



Daylighting simulation as an architectural design process in museums installed with toplights

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ABSTRACT

Museums have the most complicated lighting criteria of common building types. A stable lighting environment for visitors and artworks should be guaranteed within the exhibition areas of museums. This paper presents a challenge to the application of daylighting simulation integrated into the architectural design process (DSADP). The scale model measurements and computer simulations were carried out to verify the computer program RADIANCE. A comparison between the measurement and simulation results showed that there was considerable relative error at measurement points. Therefore, a correction factor (CF) and corrected simulation (CS) were recalculated to correct the simulation results. The Seoul Museum of Art (SMOA) was selected to make an application of DSADP. The monitor and sawtooth-shaped toplights were chosen as attractive alternatives for the existing skylight of SMOA. The application of DSADP was carried out by changing the light transmission efficiency and opening size of the toplights. The RADIANCE results showed that computer simulation models can accurately represent the lighting environment under clear sky conditions, and more importantly, they can be used to propose an alternative toplight for SMOA. Therefore, the research results showed that DSADP technology would be very useful during the schematic design stage of the architectural design process. The findings of this research also suggested that there are large differences between the real sky conditions for scale model measurements and the CIE sky conditions for computer simulations. More studies are required to reduce the differences between real and simulated sky conditions.

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1. Introduction

Over the past two centuries, museums have evolved with the changing needs of their visitors and the shift in the focus of their exhibits. Currently, museums seem to fulfill multiple functions, including the display and conservation of artworks, research, public education programs, and cultural events. Therefore, exhibits should be displayed in ways that enable visitors to see, manipulate, and interact with them, and more importantly, in ways that attract a visitor's attention to their subject matter.

Many architects have tried to support richer visitor experiences by enhancing the effectiveness of display methods during the design process. It has also been believed that art objects should be displayed and viewed under the same lighting conditions as those under which they were created. Historically, architects have opted for natural light in museums. Their main responsibility was to ensure optimum illumination for each artwork by effectively

controlling the duration and total exposure to natural light, and thus providing the correct intensity of illumination [1]. In particular, there has been a need to handle bright daylight cautiously in order to maintain the ideal illuminance distribution for revealing the unique beauty of each artwork to the museum visitors. Nonetheless, the irregular distribution of daylight and the direct sunlight passing through windows and other openings have caused difficulties not only in the display of artworks but also in their conservation.

Architects are interested in natural light for its energy conservation benefits as well as the opportunities it presents for utilizing various light qualities and color rendering effects. Museums benefit more from the qualitative than the quantitative aspects of daylighting. In the circulation areas of museums, the principal objective of the lighting environment is satisfying the information needs of visitors. Daylighting can be valuable for orientation and visual relief, particularly in very large institutions, where the visitors' experience will be much more enjoyable and less tiring if they do not feel lost in an endless maze of rooms. Daylighting can emphasize important or beautiful architectural forms and the natural illumination of surfaces adds a quiet sparkle to spaces.

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