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RESEARCH ARTICLE

Qualitative and quantitative analysis of natural light in the dome of San Lorenzo, Turin [☆]

Sadegh Panahiazar^{a,*}, Morteza Matkan^b^aUCD School of Art History and Cultural Policy, University College Dublin, Dublin 4, Ireland^bUCD School of Architecture, University College Dublin, Dublin 4, Ireland

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HDRI**Abstract**

The Church of San Lorenzo in Turin, which was designed by the Theatine architect Guarino Guarini in the 17th century, is among the most famous Christian Baroque architectural masterpieces. Guarini was given freedom to plan and design this church, which can be considered his most innovative and influential work. The most significant feature of this building is its dome, which is magnificent and slightly different from what is expected from a Baroque church. The dome of San Lorenzo has been the subject of considerable research due to its perforated surface that allows daylight to penetrate into the interior space. However, this dome has been mostly described through mere observation in a poetic and mystical manner. Although a subjective analysis is vital in understanding this architectural piece, a systematic and objective analysis that includes numerical data is required to understand fully the illumination by natural light present in this work of architecture.

This paper presents a method based on high-dynamic-range-imaging luminance analysis that employs a quantitative luminous measurement technique to analyze the daylight behavior in San Lorenzo. The first section of this paper investigates the subjective experience in the dome hall, and the last two sections objectively show the dome functions and the manner through which the design of Guarini creates various light values in different parts of the dome. Such a design is responsible for the unique experience in the dome hall.

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*Corresponding author.

E-mail address: sadegh.panahi@ucdconnect.ie (S. Panahiazar).[☆]Peer review under responsibility of Southeast University.

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1. Introduction

A review of literature on the architectural projects of Guarino Guarini, especially the Church of San Lorenzo, demonstrates that extraordinary quality of natural light is the main element in Guarini's architectural work. The Church of San Lorenzo was established in the former Piedmontese capital of Turin between 1668 and 1687. Despite its magnificent architectural detailing, amazing geometrical stylization, and splendid use of color and sculptural decoration, light is perceived as the fundamental aesthetical element of this church. Although the importance of its light has been repeatedly mentioned in literature, the dome of San Lorenzo is still mostly described in a poetic and mystical manner. Meek (1990) described "...the consequent diffusion of high-level light that converts his dome from one with single continuous mural boundary into an aerial cage, opening onto an outer zone..." Robison (1991) recounted how Guarini "manipulated light and geometry to create interiors with a seemingly limitless extension of space," and "...light and hidden structures permit elevated forms to appear to float above the interior, creating a dancing motion." Others have mentioned that "a Guarini dome, such as the one in his Church of San Lorenzo in Turin, becomes a luminous cage of slender intersecting ribs over which floats the light-filled space of the lantern visible through the complex rib network" (Trachtenberg and Hyman, 2003).

Scientific achievements in recent decades can lead to systematic and objective analyses of the lighting characteristics of this splendid work of architecture. For example, numerical data can be used to compare light levels in different parts of the dome. Such a comparison allows for the analysis of the majestic effect in the dome hall mentioned in many existing studies on San Lorenzo.

2. Methodology

This paper presents a method that can overcome the limitations of purely visual analysis. The first section provides general information on the building and existing literature. This provision helps readers analyze the design philosophy that led to the creation of the edifice and learn about the perception and understanding of scholars regarding the natural light in San Lorenzo. In the second part, the building is analyzed architecturally to help readers understand the functionality of the design. An architectural analysis using sections, elevations, and plans is provided to demonstrate the tricks and architectural details that influenced the creation of the environment described in the first section. The last part presents high-dynamic-range imaging (HDRI) luminance measurement, which provides numeric data on light behavior by using a quantitative luminous measurement technique.

HDRI was utilized to measure the volume of natural light under the dome in this study. Few other methods, such as 3D modeling or using a luminance measurement device, can be used for the same purpose. An advantage of HDRI luminance mapping is that it can be easily used for buildings, including historical ones, for which 3D modeling is nearly impossible due to complicated building details and forms and the aging

effect on the materials that reflect natural light. HDRI luminance mapping can also measure what is actually present, including complex light reflections on the complex, aged, and weathered surfaces of tiles, stones, and bricks. HDRI can measure luminance in any specific view. Furthermore, HDRI luminance mapping only requires a single-lens-reflex (SLR) camera and a computer to analyze data, whereas luminance measurement devices are expensive and unusable for other purposes.

The HDRI mapping technique is a valuable tool to scientifically analyze the luminance effect of the dome of San Lorenzo as a whole, quantify natural light in different areas of the dome, observe the luminance characteristics of each individual opening by using exact values, and ultimately understand the qualitative and quantitative presence of natural light in the interior space.

HDRI luminance measurement helps ensure that the understanding obtained from the first two sections is based on correct numeric data. The first two components make data analyses by HDRI valuable.

3. San Lorenzo and Guarini Guarino

The Royal Church of San Lorenzo, which was designed by Guarino Guarini and built between 1668 and 1687, stands in the corner of Piazza Castello in Turin (Fig. 1).

Guarino Guarini was a 17th century Italian architect and a mathematician, astronomer, philosopher, and Theatine priest who strongly valued light in all his work. Light is the foundation of Guarini's work. His book on Euclid (Guarini, 1671) reveals that Guarini's mathematics and geometry pertained to light. For him, light is the ultimate material that reveals all forms. The relationship between mathematics and light is bilateral in the work of Guarini. Guarini claimed that mathematics is light and is the source of light at the same time. In his philosophy, light and mathematics merge to become one, and architecture is created through this fusion. San Lorenzo can be considered the physical crystallization of this philosophy. Despite his vast knowledge in geometry and mathematics, Guarini was a man of God, a priest who was well-educated in philosophy

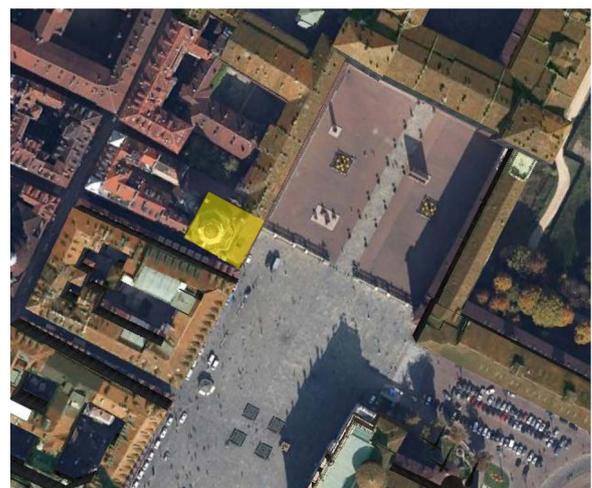


Fig. 1 Location of San Lorenzo in Piazza Castello (Image from Google maps).

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