Shadowplay: Simulated Illumination in Game Worlds

Simon Niedenthal
Malmö University
School of Arts and Communication
Malmö, Sweden
+46 40 665 7164
simon.niedenthal@k3.mah.se

ABSTRACT
Despite the fact that there are currently a number of enjoyable digital games in which light plays a key role, we lack a vocabulary with which to discuss simulated illumination in game worlds. An understanding of lighting practices in other media, such as 3d computer-generated animation and film, must be supplemented with an awareness of real-space disciplines if we are to grasp the complexity of the game lighting design task. But game design is more than a repository for existing lighting practices; the interactive nature of games allows for an extended range of visualization possibilities and a self-reflexive sensitivity to light to emerge, most clearly manifested in games described as "stealth," and "survival-horror" games.

Keywords
Lighting design, game lighting

It has long been a commonplace in gaming communities that "good graphics does not equal good gameplay." Originally growing partly out of resistance to industry agendas, this platitude has, in extreme expressions, ossified into a simple and ultimately less-than-useful dichotomy. But given the capacity to dynamically engage the senses that is inherent in interactive media, a better question for us to pose is "what sort of visual experiences best support gameplay?" One way to approach this rather large question is to move beyond a narrow consideration of "graphics" and focus instead upon our experience of simulated illumination in gaming environments. For, despite skepticism towards game graphics, the fact is that there are currently a number of very enjoyable games in which light plays a key role. In stealth and survival-horror games, such as those of the Thief, Splinter Cell and Silent Hill series, a consideration of light can be found not only in the way in which the game spaces are illuminated, but also in the sensorium that is encoded into the game's AI. In this sense, both players and non-playing characters respond to illumination decisions made by game designers, as well as gamers themselves.

But before we investigate illumination decisions further, it is necessary to create a framework for analyzing the contribution of simulated illumination to the gaming experience. Quite clearly, we lack a vocabulary with which to speak and think about light in games and the effect upon the player. According to industry accounts, game development companies are eager to make use of

Proceedings of DiGRA 2005 Conference: Changing Views – Worlds in Play.

illumination knowledge. David Polfeldt, Vice president of Malmö-based Massive Entertainment, points out that though receptive, the industry lacks a means of adequately expressing lighting concepts. Many game developers and artists tend to speak a recursive language, in which invoking "Doom 3," for example, calls up a whole host of real-time lighting and shading effects.

This paper will argue that a foundational understanding for studying lighting design in game environments can be forged by first surveying existing illumination practices. Pre-rendered 3d computer animation is created using similar digital tools, and the field has begun to develop it own form of cinematography. But the free navigation afforded by games requires us to look to other practices outside of filmic media, such as real-space lighting. Finally, games as interactive experiences must be examined for their own unique potentials. After all, in a game the player sees and is seen, illuminates and is illuminated in turn.

I will begin by contending that it makes sense, from both a game development and research perspective, to consider simulated illumination as a significant contributing element of the gaming experience. Whether one is a programmer or digital artist working at a game company, or a gamer using a level editor to produce something for their own enjoyment, there is a cluster of design decisions around the problem of light that can be made well or poorly. Light contributes powerfully to the "gameplay gestalt," defined by Craig Lindley as "a particular way of thinking about the game state from the perspective of a player, together with a pattern of repetitive perceptual, cognitive, and motor operations." Finally, if we hope that games might touch the same profound places that dreams do, I believe that illumination has an important role to play.

As media artifacts and interactive experiences, games draw from various sources of knowledge about light to achieve their effects. The existing professional practice perhaps closest to game illumination is computer generated animation. As with films such as "Toy Story," many digital games are created within 3d software packages that take film technologies as organizing metaphors. In 3ds max, Softimage and Maya, surface geometry is refined with a combination of texturing tools and simulated light sources. Lighting decisions for a game must be constantly balanced with the need to maintain a frame rate adequate for real-time playback, and the quantity of lights possible in a game scene is determined by the rendering engine. Some rendering engines allow the digital artist to employ 8 lights; really good engines up the number considerably [9]. Although in the past the real-time demands of digital games have limited the use of complex lighting setups and effects, a number of new rendering engines, techniques and workarounds allow game designers increasing control of the illumination spaces of their games, opening to them the sorts of choices that were afforded digital animators a decade ago.

Since then, the computer-generated animation industry has begun to generate its own form of cinematography, led by companies such as Pixar, whose aesthetic draws heavily upon traditional film lighting practice. Sharon Callahan [3] identifies five objectives of lighting in a digital animation scene:

1. Directing the viewers eye

2. Creating depth

3. Conveying time of day and season
4. Enhancing mood, atmosphere and drama
5. Revealing character personality and situation

If we apply these objectives to an analysis of the survival horror game “Silent Hill 2”, we can see that there are useful contributions, as well as important limitations to a filmic approach. First, light qualities are employed to direct the player’s the eye, an important part of locating useful objects in any adventure game. Health drinks, medical packs and ammunition to be acquired in a space leap out through contrast and specularity. Depth in exterior scenes is simultaneously created and limited through atmospheric perspective of fog, as well as darkness. Although “Silent Hill 2” is largely an interior game, played out in decayed, boarded-up spaces, larger lighting decisions do convey time of day and interact in an interesting way with the player’s felt sense of time. The game begins in daytime, then after leaving Brookhaven hospital the player emerges into a nightscape. A grey dawn permeates the final stage of the game at the Lake Side hotel; thus “Silent Hill 2” is played out over one day (and of course other current games introduce their own day/night cycles of varying duration). Depending on how skilful the player is, this may or may not correspond to the player’s own sense of game time. A cinematic sensitivity to the power of light to enhance mood, atmosphere and drama is readily apparent in “Silent Hill 2”. The overall low-key lighting strategy in “Silent Hill 2” is perfectly in tune with the horror genre, and provides one of the greatest sources of pleasure in the game. Finally, one can point to a number of ways in which illumination helps to sketch character and motivation in a cinematic way.

In the opening expository pre-rendered scene, James Sunderland, the game’s protagonist, stares into a mirror and relates the receipt of a letter from his dead wife. This scene introduces us to a somewhat ambiguous character, and as the game plays out we are called upon to speculate about James’ motivations and role in his wife’s death. The illumination here, coming from above and leaving his eyes in shadow, is a cinematic convention often associated with characters whose motivations are unclear. In “The Godfather,” for example, cinematographer Gordon Willis chose the same lighting strategy to make the title character appear more mysterious (besides accommodating Marlon Brando’s oral prostheses) [13]. The case of top lighting the face in such a way that the eyes remain in darkness is an example of the way in which a lighting convention can come into dialogue with deeply ingrained behaviors. According to studies of how humans read faces, we devote great mental energy to analyzing the gaze of others. It follows then that the obscuring of the whites of the eyes and the specular highlight from the eyeball through shadowing [1] would tend to leave us somewhat unsettled.[1]

As the foregoing example makes clear, a cinematic approach to game lighting is appropriate as a means of analyzing pre-rendered cut scenes, as well as useful in helping us understand larger lighting strategies that relate to game genres, time of day, narrative elements and mood. But it is

---

[1] Thanks to Steve DiPaola for this insight.

also quickly apparent that games as interactive experiences differ from films in significant ways. First, a film scene is of limited duration, and generally must communicate a quantity of information in that time. Games, on the other hand, allow free exploration and examination. In addition, film scenes are lit to be recorded from the camera. A fixed perspective for viewing a game environment of course cannot be assumed (though some games have context sensitive framing that is a kind of middle state between free exploration and fixed perspectives). So though a film lighting perspective is useful for our understanding of how games function as media artifacts with certain narrative elements, the task of lighting the interactive game world, also participates in some of the opportunities and limitations of real-space practices.

I would argue that we respond to simulated illumination in games not only from our accumulated experiences from film and other media, but also as perceiving and feeling embodied beings accustomed to acting in the world. If we accept that our experiences of simulated illumination are analogous to our experience of light in real space,[2] there is a body of research on the effects of light that can be re-purposed within game design. Recently there has been increased interest in studying the qualitative and non-visual effects of light, the ways in which illumination levels and color influence how people feel and behave. Several themes have emerged from current research. Some gender differences occur; men and woman show different levels of emotion depending upon color temperature of light [5]. Risk-taking also appears to be a phenomenon that is affected by our luminous environment [8].

According to Greg Costykian, decision-making is one of the defining hallmarks of the gaming experience [4], and interesting implications for game design emerge from experiments on the effect of light on decision-making in real space. In a study of the effects of light on mood and decision making, CLB McCloughan claims that decision times decrease, and heuristics use increase under lower illumination levels. Further, Belcher and Kluczny also suggest that in particular illumination conditions we are more likely to employ quicker heuristic strategies rather than engage in detailed analysis in our actions. "Silent Hill 2" is an excellent environment in which to trace this line of thought. There are a number of different types of decision that one is called upon to make in the game: should I blast this zombie? How do I solve this puzzle? Clearly some decisions are on the level of reflex, others require considered analysis. Belcher's model suggests that tasks such as killing approaching zombies, which are solved best by applying heuristics rather than launching into elaborate planning, are supported by luminous surroundings that would be described as poor or low acuity lighting, often the case in Silent Hill. The

---

[2] This assumption requires a sub-argument. In the late '60s a debate emerged between J.J Gibson and Goodman on the nature of the experience of viewing a picture. Goodman's position was that we learn to "read" a picture, that it functions as a kind of text. Gibson countered that the experience of looking at a picture is analogous to how we see in real space: "a picture is a surface so treated that (it) contains the same kind of information that is found in the ambient optic arrays of an ordinary environment." He also writes, more succinctly, that "interpretation depends on sensations." I take Gibson's side, and believe further that his stance can be transferred to a consideration of dynamic simulations such as games. The argument of this paper is that our experience of simulated light is not just informed by our experiences within media and by ingrained "codes" of light, nor are our perceptual systems simply cultural constructs. What makes light so interesting is the way in which socially informed media conventions come into dialogue with our bodies and senses, which have their own codes.

significance of this for the game designer is that there is room for subtle modulation in the matching of the lighting environment to the desired game experience.

To summarize our overview of filmic and real-space illumination practices, then, we can reduce lighting aims to two broad categories: functional and evocative lighting. The functional objectives prompt lighting designers to consider the adequacy of light to fulfill basic needs—as appropriate for the world to be simulated—such as dealing with the technological constraints of the renderer, ensuring that the world is described visually, and that the sort of tasks that the game calls upon the player to perform can, in fact, be performed. Much lighting design in games so far has occurred at this level. Evocative lighting decisions allow the designer to manipulate the qualities of light—colour, shadow characteristics and lighting direction—as a means of influencing the player's emotions and behavior during the game.

We may employ a simple game taxonomy to map real space and cinematic sources of light knowledge appropriately to game design. Craig Lindley proposes a triangular model integrating ludology, narration and simulation. Lindley's ludological definition of a game is "a goal-directed and competitive activity conducted within a framework of agreed rules;" a narrative is defined as "an experience structured in time;" and simulation is "a representation of the function, operation or features of one process or system through the use of another "[7]. One benefit of generating such a taxonomy is, as Lindley points out, is that it can help us apply knowledge to game design in a productive way: "The distinctions of the taxonomy . . . allow us to see where techniques from other fields can be applied."

Overlaying illumination practices upon this game taxonomy also demonstrates how other types of lighting knowledge can contribute to game lighting design. Narrative can clearly be supported by illumination techniques coming from 3d computer animation and film, especially relevant in pre-rendered cut scenes. Our understanding of how light influences people in real space has consequences for the "goal directed and competitive" activities of ludic behavior, through arousal, affect, risk-taking and decision-making. Knowledge of the digital simulation of light has come to games from computer graphics, and an example of how our experience of light can be foregrounded in simulations can be seen in fireworks simulators [10].

So far in this paper the argument has moved in a single direction, projecting from existing lighting practices from filmic media and real space onto game forms. But of course, games are uniquely interactive experiences, mediated by responsive computing systems and shaped by the player's agency. Any consideration of simulated illumination in games must take into account not just reaction to light, but player proaction in a luminous environment that is often partly under their own control. I have been concentrating upon illumination decisions made by professionals, but what is interesting about games is that these decisions are increasingly being made by players. Tactical lighting decisions by the player mid-game are an important part of the experience of the current crop of stealth and survival-horror games, and we can begin by distinguishing between additive player lighting activity, in which the player illuminates the scene with light sources, and subtractive activity, in which the player, conversely, eliminates existing light sources in the scene.

An example of how additive player lighting activity affects game balance can be observed in Silent Hill 2 & 3. Early on in the games, one acquires a flashlight, and must continually decide whether or not to use it. With the light on, objects to be acquired in the environment leap out through contrast and specularity. The light itself is comforting; without it, one moves through a twilight gloom almost sub-aquatic in character. The player must choose from moment to moment how to illuminate the scene, and the decisions are crucial for survival and continued forward-movement in the game. Konami's website tips the player off to the significance of illumination in balancing the game's risks and rewards:

> "The monsters have eyes and ears, and will use these to locate James. If they are not alerted to James' presence, they may not attack. Turning off the flashlight and carefully bypassing unnecessary confrontations is advised, however, with the flashlight off, James cannot search or look at the map and his accuracy with projectile weapons is severely impaired." [12]

The attention to light in "Silent Hill 2" thus goes far beyond storytelling and world definition; it also directly engages the player and becomes a key part of survival-horror gameplay. Another example of additive player lighting activity and its role in game balance can be seen in Doom3, in which use of the flashlight inhibits defensive action.

Examples of subtractive player lighting activity are common in stealth games, in which the game experience is built around avoiding detection while accomplishing missions. In the Thief series, players can act over distance to douse torches with water arrows, while their counterparts in Splinter Cell can do the same with more modern projectile weapons. Doing so makes the player's avatar less visible to adversaries. The significance of moving in areas of low illumination in these games is reinforced by interface elements (such as the "glowing crystal" in Thief and the stealth meter in Splinter Cell) that provide feedback on the degree of illumination of the player's current position.

As these examples of additive and subtractive lighting suggest, illumination decisions in these games do not just affect the player's surrogate and perspective, they also shape the conditions for interaction with non-playing characters through the game's artificial intelligence. For the game Thief, a sensory system was developed with the aim of increasing the suspense of possible discovery. Tom Leonard relates the aim of the game's developers:

> "The primary requirement was creating a highly tuneable sensory system that operated within a wide spectrum of states. On the surface, stealth gameplay is about fictional themes of hiding, evasion, surprise, quiet, light and dark. One of the things that makes that kind of experience fun is broadening out the grey zone of safety and danger that in most first-person games is razor thin. [6]"

AI vision in "Thief" is framed in terms of "awareness" and "visibility." Visibility is defined "as the lighting, movement, and exposure (size, separation from other objects) of the entity . . . the lighting of the player is biased towards the lighting near the floor below the player, as this provides the player with a perceivable way to anticipate their own safety."

Not only do players have the capacity to alter the luminous game environment, they can also choose how to perceive the energy of their environment. Besides visible light, Splinter Cell: Chaos theory offers player night, thermal and EMF visual modes. Each of these modes has interesting affordances and drawbacks, and the game encourages a sort of visual choreography as one proceeds through the environment: one might move in natural illumination or night mode, pausing to scan in thermal or EMF mode as one enters a new space, depending upon one's mission and the state of one's adversaries. Night vision diminishes contrast and raises value, allowing one to see into the shadows. On the negative side, it is monochromatic, so color information is lost. Hightlight areas also blow out and lose detail. Since it simulates a system in which infrared energy is projected and detected directly from the user's position, it also tends to make depth perception more difficult. So while one can navigate in this mode, one sometimes bumps into things. Both themal and EMF modes are more useful for locating objects than navigating. Thermal mode provides strong color contrast indicating areas of warmth, useful for quickly locating adversaries in complex environments, while EMF indicates areas of pulsating electrical activity.

Alternate visual modes in games have interesting implications for illumination design. First, thermal and night representations may make native sense to pit vipers or other animals, but they are not natural parts of the human sensorium, and thus are abstractions that reflect the vocabularies of surveillance and military technologies, among other references. These are certainly appropriate for the Tom Clancey world of Splinter Cell. Secondly, extending the player's sensorium affects the relationship to one's surroundings that have, I believe, particularly important consequences for stealth games, which are as much about mastering one's environment as mastering one's adversaries. Survival-horror games, on the other hand, depend more upon maintaining a certain degree of player limitation and vulnerability; I can't imagine that the experience of playing a Silent Hill game would be improved by having night vision capabilities.

Based on some of the unique characteristics of game forms that we have examined, we can see that game developers face several key strategic illumination decisions (moving from lower to higher-level concerns):

1. Defining the basic characteristics of the environment's illumination, in both time and space. Given that the player might relight the scene by adding or subtracting light, the designer's task is to define the base ambient illumination, the essential shadow density, sketching the visual affordances of the world. Here we can speak, in the parlance of film, of broader "high-key" or "low-key" strategies, in reference to the overall distribution of value in the scene. High-key is traditionally associated with comedy and lighter fare, and gives us "Super monkey ball." A histogram of a sample frame demonstrates a preponderance of middle to high range value. Lower-key strategies are of course appropriate for survival horror and stealth.

2. Defining the capabilities of the player. As we have seen, the energy of a game scene can be represented in different ways. Offering the player a range of visualization choices, as in Splinter Cell: Chaos theory, extends player capabilities, and creates the illusion, at least, of a greater degree of mastery over the environment. Once again, these choices need to be made in relation to the game genre.

3. Integrating illumination concerns within the whole game experience. This includes harmonizing visual capabilities of the player with other sense modalities, most importantly sound. It also includes considering the issue how to balance risk and reward,

to make the choices available to the player (as actor or designer) meaningful within the game genre, according to the desired emotional complex of the game experience.

But of course the experience of being in a game world involves not just responding to the consequences of overarching design strategies, it also about feeling the fine-grained texture, variations, and rhythms of light in simulated space. So let's take a luminous tour the first mission of Splinter Cell: Chaos Theory and see how light is used to shape the game experience.[3]

Our first introductions to the game, from the still images of loading screens and mission information to pre-rendered cut scenes, partake of the illumination aesthetic of portrait photography and film. The mysterious and threatening Sam Fisher of the first loading screen, eyes veiled in shadow ("he sees you but you don't see him"), knife and night vision goggles radiating specularity and 2-point star filter highlights, respectively, contrasts with the softer and fuller illumination of the somewhat weary-looking Sam about to be sent back into the fray. But together with other stills of key characters we encounter before we enter the game world, the illumination is characterized by fairly conventional strong back lighting that separates characters from the background. The cut scenes, further, maintain a cinematic practice of apparently motivated, directional lighting that defines contours, directs attention, and creates an ambiance appropriate for various media, military and control room settings.

Once we enter the game world we find ourselves in a luminous environment in which players—far from being directed where to look—have to actively engage in visual meaning-making, in dark and complex spaces, using the visual modes at hand. We begin on a beach, below a castle and lighthouse. It is a dark and stormy night, thunder and lighting effects punctuate the darkness, a moon tries to shine through the cloud cover, and wind motivates a number of (now requisite) swinging light fixtures. The seaside location is misty, and the light beams tend to be visible in the moisture, directing our attention to pools and shafts of light. We proceed from the beach through cave and castle settings, to a final rendezvous in the lighthouse. The environments of the first mission, though uniformly dark, define a full palette and spectrum of light types and colors, ranging from yellow-red candles, fire effects and incandescent lights, to cooler moonlight and arc lights, as well as non-naturalistic green phosphorescence in the cave scenes. There are several moments at which narrative events or adversary presence are communicated through moving shadows, and other moments of shadow ambiguity, in which a threatening movement turns out to be just another swinging light. The passage from dark beach to the lighthouse frames the action of the mission; the last action before extraction is to turn off the lighthouse lamp, and the level ends with Sam's brief concluding statement of relief: "darkness."

In conclusion, illumination decisions in digital games take many forms, are made by both designers and players, and have strategic and tactical consequences for the game experience. But whether one is seeking to evoke a world or set up the conditions for perception and interaction, light allows us to advance our goals for the felt game experience, be they the evocation of suspense, dread, comfort or ecstatic abandon. Light engages us through our bodies, our nervous systems, and our collective social interactions. Digital games, in which light is made present through a combination of media conventions, computer graphics algorithms and sensory

[3] This reading refers to the PC version of Splinter Cell: Chaos Theory

phenomena, thus represent an arena in which the aesthetics of light and the mechanisms of perception are open for exploration and redefinition by designers and players alike.

References:

1. Alton, John. *Painting with Light*. University of California Press, Berkeley, CA, 1995.
2. Belcher, M. Clay and Kluczny, R. A Model for the Possible Effects of Light on Decision Making, *Lighting Design + Application* (Feb. 1987), 21.
3. Callahan, Sharon. Storytelling through Lighting, a Computer Graphics Perspective, in Apodaca, A. and Gritz, L. *Advanced Renderman*. Morgan-Kaufmann, San Francisco CA, 1999, 337-382.
4. Costykian, Greg. I Have No Words but I Must Design. Available at http://www.costik.com/nowords.html
5. Knez, Igor. Effects of Light on Non-visual Psychological Processes. *Journal of Experimental Psychology,* v. 21 (2001), 201-208.
6. Leonard, Tom. Building an AI Sensory System: Examining the Design of Thief: The Dark Project. Available at http://www.gamasutra.com/gdc2003/features/20030307/leonard_02.htm
7. Lindley, Craig. Game Taxonomies: A High Level Framework for Game Analysis and Design. Available at http://www.gamasutra.com/features/20031003/lindley_01.shtml
8. McCloughan, C. L. B. et al. The Effects of Light upon Mood and Decision Making. *Proceedings of CIBSE Lighting Conference 1996*, p. 239.
9. Olsén, Daniel. Conversation (12/4/2003), and David Polfeldt (12/3/2003), Modern Games, Malmö Sweden.
10. Pyroinfinity website. See Visual Show Director: http://www.infinityvisions.com/
11. Salen, Katie and Zimmerman, Eric. *Rules of Play: Game Design Fundamentals.* MIT Press, Cambridge MA, 2004.
12. Silent Hill 2 website. Available at http://www.konami.com/silenthill2/
13. *Visions of Light: The Art of Cinematography.* American Film Institute, 1992.