The poetics of contemplative light in the Church of Notre-Dame-du-Haut designed by Le Corbusier

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Abstract: Le Corbusier was one of the most influential architects of the 20th century and his built structures and writings have become the sources of inspiration for practitioners and students. As Le Corbusier wrote: "Architecture is the masterly, correct and magnificent play of volumes brought together in light". Daylight was one of the key design elements which Le Corbusier used to illuminate and dramatise the space and form, and to evoke special luminous environments which are appropriate for the programme and function of the building in order to enhance and enrich the spatial and visual delight in architecture. The objective of this paper is to investigate the poetics of the contemplative light which one can vividly experience in the Ronchamp chapel. Through on site monitoring and physical model testing, the lighting techniques which Le Corbusier adopted in this Chapel to define the collective and individual light in this sacred structure were qualitatively and quantitatively analysed. This study concluded that Le Corbusier’s skilful orchestration and manipulation of adaptive light, building fenestration, window aperture and the sacred form have led to a poetic luminous environment where both dynamic and static luminous balance co-existed in a harmonious manner.

Much can be learnt by studying Le Corbusier’s religious buildings which were built by using daylight as the primary light source and the built form as the solar clock to register and respond to daily arc of the sun. Detailed analysis on the contemplative light created by Le Corbusier in the Ronchamp Chapel would provide valuable insights and data which can be applied to the more routine design of the luminous environment.

Key Words: Spatial poetry, adaptive light, sacred realm

1. INTRODUCTION

1.1. History

Ronchamp Chapel, one of the most influential buildings of modern architecture, is Le Corbusier’s autobiography. It is the confession of his true nature as an artist, although being an architect he was also a prolific painter and sculptor. The result of such versatile skill was the creation of a chapel at the top of the Notre-Dame-du-Haut hill in East France near Ronchamp village, 20km from Belfort, on the way to Vesoul. Ronchamp Chapel was one of the three religious buildings ever designed by him. The Chapel of Ronchamp and the Monastery of La Tourette were built during his lifetime while the parish church of Saint-Pierre was completed in 2006, 41 years after his death by French architect and Le Corbusier student, Jose Oubrerie.

In 1950 the manager of the photographic archives of France, the director of the museum of decorative arts in Paris and Canon Lucien Ledeur from the seminar of Besanon on the recommendation of Father Alain Couturier of Lyons approached Le Corbusier and asked for his help as he was well known for his design freedom and free play of expression. Le Corbusier was neither a religious extremist nor an atheist as he was raised as a protestant with both his Aunt and Pauline being devout. Bearing in mind the sensitivity of different religious identities in the 1950s, Le Corbusier when asked about his design intentions at Ronchamp he replied: "I have not experienced the miracle of faith, but I have often known the miracle of ineffable space..."[1]. After five years of design and two years of work, on the 25th June 1955, the chapel was finally inaugurated. This paper is not intended to criticise or find faults but on the contrary, it is an appreciation of adaptive light inside a sacred realm in the chapel of Ronchamp.

1.2. The Key is Light

Light has been a vital drive for Le Corbusier in designing a space. He said that "Architecture is the masterly, correct and magnificent play of masses brought together in light..."[2]. Through his religious buildings Le Corbusier used light in different ways "the key is light and light illuminates forms. And these forms take on an emotive power [...]"[3]. In this paper the author’s study will focus on Le Corbusier’s skilful manipulation of Adaptive Light in the chapel of Ronchamp. A significant attribute of the human vision is the ability to clarify between levels of light that vary from complete darkness to the vivid glare of a bright day. This phenomenon is known as adaptation and the mechanisms by which it occurs and its implications for building design have been the subject of much study [4].

1.3. Methodology

In order to understand the poetics of adaptive light in the Chapel of Ronchamp, the luminous environment had been analyzed both qualitatively and
quantitatively. The qualitative analysis, involving tonal sketching and on site observations of the luminous environment reveal the techniques used by Le Corbusiers to achieve light adaptation within a sacred structure.

In order to bring to life the light dramas through longer time periods, a detailed 1:50 scale model was constructed and tested under the Heliodon and Artificial sky. Furthermore, an animation has been composed by the authors to fully appreciate Le Corbusier's skilful orchestration and manipulation of light adaptations within the Chapel. All these information have been cross referenced by the quantitative analysis which involved spot measurements of the photometric data on site.

2. LUMINOUS ENVIRONMENT IN THE RONCHAMP CHAPEL

2.1. The “Promenade Architecturale”

The way you approach, how you enter or exit, all perceive the architects notion of procession to a building, inspired by the Greek Parthenon on the Athenian Acropolis. Le Corbusier envisioned Ronchamp as a three dimensional sculpture to be admired from all perspectives and intended visitors to follow what he described as “promenade architectural”, Of this journey he wrote: It is the “promenade,” the movements we make that act as the motor for architectural events [5].

2.2. Outside

The journey begins from the road linking Belfort with Vesoul as the white outline of the chapel starts to appear going up the hill. The adventure starts from the village of Ronchamp when the visitor takes a steep path and after arriving at the summit of path (figure 1) vision becomes shallower by the trees and bushes and then suddenly, “Outside: we approach, we see, our interest is aroused, we stop, we appreciate...” [6]. As usual, nature had a role in the design as there are various sketches of shells examining the way that outside surfaces become inside ones, and inside ones become outside ones.

2.3. Inside

One of the great accomplishments at Ronchamp is the precise planning of its various phenomena through time and space, to produce a totality of light in motion. A combination of white convex and concave sprayed concrete walls covered by a dark grey shell like roof, compiled by three towers, one being significantly taller than the others, make the Chapel. The architect used concrete because “concrete is a material that doesn't cheat...rough concrete says: " I am concrete.[7] The transition of light changes respectively as the earth rotates. The chapel's two main facades are oriented towards the South and East, separated by a pinched wall that gradually rises as it reaches the end corner. The South Facade with its gently sloping wall holds the main entrance of the chapel.

In the interior of the chapel the use of different colours is dominant to the eye, from the roof to the concrete entrance and finishing with the painted windows on the south wall. Natural light is present in every space and form. Within the chapel there are three private praying spaces under the light towers where light can be classified as Individual Light; the open space where the nave is located can be classified as Collective Light. These two types of light within the chapel contribute to a well balanced luminous environment. The approach to each space is also vital for the architectural notion of light adaptations. In relation to the Individual light which occurs inside all the towers further testing will show how the balance of light occurs to the human eye. Within the Collective Light which covers the nave, East and South wall, further qualitative analysis will show how asymmetrical balance help create a static, yet dynamic luminous environment .

The journey continues to the inside and as one enters the chapel from the North the attention is immediately drawn to the South wall, “the south wall provokes astonishment”[8], but also to the choir on the East, the East wall comes to life as the first light comes up. As one views the East façade, multiple light sources meet the eyes, a horizontal ray of light between the East wall and roof gives the impression of a floating roof, scattered holes behind the altar seem like stars in heaven, followed by a beam of light flushing through from the south east corner, and finally glimpses of natural light from the south wall openings interfere within the space as they naturally balance the scene.
The asymmetrical balance of light created by this lighting technique enhances visual perception by eliminating excessive brightness and contrast[9]. In other words in order to prevent glare the architect used various light sources from different directions to interact on each other. The only point where glare occurs from the East facade is during morning hours were the Virgin Mary Statue is lit by the morning light. As this is the only point in the chapel were glare is observed. After thorough site monitoring, it seems that this was done intentionally by the architect. The importance of Virgin Mary in Christianity is seen through a brightly lit square aperture which produces high levels of contrast, in the chapel at specific points in time, symbolizing the divine light.

Photometric measurements were taken on site as indicated in Figure 3. In the CIBSE code for interior Lighting (1994) and in Daylighting by Hopkinson, the suggested ratio of task luminance to immediate surround to general surround should be in order of 10:3:1 [10]. The strong contrast between a light source and its background can often create glare.

Figure 3: Luminance Contrast Study (on site monitoring) for East, Virgin Mary Statue-from Kaimakliotis, 2008.

Inside the chapel a single statue of the Virgin Mary was displayed in the square window on the east wall and as mentioned above Le Corbusier intentionally emphasized its importance by manipulating the brightness contrast. The ratio calculated for the Virgin Mary statue, the immediate surround and general surround is 63:3:1, indicating high contrast ratio and the occurrence of glare (fig. 3).

In the chapel three towers can be found, each represents an individual sacred space. All towers point at different directions but the third chapel extends from the sacristy in an east west axis capturing the rays of sunrise which become a holy spread as they encounter the tower's red walls.

As the visitor encounters the more private and individual spaces within the chapel, luminance levels and light sources change accordingly but only within that specific space. This is an individual light within a collective space therefore it does not interfere with the luminous balance of the east and South facade.

Moving away from the east facing tower, and as the rays of light within the east wall gradually dim out, the south wall comes to life, lighting up the deep splayed windows which capture the sun at a specific point in time. As time passes and the earth rotates around the sun different window apertures light up on the South Wall. After conducting on site monitoring, Aperture F, (figure 4) experienced glare. This was because at the specific time when the reading was taken, window F was directly facing the sun. All the openings are orientated in slightly different angles capturing momentarily the sun at different times of the day. Le Corbusier used this technique to gradually prepare one's adaptation to the constantly changing light through the thick south wall and led the visitors to the next spiritual realm.

Figure 4: Luminance Contrast Study South Wall, top centre image from physical model-from Kaimakliotis, 2008.

Although facing South one can barely experience glare as the large thicknesses of the walls gradually diffuse light through, and at the same time the shell like roof acting as a canopy on the outside, blocks most light beams from the sun, especially during summer months. An effective technique used by the architect to block the direct sun beams from the outside without interfering with the inside and therefore creating a well balanced internal lighting condition. Due to varying positions of the sun, winter sun is lower, summer sun is higher, the luminous environment during both seasons changes dramatically with the winter season exposing the south wall to direct solar penetration.(figure 5) This is the only season when sun rays are allowed to penetrate into the chapel, to bring direct light and warmth to the nave.

Figure 5: Section through south wall, images from physical model showing how roof blocks the sun in summer-from kaimakliotis, 2008.
As the South Wall gradually dims out to ambient light levels, and as the sun sets, the West facade takes on its turn to contribute to the poetics of contemplative light. In order to demonstrate the balance of light on the West façade, the architect used a combination of individual and collective light. The West facade is the only blind facade in the chapel but it is accompanied by the South Tower (figure 6), in a north/south axis receives the relatively constant north light through the calotte above it, the other tower aligned east-west axis lights the structure with the setting sun through its west facing calotte. Again the skilful lighting technique is clearly shown here as the two towers on the West facade create an asymmetrical balance which in turn enhancing the light adaptation.

Based on figure 6 we can observe how light is evenly distributed from the top of the tower to the bottom. Although human eyes operate over a large range of light levels. They need to adjust gradually to its surroundings. Le Corbusier managed to disperse light inside the tower which helps the human eye to gradually adapt to the relatively dark luminous environment.

As the journey continues on the blind West facade from the North tower, attention is drawn to the smaller chapel as the sunset funnels light through the calottes above (figure 7). A more individual space with access only allowed by the priest. Again the architect managed to calm the human eye by providing only the necessary levels of light for light adaptation.

In order for the architect to achieve an asymmetrical balance by introducing various light sources to balance the human perception of a specific place, much thinking and testing had been done. One of Le Corbusiers associates, Iannis Xenakis, a Greek architect / engineer was thought to have helped in the design and testing although the extend of his involvement in the design is unclear. As shown on figure 8 a 1:50 model was built and tested on the heliodon in order to capture the dramatic luminous environment from sunrise to sunset. The model was also used by the authors in the artificial sky to observe how light filters through the building. Daylight factor was also calculated and compared with the onsite measurements. In order to understand how the architect managed to evenly disperse natural light through various apertures of the chapel various tests have been carried out.

The daylight factor in the chapel of Ronchamp will be expected to be low since it is normal to have low illuminance levels in a church. Le Corbusier tried to control the light intensity but at the same time to balance the light inside the chapel (figure 9). a simple test was constructed to prove this. The onsite measurements for the daylight illuminance were taken when the North door was deliberately left open and then closed. The photometric data taken from the physical model were recorded with the door closed and a comparison was made. A 1mx1m virtual grid was mapped on the floor plan to help derive the daylight distribution pattern under overcast sky conditions.
Daylight Factor came out to be as low as expected. This is normal for a sacred place like Ronchamp because a more tranquil and meditative luminous environment is needed. However the Daylight Factor is double the value when the north door was left open (figure 10). Ronchamp has many window apertures but because each one has a specific task towards controlling the light entering the space and in turn contributing to the poetics of contemplative light, one single door when opened would make a huge difference inside the space. This proves how the architect used various light apertures to bring in the light in different spaces. As we can see from the graph in figure 12 the red line indicates illuminance levels when door is opened and blue line when door is closed. It is important to point out how uniform the light levels are within the sacred space while the door is kept close. Uniformity, light adaptation, contrast grading and balance of light is the lighting techniques that Le Corbusier frequently used in this sacred structure.

The Luminous environment on the South wall were tested by using the Heliodon and physical model and the results can be clearly seen on the matrix (figure 13). Light on the key dates like Winter solstice, Summer Solstice and Equinox have been investigated by taking pictures using a high resolution webcam, every half an hour starting from 6:00 in the morning till 18:00. The luminous environment varies at different times and depending how one views the south wall different perspectives can be perceived. According to Figure 13 the most interesting season to visit the chapel is winter. In winter, the south wall has full exposure to the sun due to the fact that the sun’s arc is lower, and therefore light penetrates the chapel along the whole length of the south wall. For all seasons, the most revealing times of various luminosities are when the sun rises in the morning and when the sun sets in the evening. The poetry behind light exposure is controlled at specific times of the day. Quite cleverly the architect tried to keep the luminosity of the south wall relatively constant from about 11:00 o clock until 15:00 in the afternoon. This can be observed clearly from Figure 13. In the morning the East wall becomes alive, and as the sun sets, change in luminance levels can be clearly seen on the south wall and west facade (towers). Light does not change in a drastic manner, but in a rather gradual way. Light slowly fades away, proving how the architect managed to control the light balance inside this sacred place by avoiding high brightness contrast and glare.

As the south wall provokes astonishment, it is at the same time an exhibition of the architect’s talent and techniques. It is particularly interesting to observe how Le Corbusier used the roof to partially shade the south wall in the summer. He allowed light to penetrate only through the first row of openings on the south wall. This explains the architectural poetics on the south wall besides the modulor. The south wall is 3.7 meters thick at the bottom and 50 cm thick at the top. The first row of openings on the south wall is wider than all the others as the architect used the thicknesses of the wall to diffuse light evenly through the space.

Using a high resolution web camera, inside the north facing tower of the physical model, tests have been conducted to investigated how light is being
diffused accurately and achieving sufficient adaptation levels for visual comfort.

From Figure 14 we can understand how the architect used multiple light sources to funnel light through the tower. If one light source is temporarily blocked (Figure 14-C) then the contrast ratio increases dramatically to an uncomfortable level, also reducing the light intensity through the tower (figure 14-1) tip the balance in the luminous scene. Image D and image 2 in Figure 14 shows all the light sources actively working together to create a well balanced luminous environment at the west end of the chapel.

Finally the poetry behind the contemplative light can be further explained by referring to Figure15. two interior views captured moments within the chapel showing how Le Corbusier used a minimum of two light sources within a scene to create asymmetric balance of light. If high degree of brightness contrast exists between the brightly lit opening and the darker surrounding, then glare will occur. But glare can be avoided by allowing natural light to enter a space from at least two directions. Also Le Corbusier rarely used direct light, light gets filtered as it enters the space by using various calottes, colored glass, wide aperture openings with splayed reveal, and thick walls, Le Corbusier achieved the dynamic luminous balance by allowing diffused and reflected light to enter the Ronchamp Chapel, thus providing desirable luminous environment for the visitors. This study demonstrates how light balance and adaptation had been skillfully considered and manipulated by Le Corbusier in the sacred realm.

3. CONCLUSION

Ronchamp is a light machine, a solar clock registers the movement of the sun in different seasons. Different light traps capture the sunrise and follow through to sunset. What is fascinating is that whatever the devices are on the outside, they mirrored on the inside. Glare is skillfully avoided within the chapel by using architectural elements like calottes, doors and splayed apertures. Thicknesses of walls also play a vital role in funneling light though the tapered South wall. As the roof design might have been inspired from a crabs shell, it plays a significant role for blocking out the summer sun and controlling the luminous environment inside Ronchamp Chapel.

4. REFERENCES