

Divine Shine. Light in eighteenth-century religious architecture: Spain, Mexico and the Philippines

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Abstract: Light can be considered one of the key elements in the history of architecture, although technical limitations have made its analysis difficult until recently. It is now time to address how early modern architects dealt with luminescence by creating differentiated spaces. More specifically, this paper aims to prove that religious structures built in cities under Spanish rule during the eighteenth century in Europe, the Americas and Asia replicated a clear pattern. To prove this preliminarily, significant examples have been selected from different countries. Four are from Spain: (1) San Luis de los Franceses, (2) San Jacinto, (3) San Pablo (Seville) and (4) Cadiz's Cathedral. One is from Mexico: (5) the Basilica de Guadalupe. Finally, one is from Manila in the Philippines: (6) the city's eighteenth-century cathedral. Some of these structures are not preserved or have been drastically altered, requiring them to be reconstructed. Given the methodological challenges, tools including CAD modeling, terrestrial laser scanning, and photogrammetric instruments have been employed and their results compared. Afterwards, results have been analysed with specific software, such as Relux for 3D objects and Dialux for CAD models. Initial results demonstrate that there was a pattern of lighting maintained on different continents, even when contemporary treatises and contracts rarely addressed this topic. The presbytery is usually dark compared with the light of the nave and the choir. Along the same line, walls are not illuminated, thus highlighting the central space. Finally, it is noteworthy that sunlight is avoided in favor of a more homogenous solution.

Keywords: *Light simulation—Digital architectural history—Early Modern—18th century—Religious architecture*

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Introduction

The history of early modern architecture has usually emphasized the importance of light in its development, especially in churches (Riegl, 1908, p. 195; Bonet Correa, 1978; Blunt, 1979; Levy, 2004). Probably based on Biblical sources, light was understood as a representation of God (1 John 1:5), as well as an architectural tool to create space, just as painting was developing as a medium. Therefore, many churches were organised to place the better-illuminated areas at the presbytery, where the presence of God existed. At first, light was used as a rhythmical resource, to highlight some areas and perspectives (Riegl, 1908, p. 195), but from the seventeenth century onward, a new range of possibilities seems to appear. The development of dramatic techniques also affected the religious

space and light became an awe-inspiring resource to get the faithful's attention, as Blunt (1979, pp. 23–24) already emphasized in Borromini's case, even without the possibility of proving it using digital analysis. In addition to bathing some parts of the interior with light, it was required to highlight tiny ornamental elements. A good example of this, still little studied, is a hidden window in a tabernacle designed by Pozzo in the Gesù Church in Rome. Light reflected onto the halo of the saint and from there to the surrounding mirrors creates a surprising effect (Levy, 2004, pp. 170). To achieve this, previously bright Renaissance churches needed to have reduced their interior lighting to underscore such an impact. At this point, it seems probable that every architectural tradition explored different options (Fabri, 2008; Poppe, 2008), including the possibilities of artificial light sources. Spanish Baroque interiors put forth a different space when compared with previous ones (Bonet Correa, 1978; Luengo, 2016; Luengo Gutiérrez and Luengo Gutiérrez, 2019). As has been traditionally understood, sunlight emphasized the nave, while the main altar remained dark, creating a "cave effect". Such innovations were parallel to their expansion and consolidation, first in the Americas and later in the Philippines, creating a culturally globalised scenario. Traditional historiographical interest on light has been based on subjective approaches (Riegl, 1908; Bonet Correa, 1978; Blunt, 1979; Levy, 2004), due to the lack of analytical tools that are now available. In recent years, some efforts have allowed us to reconstruct destroyed structures digitally and to survey preserved ones in each of these three countries, permitting a digital analysis from light simulations (Almodovar-Melendo; Cabeza-Lainez and Rodríguez-Cunill, 2018; Luengo, 2019). In parallel, a few scholars have worked on the topic for other chronological and geographical frameworks with significant successes (Moullou et al., 2012; Moullou et al., 2015; Papadopoulous, 2017), which stresses the possibilities of these techniques enriching traditional discussions on architecture's evolution. This growing academic field requires more digital examples, including both natural and artificial light simulation, to uncover diverse spatial solutions.

Objective

This paper aims to define the particularities of the Spanish religious interior in terms of sunlight, initially through the use of candles, according to the experiences of Moullou et al (2015). Additionally, the methodological aspect is also relevant. Thus, different technical approaches will be compared in the results to find the most accurate or least costly option. Until now, the afore-mentioned papers carried out their analyses using local data collections or manual reconstructions based on measurements. In these latter cases, architectural volumes were reproduced, simplifying the remaining decorative elements, mostly included in the church design from the beginning. To do this, a selection of eighteenth-century churches has been made, including four in Spain: (1) San Luis de los Franceses, (2) San Jacinto, (3) Seville's San Pablo and (4) Cadiz's Cathedral; one in Mexico: (5) the Basilica de Guadalupe; and one in Manila, the Philippines: (6) the city's eighteenth-century cathedral. Although located on different continents, Seville and Cadiz are at a similar latitude (N37°22'58.19", N36° 31' 48" respectively), while Mexico and Manila are closer to the equator (N19° 29' 52" and N14° 36' 2"). Despite this difference, and its effect on sun incidence, the results are not expected to differ drastically. With this in mind, and remembering that the correspondent Pre-Hispanic religious traditions are different, it would be clear that it is an attempt at Western artistic uniformity. Digital reconstruction has been obtained using different methods for purposes of comparison. Some have been carried

out using a RTC360 laser scanner (1 and 3); one using close-range photogrammetry (2) (see Fig. 1), while the final two were manually reconstructed (4, 5 and 6) (see Fig. 2 and 3), due to some changes in the building or its complete destruction. Although the details obtained, and the time required are not the same, this paper aims to discuss if these three options are enough to arrive at basic conclusions and which relevant differences have been found.

The selection demonstrates a significant range, covering the issue both geographically and chronologically, but several problems arise. Some of these structures were not preserved or were drastically altered, especially in lighting terms. Furthermore, the intent of this research was demonstrating that the building was planned to maintain a uniform lighting pattern throughout the entire year, not focusing only on particular dates. For this reason, an empirical approach was avoided, and a digital simulation preferred. To compare the quality of the results, different digitalization processes were employed.

Methodology

The current status of the particular church determined the methodological approach. The easiest option was an analysis through a CAD reconstruction. This was used in Manila's cathedral, which is not preserved except for historical plans and several descriptions, where references to ornamentation are rare. Although most data was available in historical studies (Luengo, 2019), some aspects, such as the measurements of the windows, were taken from those included in the façade, relying on architectural coherence. Such decisions, in addition to the doubts about the possible differences between the project and the final structure, weaken the results' reliability. The Basilica of Guadalupe in Mexico City still exists, but this investigation has not yet been able to gain access to a digitalization of the building, thus requiring its manual reconstruction, similar to that made for Manila. The Cadiz Cathedral exhibits a more complex situation. Although the building is still in use, the building process was very complex, especially the lighting aspects, which changed at various stages during the building process. For this reason, a similar approach was chosen. An initial reconstruction was carried out using the information available in historical plans and descriptions. A second reconstruction was done, taking data from a contemporary wood model still preserved. In all these cases, based on CAD approaches, buildings are simplified, not including, for instance, tabernacles, artworks, platforms, pipe organs, or choir stalls. They may affect the results, but the information as to their historical locations, being time consuming to reconstruct, led them to not be included in this examination. These CAD models were analysed with Dialux due to its possibilities in designing complex architectural spaces. Material properties were not assigned to surfaces because most of them were about 50 % reflection factor, not affecting significantly final results. Solstice and equinox both at midday and early morning, when masses took place, were included in the process.

The other churches are well preserved in Seville. Although they have been modified, it is easy to undo these changes digitally. Thereafter, a digitalization process was initiated using photogrammetry and three-dimensional scanning. The first technique was applied to San Jacinto, because unfortunately most of its decorations have disappeared, making the effort easier. The three-dimensional file was converted into OBJ to be later analysed with Relux. This software is better prepared to deal with such files, which are not accepted by Dialux. As can be seen in Fig. 1, in addition to the data on the

common spaces, which may be similar in detail when compared with other approaches, analysing the church with all its ornamentation allows us to understand its illumination in a more complex manner. After this milestone, the two remaining examples were addressed. In contrast to the characteristics of San Jacinto, San Pablo and San Luis de los Franceses are complex buildings with a full ornamentation program still preserved. This complex scenario may provide very interesting results but necessitated a different instrument. For them, a Leica RTC360 scanner was used, digitizing the interior only. The file included an immense amount of detail, even when some surfaces on the top parts of the edifice were not recorded. This signifies a large number of geometrical facades, making a subsequent digital processing with the afore-mentioned software impossible. Thus, the original file was simplified, removing data on textures and reducing the level of detail until a minimally viable reconstruction was accomplished. The file was reduced under 64000 faces, confirming that space was still recognizable.

In addition to this equipment, it is important to note that the analysis was based on simulations for the winter and summer equinoxes in the mornings. It was taken for granted that no coloured windows were included, because coloured windows were uncommon after Gothic architecture went into decline, at least according to the examples preserved. Considering liturgical uses of the time, attempts between 9am and 12 noon were included, this being the time of day in which both choir and major masses were celebrated in churches. Moreover, adjacent buildings were not considered in any instance. Although the lack of tall structures nearby is clear in historical sources in most cases (1, 2, 4 and 5), it is difficult to prove for all examples.

Results

Regardless of the method used, the results obtained do not differ significantly. San Pablo (1690–1709) and San Jacinto (1730–1774) in Seville were both Dominican convents renovated or designed by Figueroa in the eighteenth century. They represent the typical example, where the presbytery and the lateral naves are consciously darkened in favour of the central one. At the same time, the upper part of the building, especially the vaults, are brighter. Most of the building remains under 250 lux, what signifies a satisfactory context for the preservation of paintings and gilded tabernacles. One of the members of this architectural dynasty also built San Luis de los Franceses (1699–1730). While San Pablo and San Jacinto are large three-naved churches, San Luis de los Franceses reflects a Greek floorplan. The general results by Almodovar, Cabeza and Rodriguez (2018), confirmed by this study using a different approach, shows that an average of 150 lux at the central part of the building is common, while the maximum of 400–1000 lux must be associated with specific and significant uses of light in a dramatic or baroque sense.

The oldest example emanating from European models analysed here is the Basilica of Guadalupe in Mexico City (1695–1709), built by Pedro de Arrieta. According to the results on the plan, the luminance average must have been between 100 and 250 lux. In this specific case, no difference has been found between the altar and the nave, likely because of its centralized plan. The next example, the Cadiz Cathedral (1722–1838) is much more complex. During its building process, different technical discussions emerged, including those about lighting effects. Summarizing it from previous studies (Luengo, 2019), it can be said that the final building emphasizes the transept with results of 5000

lux, while both the lateral naves and the presbytery remain at 1000 lux. It seems clear that the pattern is maintained, but the luminescence increased in the subsequent projects proposed that century. Finally, the now-lost Manila Cathedral (1750–1764) was designed to allow an average luminescence of 330–500 lux at the central nave, while lateral ones and especially the transept remained bleaker.

Conclusions

These analyses, along with those previously published, demonstrate that there was a lighting pattern to be preserved on different continents, even when contemporary treatises and contracts rarely address this topic. The presbytery is usually dark compared with the light of the nave and the choir. Along the same line, walls are not illuminated, highlighting the central space. Finally, it is noteworthy that sunlight is avoided, in favour of a more homogenous solution. This solution is clearly linked with the liturgical functions of artworks. On the one hand, avoiding direct sunlight on the walls is required to preserve paintings, which must be kept under 250 lux. On the other hand, darkening the main altar allowed priests to use candles and mirrors to theatrically manage artificial light at every event. Finally, highlighting the upper part of the building stressed the building's divine character while simultaneously reducing the effect of heat in tropical climates. After this baroque solution, which was part of the Enlightenment, churches were clearly better illuminated, by an average range of 300–500 lux. Such levels brightened the spiritual space while at the same time made it impossible to maintain the variety of artworks previously used. Paintings, tabernacles, little chapels, and even pipe organs and choir stalls were eliminated or simplified as part of a new paradigm, an effect of this new lighting scenario.

Choosing dark spaces in the most relevant parts of the building requires the consideration of the use of candles, the analysis of which previous studies have initiated, although they focus on other chronological and geographical contexts (Moullou, Doulos and Topalis, 2015). While much research should be performed on the analysis of different historical luminary tools and their materials (e.g. spouted lamps and floating-wick lamps, fueled either by oil, beeswax, fat or tallow), it has been demonstrated that a single candle should provide less than 20 lux at 25 cm when fueled by olive oil or a little more when made with beeswax (Moullou, Doulos and Topalis, 2015). According to contemporary engravings showing the interior of churches or the institutional budgets dedicated to lighting, it seems that the number of candles could reach more than one hundred during large festivities. Considering that most of these celebrations were held during the day, their effect depended on the darkness in the presbytery. Combining the results with the possibilities of artificial light, it is clear that they allowed priests to manage light to emphasize liturgical spaces or pieces in a freer manner than could sunlight. As a consequence, this paper demonstrates that the function of light was preserved in different geographical contexts. Lack of skilled architects, challenges due to natural phenomena like earthquakes or different cultural approaches to light were not obstacles to maintain a common interpretation of sacred space. Therefore, presbyteries were kept dark to be artificially and theatrically illuminated by candles. On the contrary, naves had more sunlight. In any case, the rays of the sun were not common in preference to faint effects.

In addition to these conclusions, it is important to focus also on methodological challenges as they relate to the historiographical discussion. From the examples here, it can be said that analysis from

basic manual reconstructions is a good preliminary step. From these, it can be shown how light is generally used in the church. Thereafter, it is possible to identify some instances wherein the architect seems to have paid little attention to this possibility, probably eliminating the need for further simulations as well as identifying some national characteristics, e.g. elucidating differences between French, Italian and Spanish traditions, a possibility yet little explored. Similarly, the role of decoration cannot be understood as a mere decorative function. On the contrary, furnishings might be the reason for the general lighting display, as has been noted in Rome's Gesù Church (Levy, 2004); or furnishings may underline the iconographical discourse. For this reason, paintings, tabernacles, pipe organs, among other examples, play a significant role in the analysis. Assuming this to be true, the current technical problem must be addressed. Both from photogrammetrical or laser scanning, the reconstructions incorporate these pieces as they currently exist. Whether by reducing detail or removing textural information, the interpretation of light can be carried out. It is reasonable to think that such issues of processing capacity will be resolved in the coming years, it being preferable to begin from the best digitalisations possible. In addition to all this, it is important to note that traditional analyses based on results from plans and profiles are not enough, precisely because of the relevance of these artworks. As an initial approach, it would be interesting to examine the effects of light on them, while it is also significant to control how the light is perceived by the user, and thereafter, what the results show at 1.60 meters.

From the results obtained, several questions can be addressed. Most of these churches have been subsequently modernized with artificial lighting. Due to their dimensions and daily activities, both the economic and environmental costs are significant when the solutions do not stress the original spatial conception but instead create a completely different display. For this reason, in addition to these two problems, the building as an example of the past is not highlighted but somehow modified. It is evident that the liturgical requirements have changed considerably after the Second Vatican Council, and more specifically after the *Sacrosanctum Concilium* constitution (1963). Nevertheless, the discussion about the characteristics of the religious space must be opened from a more sustainable perspective. Finally, there is an increasing interest on empirical studies on the topic. Religious space requires the movement of the user to be understood, and such activity produces changes in perception. Future approaches might connect the results recently published by psychologists on the matter (Skarlatou, 2011), and couple them with a historically logical use of the space, to begin analysing these spaces more interdisciplinary.

Figures

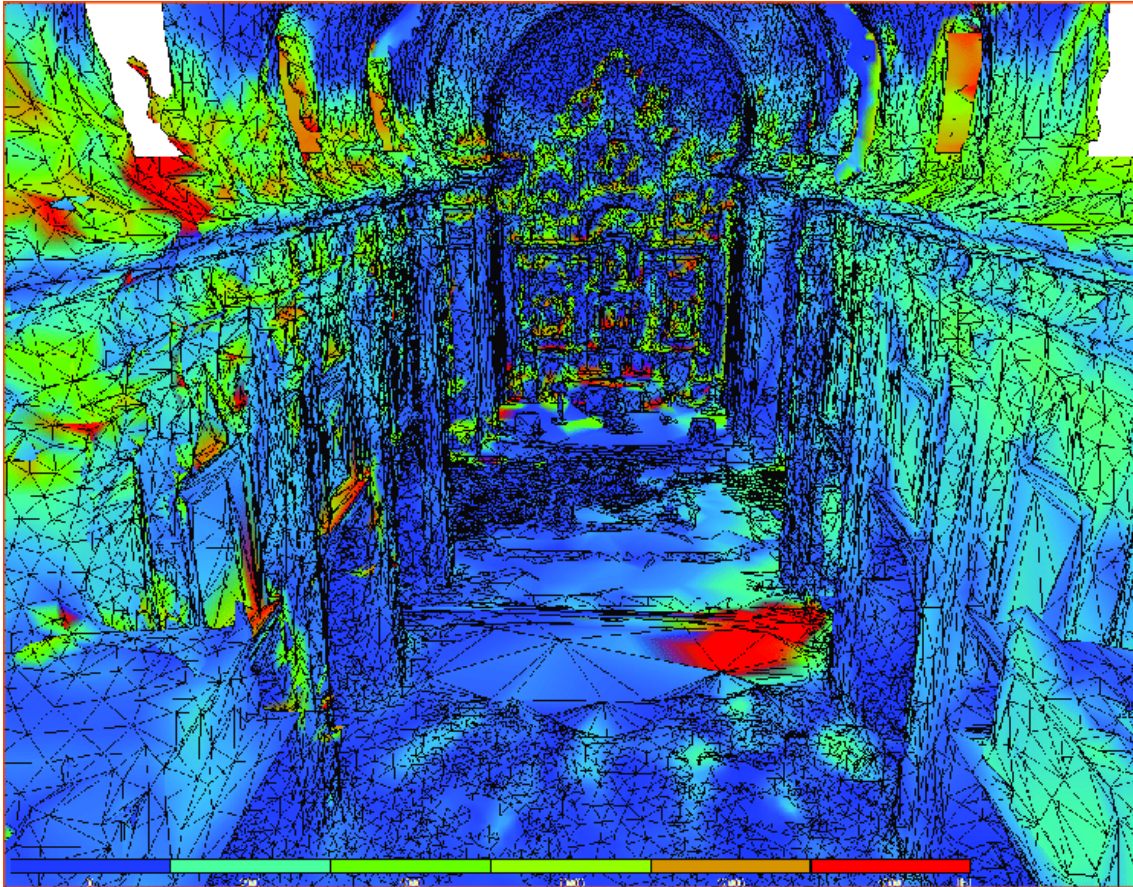


Fig. 1. Digital analysis of light incidence in San Jacinto Church. Seville, Spain. (© P. Luengo)

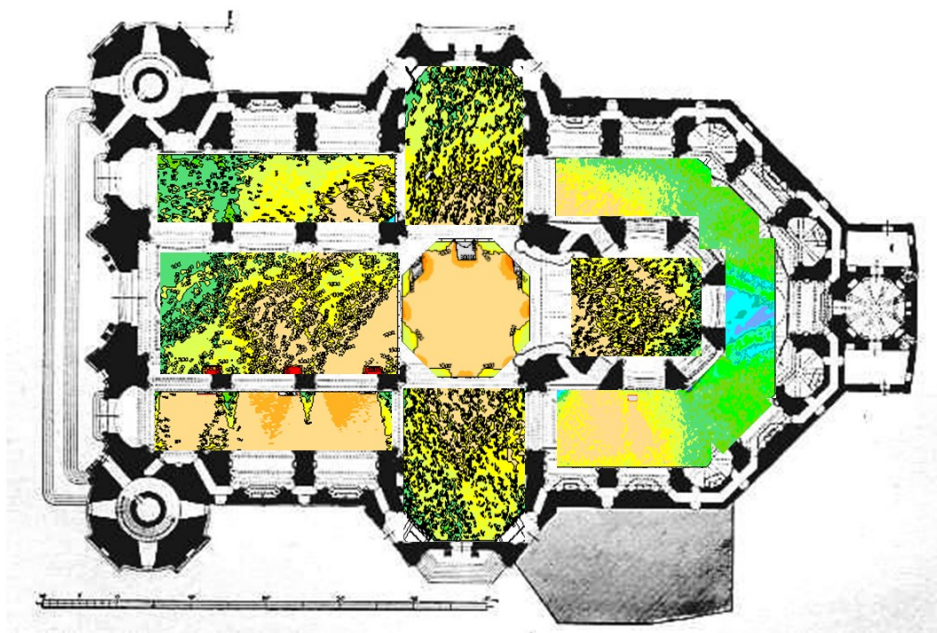


Fig. 2. Digital analysis of light incidence in Cadiz Cathedral. Cadiz, Spain. (© P. Luengo)

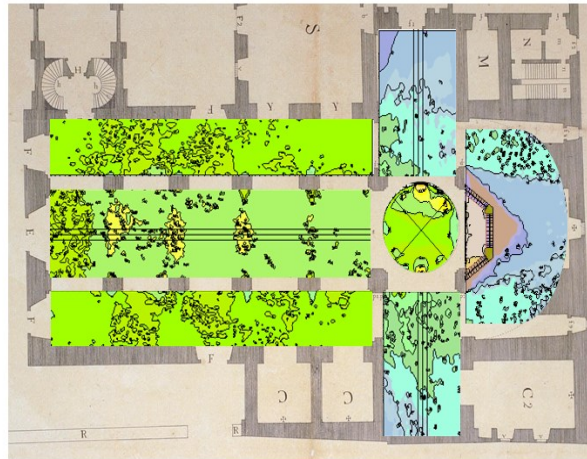


Fig. 3. Digital analysis of light incidence in the eighteenth-century Manila Cathedral. Manila, Philippines. (© P. Luengo)

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