

**PIXEL NOIR: A STYLE FOR CINEMATIC  
COMPUTER-GENERATED LIGHTING**

A Thesis

by

LEI HAN

Submitted to the Office of Graduate Studies of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of  
MASTER OF SCIENCE

December 2004

Major Subject: Visualization Sciences

**PIXEL NOIR: A STYLE FOR CINEMATIC  
COMPUTER-GENERATED LIGHTING**

A Thesis

by

LEI HAN

Submitted to Texas A&M University  
in partial fulfillment of the requirements  
for the degree of

MASTER OF SCIENCE

Approved as to style and content by:

---

Carol LaFayette  
(Chair of Committee)

---

Ergun Akleman  
(Member)

---

Derya Güven Akleman  
(Member)

---

Phillip Tabb  
(Head of Department)

December 2004

Major Subject: Visualization Sciences

## ABSTRACT

Pixel Noir: A Style for Cinematic Computer-Generated Lighting. (December 2004)

Lei Han, B.E., Southern Yangtze University, China

Chair of Advisory Committee: Prof. Carol LaFayette

This thesis provides an example of creating a special cinematic style of Film Noir in computer-generated animation. The thesis is designed as a discussion of how a unique lighting style in computer graphics can be used to enhance visual storytelling for cinematic purposes. It provides digital filmmakers a beginning guide to deal with various lighting situations, and with cinematic lighting in 3D production.

To my family and friends

## ACKNOWLEDGMENTS

I would like to express my sincere thanks to my thesis committee chair, Prof. Carol LaFayette, for sharing her excellent knowledge on film and for encouraging me to finish this tough project. I would also like to thank my committee members, Dr. Ergun Akleman and Dr. Derya Güven Akleman, for providing their help and encouragement throughout this process.

My gratitude goes also to Dr. Donald H. House and all of the faculty and staff of the Viz Lab, who have provided answers to my questions and have enhanced my learning experience. I also thank Zhang Xiao for providing me valuable advice on computer graphics. Thanks also go to all the friends that I have made during my time in the Viz Lab, for sharing their ideas about art and technique and for all of their help and enthusiasm. Finally, I would like to thank my parents, Han Shouben and Wang Shulan, and my wife Yu Tieying for their unconditional support and love through the years.

## TABLE OF CONTENTS

CHAPTER		Page
I	INTRODUCTION . . . . .	1
	I.1. Motivation . . . . .	1
	I.2. Introduction . . . . .	1
	I.2.1. Film Noir . . . . .	1
	I.2.2. Lighting Control in Digital Cinematography . . . . .	5
II	RELATED WORK . . . . .	6
	II.1. Digital Lighting . . . . .	6
	II.2. Related Works: Noir in Animation . . . . .	7
	II.2.1. Traditional Animation . . . . .	7
	II.2.2. 3D Animation . . . . .	7
III	METHODOLOGY . . . . .	10
	III.1. Lighting . . . . .	10
	III.1.1. Style of Lighting in Film Noir: Low-Key Lighting . . . . .	10
	III.1.2. Computer Graphics Lighting . . . . .	13
	III.1.2.1. Shape . . . . .	13
	III.1.2.2. Shadowing . . . . .	14
	III.1.2.3. Texture . . . . .	15
	III.2. 3D Noir Filmmaking: Planning and Production Design . . . . .	16
	III.2.1. From Pencil to Pixel: Storyboard . . . . .	16
	III.2.2. Maya: Modeling and Animation . . . . .	18
	III.2.3. RenderMan <sup>TM</sup> Shader Concept . . . . .	18
	III.2.4. Digital Compositing . . . . .	21
IV	IMPLEMENTATION AND RESULTS . . . . .	23
V	IN CONCLUSION . . . . .	26
VI	FUTURE IMPLICATIONS . . . . .	27
	REFERENCES . . . . .	28
	VITA . . . . .	29

## LIST OF FIGURES

FIGURE	Page
1      John Huston <i>The Maltese Falcon</i> 1941. . . . .	2
2      Otto Preminger <i>Laura</i> 1944. . . . .	3
3      Edward Dmytryk <i>Murder My Sweet</i> 1944. . . . .	4
4      Roots of Film Noir: German Expressionism. (A) Fritz Lang <i>M</i> 1931, (B) Joseph H. Lewis <i>The Big Combo</i> 1955. . . . .	4
5      Quay Brothers <i>Dramolet</i> 1988. . . . .	8
6      Sam Chen <i>The Eternal Gaze</i> 2003. . . . .	8
7      Three-Point Lighting: (A) High-Key, (B) Low-Key. . . . .	10
8      Robert Siodmak <i>The Killers</i> 1946. . . . .	11
9      Frank Tuttle <i>This Gun For Hire</i> 1942. . . . .	12
10     Edward Hopper <i>Night Shadows</i> . . . . .	16
11     Storyboard. . . . .	17
12     MAYA: Modeling and Animation. . . . .	18
13     MAYA: Modeling a Noir Street. . . . .	19
14     RenderMan <sup>TM</sup> Shader Concept. . . . .	20
15     Baking Occlusion. . . . .	22
16     Indoor Rendering Result 1. . . . .	24
17     Indoor Rendering Result 2. . . . .	24
18     Outdoor Rendering Result 1. . . . .	25
19     Outdoor Rendering Result 2. . . . .	25

# CHAPTER I

## INTRODUCTION

### I.1. Motivation

“The mood of tragedy is enhanced by a strong contrast of deep blacks and glaring whites—shadows and highlights. In drama we light for mood, we paint poems. Lighting with its ups and downs becomes a symphonic construction paralleling the dramatic sequences.” –John Alton [1]

### I.2. Introduction

“A dark street in the early morning hours, splashed with a sudden downpour. Lamps form halos in the murk. In a walk-up room, filled with the intermittent flashing of a neon sign from across the street, a man is waiting to murder or be murdered, shadow upon shadow upon shadow.” [1] The specific ambience of Film Noir is a world of darkness and violence.

#### I.2.1. *Film Noir*

It was during the summer of 1946 that French moviegoers discovered a new type of American film. Five movies showing in Paris that year were classified as Film Noir – movies that shared a strange and violent tone tinged with a unique kind of eroticism. These five movies include John Houston’s *The Maltese Falcon*(see Figure 1), Otto Preminger’s *Laura*(see Figure 2), Edward Dmytryk’s *Murder, My Sweet*(see Figure 3),

---

The journal model is *IEEE Transactions on Visualization and Computer Graphics*.



Billy Wilder's *Double Indemnity*, and Fritz Lang's *The Woman in the Window*.



Fig. 1. John Huston *The Maltese Falcon* 1941.

Film Noir, a Hollywood genre of the 1940s and 1950s, has both foreign and domestic roots: German Expressionism and French Poetic Realism; the gangster film and the hard-boiled novel.(see Figure 4) To summarize the soul of Film Noir, I would like to cite Raymond Borde and Etienne Chaumeton's insightful comments made in 1955: "...the moral ambivalence, the criminality, the complex contradictions in motives and events, all conspire to make viewers co-experience the anguish and insecurity which are the true emotion of contemporary Film Noir." [2]

Almost all critical commentators would agree that lighting style is a key element in understanding Film Noir. Besides the tough, cynical tone, Noir movies established some unique visual effects such as low-key lighting, harsh high-light, high contrast and dark shadow, greater depth of field, and antitraditional mise-en-scene.[3]



Fig. 2. Otto Preminger *Laura* 1944.



Fig. 3. Edward Dmytryk *Murder My Sweet* 1944.



(A)



(B)

Fig. 4. Roots of Film Noir: German Expressionism. (A) Fritz Lang *M* 1931, (B) Joseph H. Lewis *The Big Combo* 1955.

### *1.2.2. Lighting Control in Digital Cinematography*

Lighting control is an important and widely studied topic in digital cinematography. The primary purpose of cinematic lighting is to support the story by contributing to the overall visual structure of the film. It is not enough that the lighting design simply illuminate the scene so that the viewer can see what is happening, or makes the scene look pretty. It is the lighting designer's job to captivate the audience by emphasizing the action and enhancing the mood. As a main tool of storytelling, lighting control involves vision, planning and knowledge of key cinematic principles. In contrast to traditional film lighting, digital lighting has more flexible controls. But digital lighting also has one limitation: the time required to render each frame. The type of lighting you choose (such as a volume spot light) can make a significant impact on your render times and hence, your production schedule.

## CHAPTER II

### RELATED WORK

There are several studies in the literature that have inspired my work. First, Alton[1] extended previous research on lighting by reproducing 295 photographs and line cuts illustrating the majority of technique and light that cinematographers had used in Hollywood movies before 1950s. Alton illustrated his belief in *Painting with Light* at the end of his chapter on “Mystery Lighting”[1]:

To realize the power of light and what it can do to the mind of audience, visualize the following little scene: The room is dark. A strong streak of light sneaks in from the hall under the door. The sound of steps is heard. The shadows of two feet divide the light streak. A brief silence follows. There is suspense in the air. Who is it? What is going to happen? Is he going to ring the bell? Or just insert a key and try to come in? Another heavier shadow appears and blocks the light entirely. A dim hissing sound is heard, and as the shadow leaves, we see in the dim light a paper slip onto the carpet. The steps are heard again This time they leave. A strong light appears once more and illuminates the note on the floor. We read it as the steps fade out in the distance. “It is ten o’clock. Please turn off your radio. The Manager.”[1]

#### II.1. Digital Lighting

Lasseter [4] set up the principles of 3D computer animation incorporating lighting control as an important component of the animation process. More recently, Barzel [5] described the controls and features of a light source model for lighting computer graphics films. Basically, his model is built upon generalized light cones, emphasizing independent control over the shape and texture of light and shadow. Barzel’s model

has been successfully used to light many short works including the movie *Toy Story*. Finally, Calahan, Carson, Kahrs and Poster [6] discussed the main elements of pixel cinematography, presenting a variety of simple and complex lighting strategies. Using a hybrid approach of traditional cinematography and their knowledge about composition, color, balance, and the behavior of light and materials, these researchers offer a comprehensive approach for Noir lighting particularly useful in the field of computer graphics.

Overall, as a nascent research area in computer graphics, the topic of digital cinematography has attracted increasing attention from scholars in different disciplines. Although in some computer-generated animations Noir style lighting has been used in some shots, according to my knowledge, no efforts has been made to create an entire photorealistic Noir style feature film using 3D techniques.

## **II.2. Related Works: Noir in Animation**

### *II.2.1. Traditional Animation*

Film Noir lighting has been used in some stop-motion films and animations as well as in classic American film. A good example is work by the Quay brothers. The Quays choose to use what they call a “lateral hierarchy” of cinematic formal aspects. Although the Brothers Quay’s works are independent of any definable genre, their lighting style has a sense of Noir(see Figure 5).

### *II.2.2. 3D Animation*

Sam Chen’s *The Eternal Gaze*(see Figure 6), which took SIGGRAPH 2003’s award for Best Animated Short Film, is inspired by the life of painter and sculptor Alberto Giacometti, and focuses on the artist’s torment as he spends the last years of his life



Fig. 5. Quay Brothers *Dramolet* 1988.



Fig. 6. Sam Chen *The Eternal Gaze* 2003.

struggling with his work. Chen's chief inspirations for *The Eternal Gaze* were movies: *Blade Runner* most of all—"for its Film Noir look, its pacing, and its melancholy." and *Citizen Kane*, "for its use of black and white." "I watched it once a month while I was making my film." he says[7].



## CHAPTER III

### METHODOLOGY

#### III.1. Lighting

##### III.1.1. *Style of Lighting in Film Noir: Low-Key Lighting*

In contrast to early 40s' dominant high-key lighting, the lighting technique in film Noir is low-key. The ratio of key to fill is great, which creates areas of high contrast and rich, black shadows. The low-key lighting technique is not only used on characters, it also used in environmental lighting, casting shadows on elements of the set.

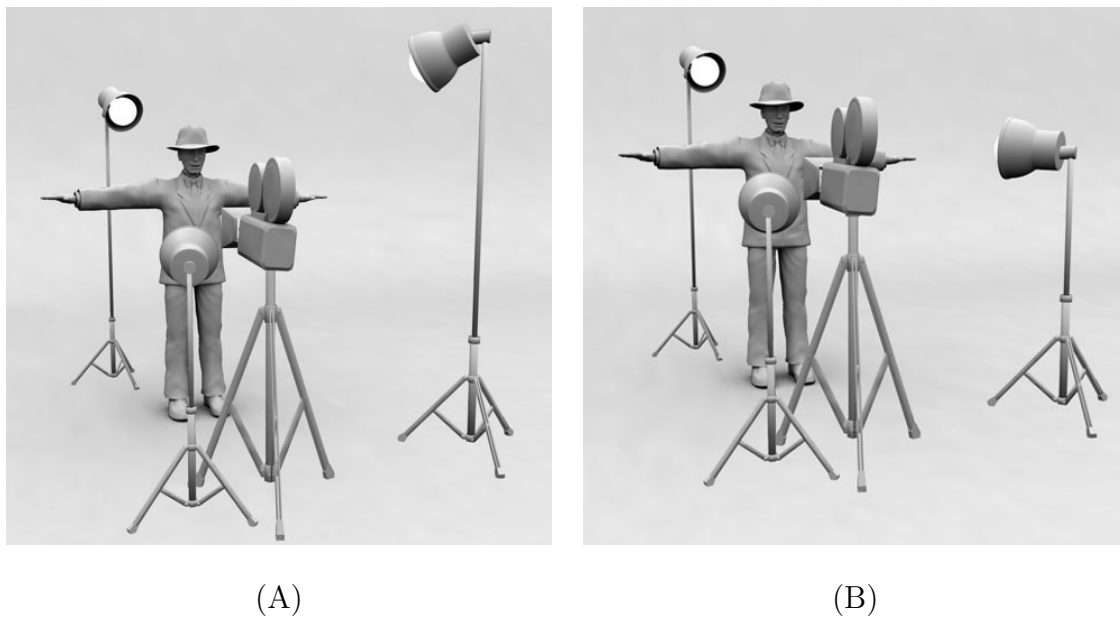


Fig. 7. Three-Point Lighting: (A) High-Key, (B) Low-Key.

The most common traditional placement of lights, then and now, is known as “three-quarter lighting”, or three-point lighting, in which the key light is positioned high and about 45 degrees to one side and in front of the actor, and the fill is low

and close to the camera to soften the harsh shadows created by the key(see Figure 7). The Noir cinematographers placed their key lower, and eliminated the fill to produce harsh high-light, high contrast and dark shadow.



Fig. 8. Robert Siodmak *The Killers* 1946.

Shadows can be a creative tool in storytelling, more than just a result of light. Edmond O'Brien's shadow in *The Killers*(see Figure 8) suggests an alter ego, the dark side of the character, similar to the shadow in *This Gun For Hire*(see Figure 9) which produces a “double-shot” for one character.



Fig. 9. Frank Tuttle *This Gun For Hire* 1942.

### *III.1.2. Computer Graphics Lighting*

#### *III.1.2.1. Shape*

The basic task of lighting is the placement and shape of light in a scene. Real world cinematography commonly uses spotlights and barn doors to achieve desired shapes; computer graphics lighting controls the shape of light along the following dimensions:

- 1) Generalized cone/pyramid: The light affects a region whose cross-section is a super-ellipse, continuously variable from purely round, through rounded-rectangle, to pure rectangle. The slope of the pyramid can be varied until at the limit the sides are parallel. The pyramid may be truncated, as if it were originating from a flat lamp face, and be sheared, for window and doorway effects.
- 2) Soft edges: To soften the edge of the light, we need to define a boundary zone in which the light intensity drops off gradually. The width and height of the boundary zone can be adjusted separately. Thus we have two nested pyramids: the light is at full intensity inside the inner pyramid, and has no effect—i.e., 0 intensity outside the outer pyramid, with a smooth falloff between them.
- 3) Cut-on and cut-off: The light shape can be further modified by specifying near and far truncation, again with adjustable-width smooth drop-off zones. These drop-off zones have no real-world physical analog, but are very useful to soften a lighting setup, and to keep the light from spilling onto undesired parts of the scene. The ability to adjust the shape and edge drop-off of lights easily allows for soft lighting of a scene, faking area-light penumbra effects. In my experience, the majority of lights are chosen to be rectangular, with large edge zones to provide smooth gradations. Conical lights are normally used when the scene includes a practical source, such as a flashlight. The light shape can of course be rigidly rotated, scaled, and placed anywhere in space. This is the strength of computer graphics lighting over real-world lights: the lighting designers are not

encumbered by physical structures and mechanisms that must be hidden or placed off-camera; computer graphics lights can emanate spontaneously from anywhere in space, giving the lighting designer great freedom.

### *III.1.2.2. Shadowing*

Shadows and shadow placement are important aspects of cinematography. Computer graphics allows great freedom to control shadows for artistic effect. In the following discussion, it is convenient to think of shadow projection as defining a “volume of darkness” inside of which illumination is inhibited; this volume can be manipulated as an independent entity. When controlling shadowing, a few aspects need to be noted. 1) Shadow selection. A light doesn’t necessarily have to cast shadows. The key light casts shadows, but the background fill lights do not. Shadows may also be disabled on a per-object basis. Thus a difficult problem in real-world cinematography, but suppressing unwanted shadows, is trivial in computer graphics. 2) Shadow direction. The direction that shadows are cast doesn’t necessarily have to follow the light—each “volume of darkness” can be aimed as needed. It is perhaps surprising just how far shadow directions can be shifted from true without incurring visual dissonance. “Cheating” the shadow directions can be a powerful tool for controlling image composition. 3) Shadow sharing. A seemingly bizarre capability is for a light to share its shadows with other lights. That is, a “volume of darkness” defined by a given light and object can inhibit illumination from other lights as well. This allows the lighting designer to strengthen shadows that might otherwise be washed out by nearby lights. 4) Fake shadows. It is often useful to create extra shadows, to imply nonexistent off-screen objects or simply to darken a scene where needed. In real-world lighting, opaque cards can be placed in front of a light. In my model, blockers can similarly be defined; each is specified by a 2D super ellipse that can be placed

anywhere in space. As with ordinary shadows, the direction that the blocker casts its shadows can be adjusted, and a blocker can be shared among several lights. 5) Shape trimming. A blocker can be made large and placed so as to trim the shape of a light. Animating a large blocker can be an easy way to fake the effect of a door opening off screen. 6) Shadow softening. To keep shadows from being too harsh, any shadow or blocker can be made translucent, to only partially inhibit illumination. Shadow edges can be softened as well: for blockers, this is done via an edge-zone drop-off in the same manner as the light shape; for object shadows, the boundary of the “volume of darkness” is blurred. Finally, rather than going to black, a shadow can be assigned a color; subtle use of colored shadows can add richness to an image.

### *III.1.2.3. Texture*

Just as images are used in computer graphics to create texture on surfaces, they can be used to create texture in lights via projection. 1) Cookie. A single-channel matte image can be used as a “cookie cutter,” to get cross-sectional shapes other than the built-in super ellipses, or, more subtly, to fake complex shadows from off-screen objects. 2) Slide. A full-color image yields a slide-projector effect. An unfocused projection (such as from a television set) can be achieved by applying a blur filter, its width increasing as the projection distance increases. 3) Noise. In addition to stored image files, the light can be projected through a 2D noise function that modifies the intensity or color, yielding “dirty” lights. As with shadows and blockers, it is possible to “cheat” the origin and direction of an image projection, to blur it, and to adjust its intensity.

## III.2. 3D Noir Filmmaking: Planning and Production Design

### III.2.1. *From Pencil to Pixel: Storyboard*

Planning and visualizing shots is the key to reaching the final goal. Film Noir's setting is usually that of dark, slick city streets, a city of crime and corruption. In Edward Hopper's *Night Shadows*, the exaggeration of shadow shows the loneliness of the character.(see Figure 10)

I need to revisualize a typical Noir street.(see Figure 11) I start with a basic simple building typical of a 1940s film, then proceed to add details, such as stylized lampposts and fire escape ladders.



Fig. 10. Edward Hopper *Night Shadows*.

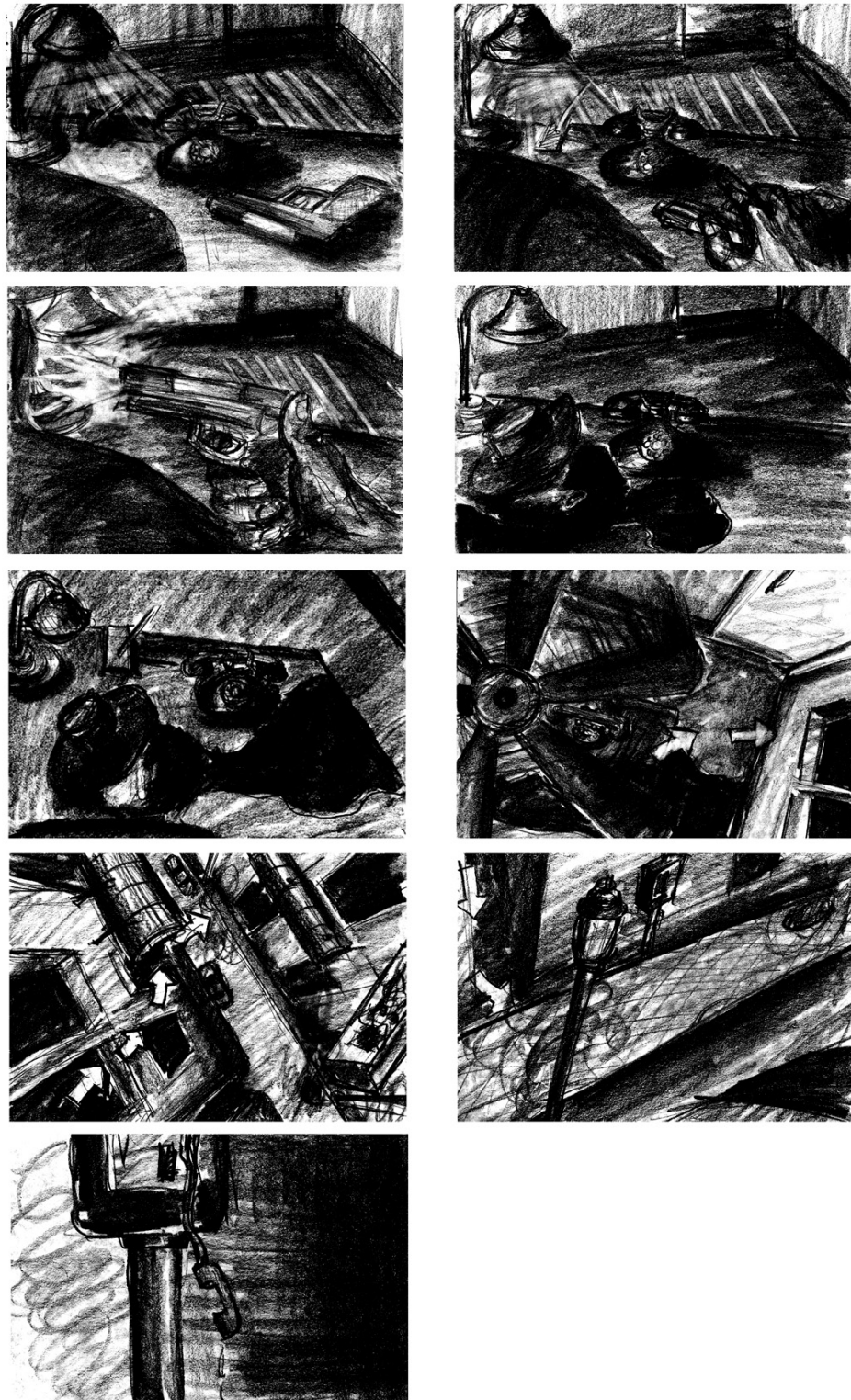


Fig. 11. Storyboard.



### III.2.2. *Maya: Modeling and Animation*

All my scenes were modeled and animated in Alias Maya<sup>TM</sup> including camera motion. I used some special deforming tools such as influence objects, set driven keys and wrap deformers to animate certain elements.(see Figure 12)For the out-door shot, I ensured the model did not get too complex and added just enough details on the buildings to prepare them for shading, texturing and lighting.(see Figure 13)

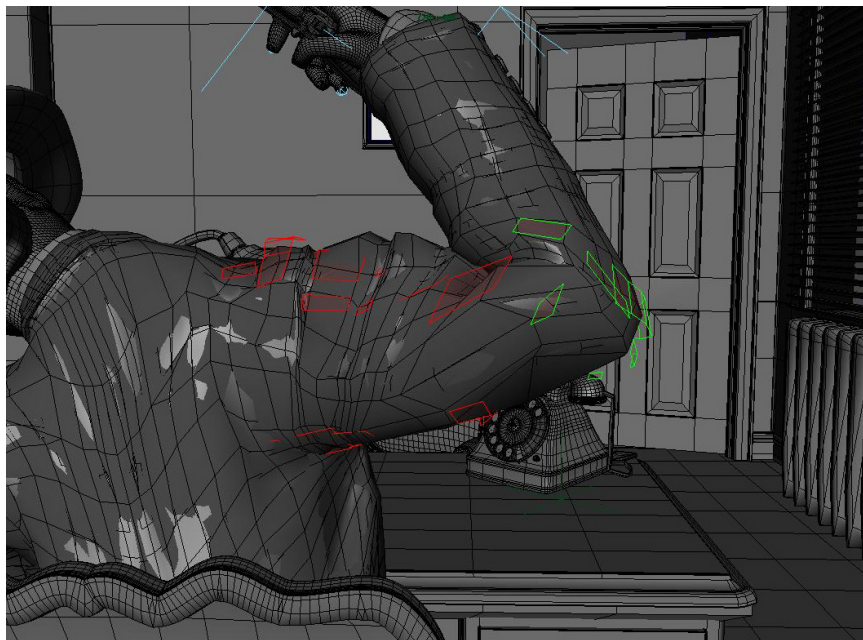


Fig. 12. MAYA: Modeling and Animation.

### III.2.3. *RenderMan<sup>TM</sup> Shader Concept*

MtoR<sup>TM</sup> converts Maya<sup>TM</sup> scenes to RenderMan<sup>TM</sup> Interface Bytestream (RIB) in a very simple and predictable way. RIB files made by MtoR<sup>TM</sup> are extremely predictable in structure. When rendering, I used subframe encoding, meaning that RIB descriptions for shadow and environment maps were written as individual files, and

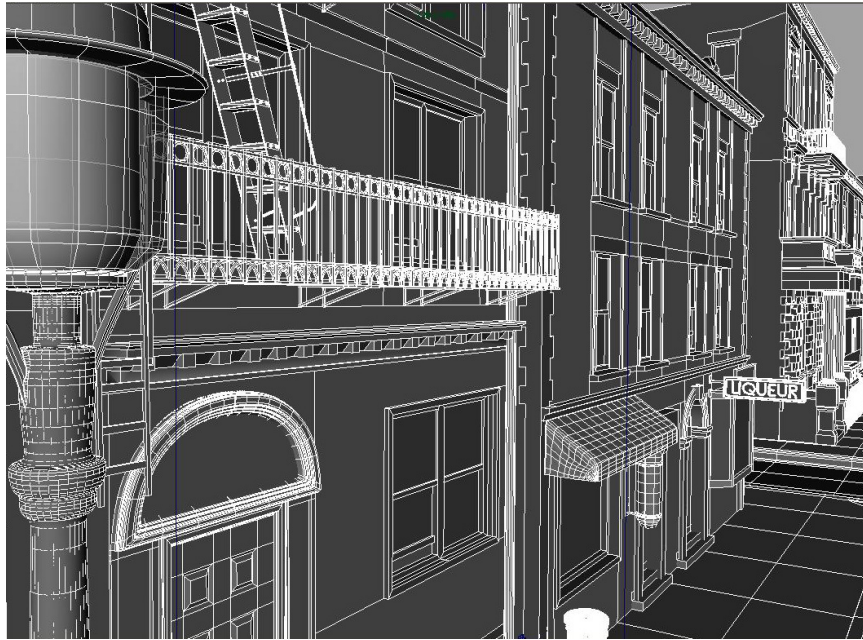


Fig. 13. MAYA: Modeling a Noir Street.

wrote one frame each RIB. This made it easier to control and easier to distribute render jobs between multiple CPU nodes.

MtoR<sup>TM</sup> comes with a number of ready-made , very powerful shaders. When I began to shade this project using MtoR<sup>TM</sup> , I was quick to use these shaders. Unfortunately, the shaders don't come with source code, and that presented real problems later. While I generally used only a small number of different shaders, it was important that I have the source code for all shaders, to alter them for special needs or to fix them when things went wrong.

As a result, I needed to design some special shaders for this project, for example, the shader for the man's suit. I needed a soft high-light edge to shape the outline of the suit. I found the fresnel model used for skin shading fit this requirement, so I used a simple displacement shader with gray cell ensemble with the skin shader, then applied a gaussian filter to make it look soft.(see Figure 14)

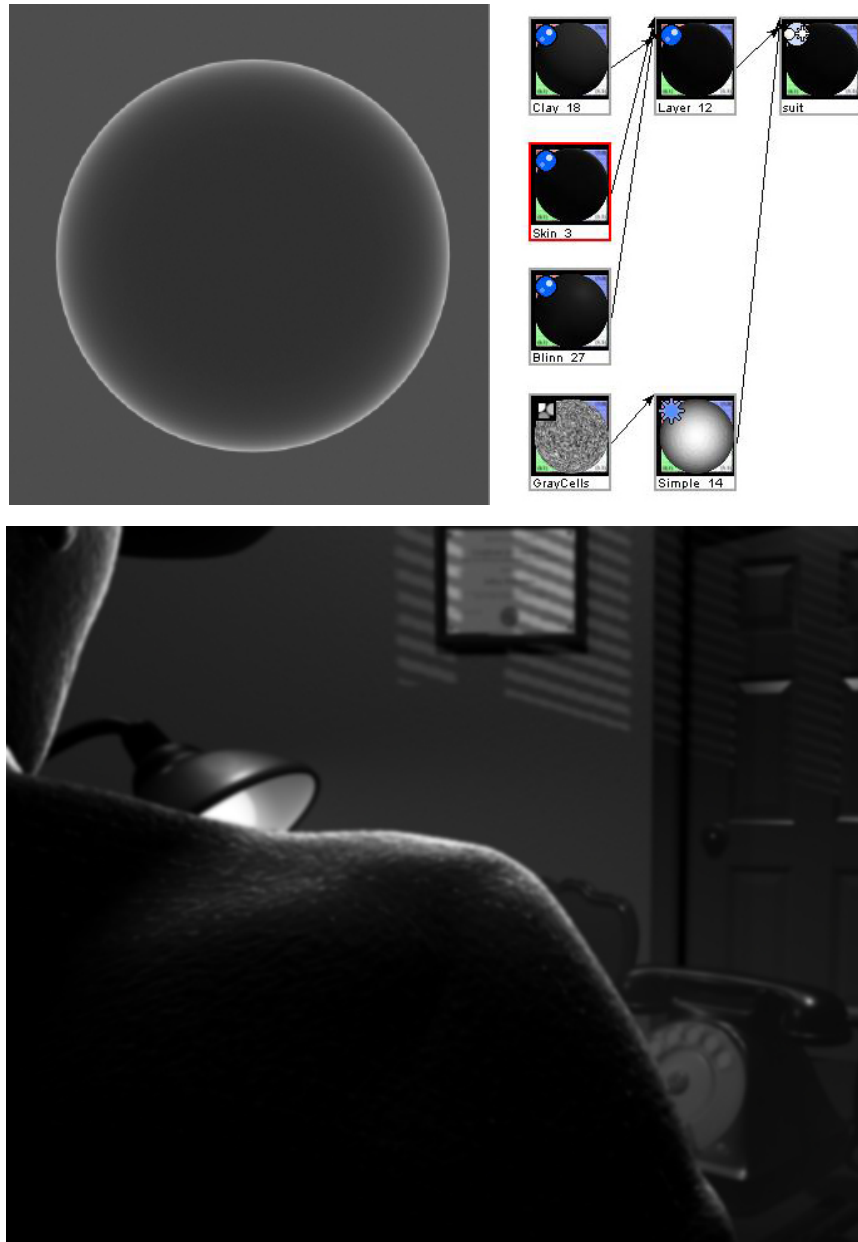


Fig. 14. RenderMan<sup>TM</sup> Shader Concept.

### *III.2.4. Digital Compositing*

Indirect illumination can create convincing lighting effects, but it can also create explosive render times. I used RenderMan<sup>TM</sup> baking techniques to cache an irradiance file, then reused this file for rendering.(see Figure 15)

Almost all professional productions render in multiple passes and finish though compositing. I separately rendered the color pass and occlusion pass, then composited in Shake<sup>TM</sup>.

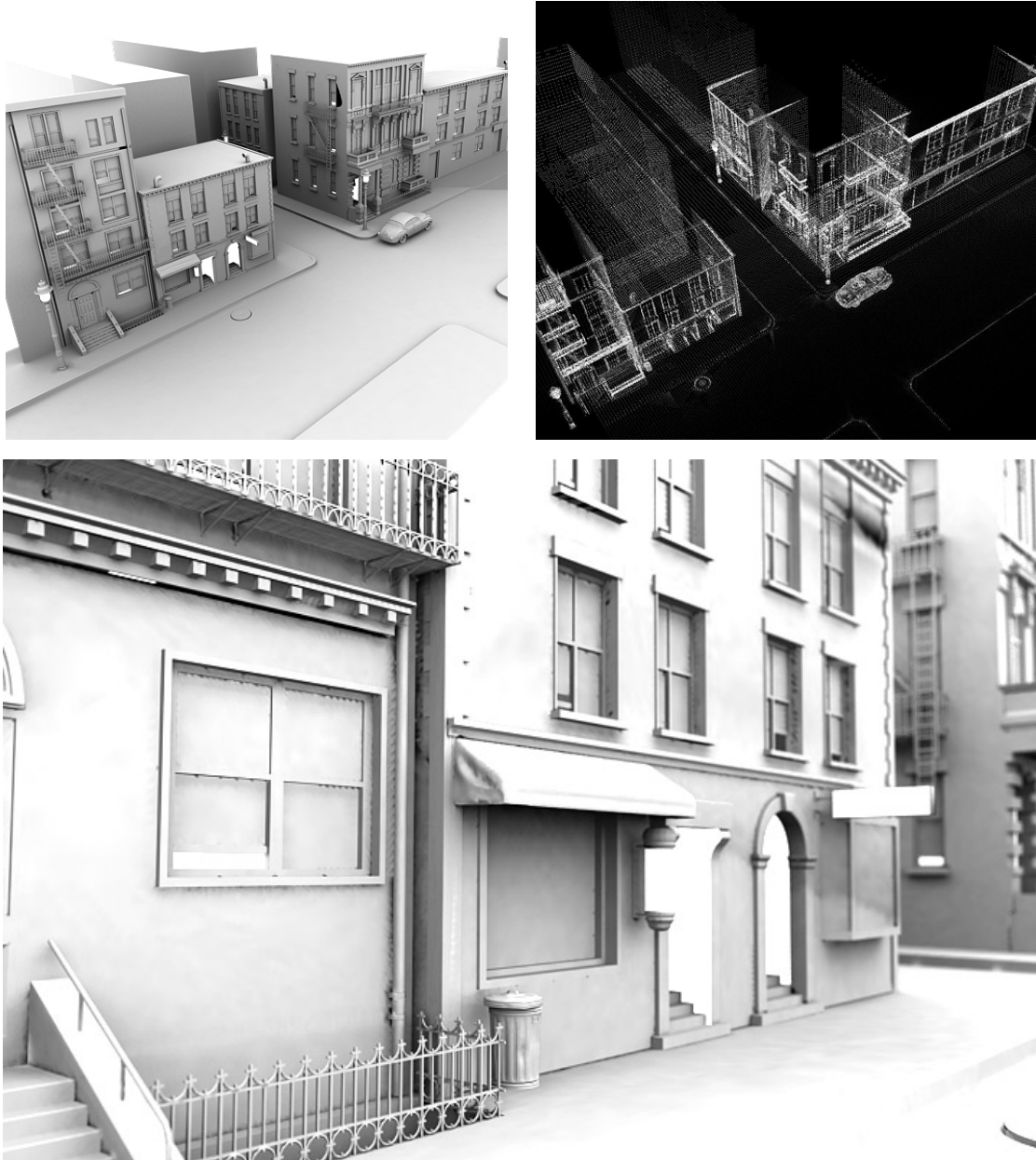


Fig. 15. Baking Occlusion.

## CHAPTER IV

### IMPLEMENTATION AND RESULTS

Tools I have used in this project:

- Alias Maya<sup>TM</sup>

Used for modeling, animation and camera motion.

- Pixar RenderMan<sup>TM</sup>

Used for shading, lighting and rendering.

- Adobe Photoshop<sup>TM</sup>

Used for texture paint.

- Apple Shake<sup>TM</sup>

Used for compositing different render passes, color correction and camera shaking.

Figures 16–19 show the result of rendering and compositing.



Fig. 16. Indoor Rendering Result 1.



Fig. 17. Indoor Rendering Result 2.





Fig. 18. Outdoor Rendering Result 1.



Fig. 19. Outdoor Rendering Result 2.



## CHAPTER V

### IN CONCLUSION

The lighting style I present provides an example of how to create a special cinematic style of Film Noir in computer-generated animation.

In sum, this thesis contributes to the literature in the following two aspects. First, it provides a pipeline to create a unique lighting style based on traditional film cinematography using computer animation. Second, it suggests a useful digital model for cinematographers to develop Film Noir's lighting effects.

## CHAPTER VI

### FUTURE IMPLICATIONS

- Lighting style in Neo-Noir. So-called Post-Noirs (Tech-Noirs, Neo-Noirs, or Cyberpunk) appeared after the classic period with a revival of the themes of classic Film Noir. Tech-Noir refers to a hybrid of high-tech sci-fi and Film Noirs portraying a decayed, grungy, unpromising, dark and dystopic future best exemplified with the following films: Ridley Scott's *Alien* (1979) and *Blade Runner* (1982), James Cameron's *The Terminator* (1984), Alex Proyas' *Dark City* (1998). In fact most Neo-Noir already uses 3D techniques in lighting and effects.
- Film Noir lighting on 2D media: Toon Noir and Web Noir.
- Lighting with effects. Render out the smoke and fog pass blend with lighting for the outdoor shots.
- Bake lighting techniques. Additional light means more rendering time. Baking light to the texture can save rendering time.

## REFERENCES

- [1] J. Alton, *Painting with Light*. New York: the Macmillan Company, 1949.
- [2] R. Borde and È. Chaumeton, "Toward a Definition of Film Noir", *Film Noir Reader vol.1*, pp 17-25, 1996.
- [3] J. Place and L. Peterson, "Some Visual Motifs of Film Noir", *Film Noir Reader vol.1*, pp 65-75, 1996.
- [4] J. Lasseter, "Principles of Traditional Animation Applied to 3D Computer Animation," *Computer Graphics*, vol. 21, pp. 35-44, July, 1987.
- [5] R. Barzel, "Lighting Controls for Computer Cinematography," *Journal of Graphics Tools*, vol. 2, no. 1, pp. 1-20. 1997.
- [6] S. Calahan, D. Carson, J. Kahrs and S. Poster, *Pixel Cinematography, a Lighting Approach for Computer Graphics*, ACM SIGGRAPH'1996 Course Notes no. 30, July, 1996.
- [7] J. Donelan, "Cover Story: Character Studies", *Computer Graphics World*, vol. 26, pp 10-15, August, 2003

## VITA

### **LEI HAN**

177 Lake Shore Rd. Apt 2  
Brighton, MA 02135  
Leihan@hotmail.com

### **Education**

M.S. in Visualization Sciences Texas A&M University, December 2004  
B.E. in Industrial Design Southern Yangtze University, China, August 1992