

Frank Lloyd Wright's Treatment of Light in Unity Temple: Digital Model and Simulations

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Abstract. *The paper demonstrates the utility of digital models and simulations in the study of light in sacred architecture. Specifically, it applied this method and analyses on Frank Lloyd Wright's treatment of light in Unity Temple, Oak Park, Illinois (1905). The findings of the light simulations augmented the observation and qualitative analyses of Wright's lighting design and show that his treatment of light fulfilled the accentuated, architectural, and celebration lighting recommendations of IES, while the task lighting of reading was partially fulfilled. Still, Wright's original design provided the dramatic effect of light and shadows and enhanced the spiritual experience in the Temple.*

Keywords. *Light simulations, Frank Lloyd Wright, Unity Temple*

Introduction

The objective of this project is to highlight the utility of digital models and light simulations in the study of light the treatment in sacred settings. Although digital investigations of light can be applied to any type of building, given the centrality of light in the spiritual domain the paper focuses on the treatment of light in religious architecture. Specifically the study analyzes Frank Lloyd Wright's treatment of light in Unity Temple, Oak Park, Illinois (1905).

Numerous studies demonstrated that light provides premonitions and points of departure for spiritual and mystical transcendence, creating a bridge from the profane (the earthly world) to the sacred (a state of pure light) and puts man in touch with the eternal (Eliade, 1958; Arnold, 1975; Hayes, 1983; Gelfenbien, 1986; Plummer, 1987; Millet, 1996; Geva and Mukherji, 2007). The divine response "comes back as streaming light out of the direction into which people have surrendered themselves" (Schwarz, 1958). The symbol of light represents the deity, and creates a space where heaven and earth are melting into one another. Thus, light is rich in associations and carries rooted meanings that dramatizes the spiritual state of the space and enriches its mystical experience.

Wright used day lighting to introduce a special spiritual ambience into Unity Temple. He carefully manipulated sunlight and skylight to create a natural glow in the building emphasizing the temporal meaning of changes in time and seasons: "...the sky pilot on the floor with flock" (Wright 1946/1997), and the building "became a creation of interior space in light" (Wright 1931/1992).

Unity Temple (1905)

Unity Temple is a complex of three buildings that are spread along a 142 feet main axis from north to south (Figure 1). The main building is the Temple, which is located on the north; the second building located on the south is the Unity House, and includes a main gathering/reception and a kitchen on the ground level and open classrooms above; the third building of the complex consists of a foyer/entrance that connects the Temple with the House. Its upper floor includes the pastor's office.

This project focuses on the Temple, which was designed in a shape of a cube of 64'-0" sides in plan and 47'-0" in height. It includes an auditorium with three open galleries, a space for the organ on the fourth side, and a lower floor for storage and restrooms (Figures 2). Wright used the cube -- a pure geometric form -- since he believed



Figure 1. Frank Lloyd Wright's Unity Temple

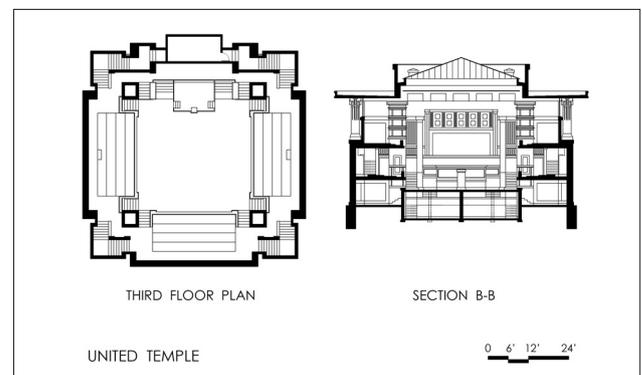


Figure 2. Plan and section of the Temple (drawn by Lu Zhipeng)

in its novelty: "the first idea was to keep a noble room for worship in mind, and let that sense of the great room shape the whole edifice" (Wright, 1932). Pastor Johonnot expressed the support of the Unitarian congregation for Wright's design in his New Edifice of the Unity Church (1906): "By the simplicity and beauty of the design and by its departure from traditional lines, the simplicity and freedom of the faith held by the members of Unity Church is outwardly expressed; the architecture thus typifies the faith of the church".

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The Temple was constructed with reinforced concrete poured on site. The heavy thick concrete walls answered not only the monumental and religious aspects of the design, but also catered to environmental concerns such as thermal mass and noise reduction (Geva, 2002). Wright designed a pattern on the exterior columns that hold the roof and frame the windows. In addition he designed long cantilevered overhangs to accentuate the horizontal form of the complex, to create a square cross, and provide shading.

Light in the Temple

Wright believed that “Sun-acceptance in building means... wall-surfaces that eagerly take the light and play with it, break it up and render it harmless or drink it in until sunlight blends the building into place with the creation around it...” (Wright in Atkins 1998). He accentuated the spiritual journey in the Temple through a repeated interplay of light and darkness (Scully 1996). This interplay not only enhances the spiritual feel in the Temple but also creates an illusion of the concrete roof and its large overhangs floating over the walls (Scully 1996; Joncas 1998). Wright used multi sources of light to admit daylight into the Temple and various light fixtures to enrich the experience at night as well as to compliment some darker areas during the day (Figure 3). Wright’s lighting techniques included upper windows on four sides of the building, which act like clerestories. These windows are shaded on all sides by deep cantilevers, which serve as reflecting surfaces while their shading effect impacts the amount and quality of light pouring into the building. A double system of skylight that consists of an exterior pitched glass roof and interior flat painted skylight ceiling, which covers the whole auditorium and distributes even and soft light. The combination of various light sources provides a balanced, more uniform, and contrast free light. This effect introduces a soft distribution of the natural light throughout the interior and enhances the concept of “holy” light. Still, Wright focused the attention of light on the pulpit, while the galleries become darker as we move away from the main floor. Although Wright’s design of Unity Temple departed from conventional church design, this treatment of light follows the tradition of creating a focal point on the altar/pulpit. Background light fixtures and window slits in the corners illuminate the darker parts, but not enough for reading function. However, the use of indirect lighting in the darker spaces of the temple suggests “a sense of inwardness, an invitation to meditation” (Kieckhefer 2004). This sensation complies with Wright’s aspect of individuality in faith and design.



Figure 3. Interior of the Temple: view to altar/pulpit

As can be seen in Figure 3, Wright introduced innovative artificial light fixtures as an integral part of the lighting in the Temple. It should be noted that he was one of the first architects in Chicago to introduce electrical lights in his buildings. The major hanging fixtures accentuate the cubical form being positioned at the four major columns of the Temple, while wall fixtures are serving as background lights.

Method, analyses and results

This work utilized digital model and simulations to augment the observations on Wright’s treatment of light in Unity Temple. The analyses of his lighting design were conducted in three phases: (a) constructing a 3D digital model of the Temple; (b) running a digital lighting simulation software – Lightscape on the model of the Temple; and (c) comparing the simulations values to the IES standards for houses of worship.

(a) Constructing a 3D digital model of the Temple

A 3D model of the interior central sanctuary space of Unity Temple was constructed in AutoCAD based on Wright’s original drawings of the Temple (Frank Lloyd Wright Foundation Archive). The model was constructed as 3D surfaces (any regular planar triangles or convex quadrilaterals) instead of solid walls to optimize it for radiosity processing. To compute daylight, 3D surfaces were also created for the patterned leaded skylights and clerestory windows, the main source of natural light in the sanctuary. Additionally, all light fixtures inside the structure were modeled and placed in their precise position and were calculated along Wright’s original design. For a more accurate lighting analysis, 3D surface models representing long solid wood benches were also created and placed in position around the pulpit. This ensured that light was computed based on its absorption and reflection off the interior furniture in the central sanctuary.

(b) Digital analysis of the treatment of light in Unity Temple

The project utilized Lightscape, an advanced lighting and visualization application founded on a physically based simulation of the propagation of light through the environment (Autodesk, 1999). The program includes local illumination algorithms which portrait how individual surfaces reflect or transmit light and predict the quality and distribution of the light leaving that surface. To achieve more accurate images, the program use a combination of local and global illuminations, which enables the simulation results to portray highly realistic renderings with accurate measurements of the distribution of light within the scene (Geva and Mukherji, 2007).

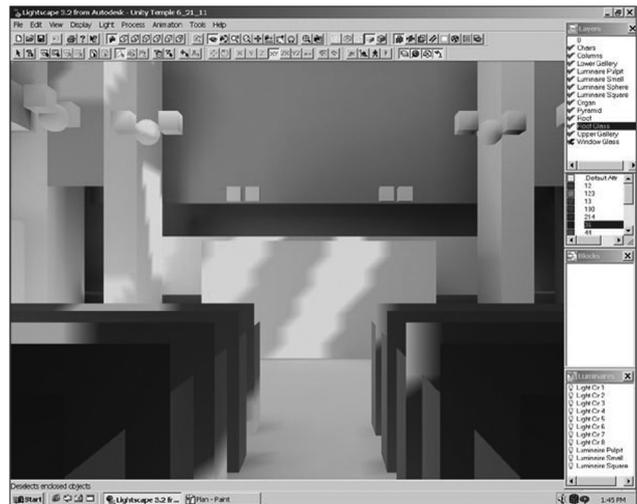


Figure 4. Temple’s pulpit/altar: digital light image

The 3D AutoCad model was imported into Lightscape as an input file. The surfaces and openings of the model were assigned their texture and physical parameters (such as color transparency, shininess, refractive index). In addition, day lighting systems were defined according to the geographical location, date, time, and sky conditions. The simulations were run on the interior horizontal and vertical surfaces on three time frames (9:00 AM, 11:00 AM, and 6:00 PM) during the summer and winter solstices (June 21st and December 21st respectively). The horizontal surfaces included the floors of the main area and the lower gallery, and the benches on the main floor and the lower and upper galleries. The vertical surfaces included the three walls of the upper and lower galleries, and the pulpit.

The output of the simulations consists of lighting analysis, a single images for analysis and presentation, and data for animations such as walk-through images for presentation. In addition, these analyses display the different ratios of the average, minimum, and maximum values of light. These three ratios are used in conjunction with the average values to roughly measure the uniformity of the distribution of the light over a selected surface. The highest average results of running the simulations on Unity Temple were found to be on the pulpit especially at 11:00 AM on both dates: 6448 lux in June 21st, and 3875 lux in December 21st; while at the same time the highest averages of the light in other parts of the Temple were much lower (in June 21st, the light on the upper gallery wall was 1499 lux, and on the main floor 1433 lux; in December 21st, the upper gallery wall was 1451 lux). Additional findings of running the simulations on other horizontal and vertical surfaces and on the benches reveal the same trend. These findings demonstrate Wright's design intentions to focus on the pulpit surface by washing it with light values that are larger than any other area in the Temple, and to leave the rest of the areas gradually darker. Hence, these results corroborate the observation analyses and show empirically the dramatic effect of light in this sacred building (Figure 4).

(c) comparing the simulations values to the Illuminating Engineering Society (IES) lighting standards

The IES Lighting standards for houses of worship include four qualitative guidelines that combine function and spiritual tasks and recommended illuminances for these principles. Task lighting (function) requires 100 lux in simple interiors for groups with religious fervor; accent lighting (spiritual) requires 300 lux; architectural lighting (function and spiritual) 25 lux; and celebration light (spiritual) needs to be controlled according to the church ambiance and activities.

To validate the simulations results, the values obtained from the lighting analyses of Unity Temple were compared to these standards. The findings illustrate that Wright's treatment of light in Unity Temple achieved the recommended principles of the IES for houses of worship and can be evaluated even along current standards and recommendations.

Summary and conclusion

The paper demonstrated the potential of digital applications in the study of lighting in sacred buildings. Specifically, the simulations results corroborated the qualitative evaluation and illustrated Wright's original lighting intention. The discussion on Wright's lighting design along current IES lighting recommendations for houses of worship shows that Wright catered to the spiritual and celebrated light in the ambiance of the Temple, and highlighted the architectural lighting by focusing on the altar/pulpit as the focal point of the sacred space. However, the task lighting in the Temple was only partially achieved, since parts of the Temple are too dark for reading. To overcome this functional lighting

deficiency, larger watts blobs replaced the original over time. Yet, the larger watts increased the heat and caused some of the original light fixtures to deform. Therefore, new replicas of Wright's light fixtures had been installed. Although this solution solved the task (functional) lighting and demonstrated an attempt to maintain Wright's fixture designs, the space is much more lit and lost some of the original dramatic effect of the interplay of light and shadows. In addition, it does not enhance anymore the pulpit as the Temple's focal point (Figure 3). The dilemma between current functional lighting needs and the original lighting intentions of the architect is part of recent discussions of preservation and restoration of historic houses of worships that need upgrade in their lighting system.

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