objects provide. For instance, it might be odd if you had a single directional light source casting hard shadows in the office: while the objects communicate an interior scene in which one would see incandescent and/or fluorescent lights, the lighting would read more like outdoor sunlight.

Also, lighting gives a sense of time that the objects and their surfaces alone can’t provide. Nighttime light is usually thought of as being generally blue in hue, high noon light is almost white, and sunset is warmer oranges.

One scene I worked with in terms of using lighting to change its sense of time is that of mushrooms on the forest floor. I worked with the same models, camera angle, etc., but simply changed the lighting color scheme (as well as the angle of rotation on the light projection map used to simulate leaf shadows) to give the feeling of different times of the day. The nighttime scene has low color saturation, and leans toward the monochromatic, as everything is bathed in a stylized blue light to indicate evening. The daytime scene, however, is very warm (See Figure 9). The light has a bit of a yellow cast to it, and there
is more value contrast between the light and the shadows. Though it is day, the overall scene is nevertheless intentionally rather dark to give the feeling of being on the forest floor under a dense cover of leaves. The colors of the various objects are considerably more saturated and one can see more detail of the surfaces. Through the distinct use of the warm and cool color palettes, as well as the different color saturation levels and levels of value contrast, the comparison between day and night is convincingly depicted.

Figure 9: Mushrooms on Forest Floor - Day

4.4 Lighting for narrative/emotion

This is linked to lighting for a sense of place and time, but takes lighting even further, with more artistic license. This is where you might decide to light a scene brightly with low value contrast (high-key lighting) to make it a calm, peaceful scene to support a happy moment in the narrative. You might decide for a scary scene to have very little light, except in a specific area, and with higher-contrast.
CHAPTER 5: CONCLUSION

Much of my work for the past two years has consisted of stills, conceived outside of what might be considered traditional narrative. For the most part the scenes were created so that elements such as texture, value, and color are worked to give a naturalistic feel, and usually to connote a particular sense of time and place. It has been my intent that at some point my work would utilize formal issues specifically to visually support or convey a given concept or narrative. I feel I have obtained this with my thesis exhibition in a way that integrates much of my work with brand new work by method of presentation.

Because the bulk of the work I have completed in graduate school has not only been naturalistic, but of organic/landscape imagery, there has been discussion at critiques and graduate seminars as to my intent of creating such believable representations of nature. Much of what I hear is a question of both context and content, and the interrelation between the two.

When considering context, my primary issues have been scale and viewing environment. For scale, though I feel my images work well on a small, intimate level in that they bring the viewer into a quiet exploration of the detail within, I have longed to view them on a much larger scale. I have chosen to spend my time increasing the quality of my images versus exploring display options, but conceptually I liked the idea of
eventually seeing them on large flat display panels with very slow animation, such as
movement of clouds or slight changes of light. I could see them getting away from the
context of viewing computer graphics as fast, slick, and effects intensive, but images more
quiet and subtle, yet large enough to command a presence. I also liked the idea of
employing aspects of CG that has advantages over painting (radiant light, internal change
over time). Thoughts of it being displayed in a manner that surrounds the viewer as virtual
reality or some other similar fashion were also explored, which is large scale in terms of
being completely immersive.

For the viewing environment, I dislike the idea of having my images viewed in a
gallery context. I want an integration, with life and art not viewed as separate entities. I
think the gallery context can prevent this way of interacting with and relating to visual
work. I am not sure I want people feeling like they have to analyze everything, but to
enjoy the experience, be surrounded by it, perhaps not even consciously aware of it, but
have it serve as something in the background to everything else. Possible viewing
environments I have discussed with people have been within the home, public spaces such
as airports, libraries, or offices.

Because of the content of my images, several people expressed concern with my
preferred methods of display. The concerns dealt primarily with the displacement of
nature. Would images be projected so realistically that people would not be concerned
with actual interaction with nature or whether nature itself is destroyed? I think the
concern largely comes from a general fear of the expanding computer technology that has
come fast and furious into nearly everyone’s life. I personally view the brunt of this as
being reactionary feelings hyped by media. Most people reasonably familiar with the state of CG display know that it is nowhere near being a replacement for the real thing, and even imaging the best possible development, it is almost inconceivable to picture it being able to replace every nuance of the actual experience. There's nothing like real experience, and people will always be able to tell the difference.

As to my naturalistic CG images, it is not my intention to try to replace nature, anymore than it has been for landscape painters throughout history. Landscape is simply an inspiration. In the end I actually do want the viewer to be aware that they are looking at a creation, a 3D computer graphic image, and not wonder at it for being a photorealistic reproduction (when I get this response, I know I have failed somewhere) but for it being an interesting image. Specifically, know it is a CG image. I chose this medium for a huge range of reasons. I love it and enjoy it, and while I want to explore its possibilities and push its capabilities, I do not want to hide it as the means of image construction. I think one way to achieve this is by making the viewer aware of the medium and force the issue of the method of creation and presentation.

The way I have chosen to approach these issues is through an installation for my thesis exhibition. I actively worked to have it outside of the gallery context, and so searched for a space that would not be a gallery or be read in that manner. I wanted the space to relate to the images. I also needed a space that would allow large scale projection, as well as control over lighting so high quality projection could be achieved. The Haskett Hall sound stage met these requirements quite well.
The communication of the method of creation of the images is provided both by incorporation of my landscape images into more mechanistic imagery, as well as the methods of projection itself. I wanted to bring very direct attention to the fact that the images are projected, not in a streamlined, ergonomic manner where the mechanics are hidden, but bring the mechanics to the outside. I built a monitor in 3D in which to project a range of my landscape images which employs all the aspects of naturalism developed thus far (See Figure 10). This visual image is an acknowledgment of the mediation of nature, or nature viewed through mechanistic means. It is further enhanced by the fact that the images are not simply projected by the monitor, but occasionally flicker and reveal scan lines that further bring attention to the concept of their origin. Of course the next question might well be is this not another image that could be read as actual versus projected or created? I address this by embedding some of the same visual artifacts people associate with video projected and computer generated images, though at less frequent intervals for subtlety and diversity.
Figure 10: Monitor Displaying Processed Landscape Image

I also have a projection of an animation of branches and stars twinkling, but now within what could be read as a metallic window frame. But it also has occasional artifacts placed during post-processing to show that it, too, is a creation and not an actual window.

There is also no attempt to hide the projection devices, but rather, they become a part of the installation space. Also included in the installation space are actual TV monitors that also display other images, and slide projectors that fill the space with stills. There is no question of their projected nature.

There may be a question of how immersive this approach is. But, the equipment is working in tandem with the imagery to create the exact immersive experience I am hoping for. This is in conjunction with the pipes, concrete, and other artifacts that are native to Hasket sound stage that integrate well with the projected images and projection.
equipment itself. The lighting and formal aspects of the installation space support that of the CG images.
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