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Daylighting Optimization Study: Rock Creek High School Commons Skylight Optimization

Razieh Hosseini Nezhad
Portland State University, razieh@pdx.edu

Heather McGinn
Portland State University

Nicholas Papaefthimiou
Portland State University, ndp4@pdx.edu

Rosemary Hill
Portland State University

BORA Architects

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Daylighting Optimization Study

Rock Creek High School Commons Skylight Optimization

BORA **Architects:**
Heather McGinn, Jacob Peel, Nick McFadden

Portland State UNIVERSITY

PSU M.Arch Students:
Razieh Hosseini Nezhad and Ashley McDaniel-Harpster

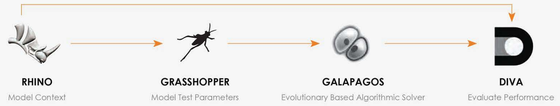
PSU School of Architecture Advisors:
Nicholas Papaefthimiou, Rosemary Hill

Project Overview:

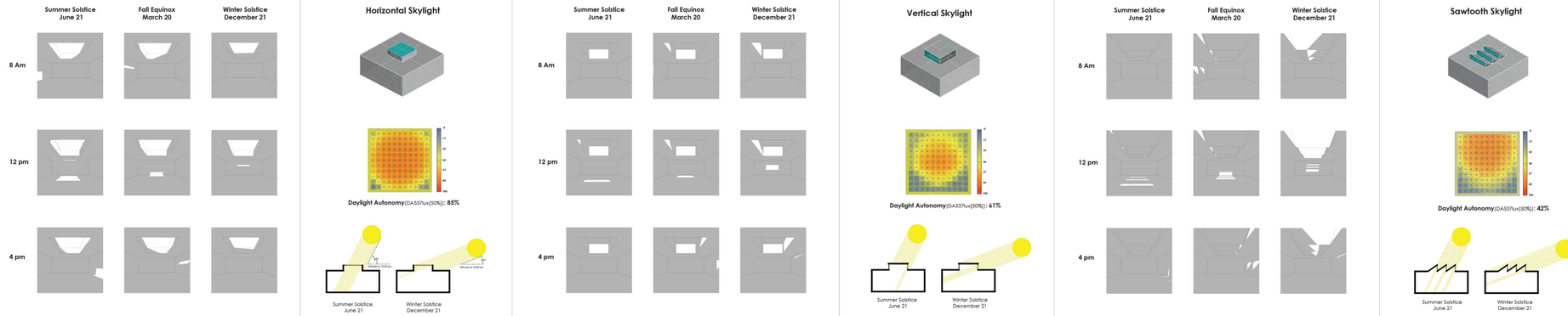
Rock Creek High School
Location: 14897 SE Parklane Dr., Happy Valley, OR.
Year of Completion: 2010
Square Footage: 123,000 square feet
Occupancy: 860

ABSTRACT

The aim of this study is to optimize the shape of the skylights in order to enhance daylighting. Rhino, Diva, Grasshopper, and Galapagos are the softwares utilized to test differing shapes on top and bottom of the shaft of the skylight, and the findings show preference to those with beneficial impacts on Spatial daylighting autonomy (sDA) of greater than 55% and Annual Solar Exposure (ASE) of less than 10%. Selecting metrics within the above parameters result in optimal skylight geometry with highest daylighting output. The initial purpose of the experiment was to optimize the design of the skylight shaft with the goal of providing the best distribution of daylight while minimizing potential for glare; however, it appears that this shaping may have negligible effects on how the skylight performs as long as the sDA is greater than 55%



Exposure to Direct Sun



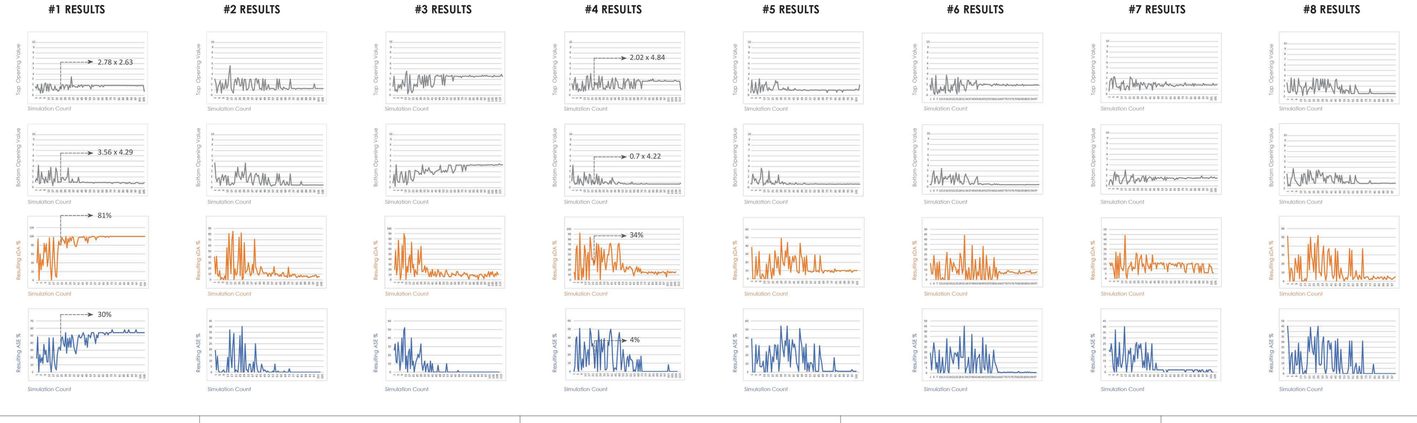
Simulations

Top Opening
The algorithm tests differing shapes on top of the shaft of the skylight, and shows preference to those with beneficial impacts on sDA and ASE.

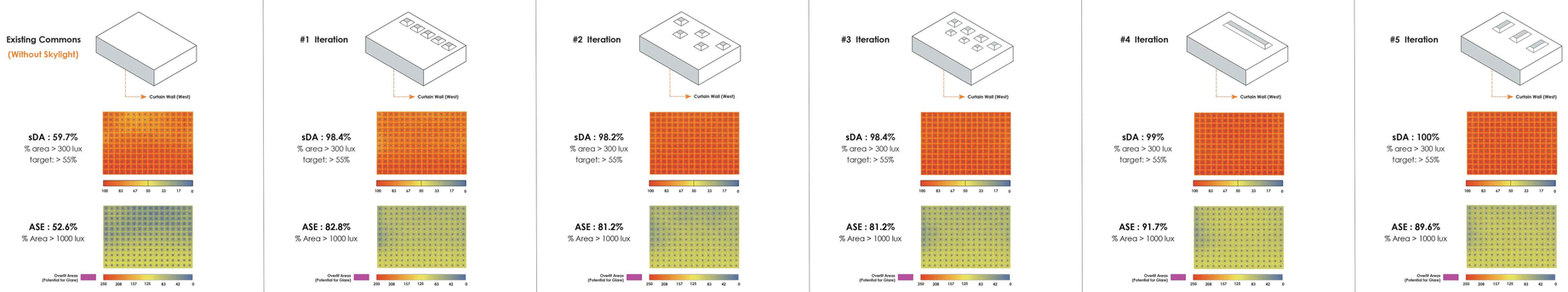
Bottom Opening
The algorithm tests differing shapes on bottom of the shaft of the skylight, and shows preference to those with beneficial impacts on sDA and ASE.

Daylight Autonomy (sDA300/50%)
A percentage of regularly occupied floor area that receives 300 lux or greater from the sun 50% of the time between 8 am and 6 pm.
• LEED v4 sets minimum sDA at 55%
• Objective: maximize sDA

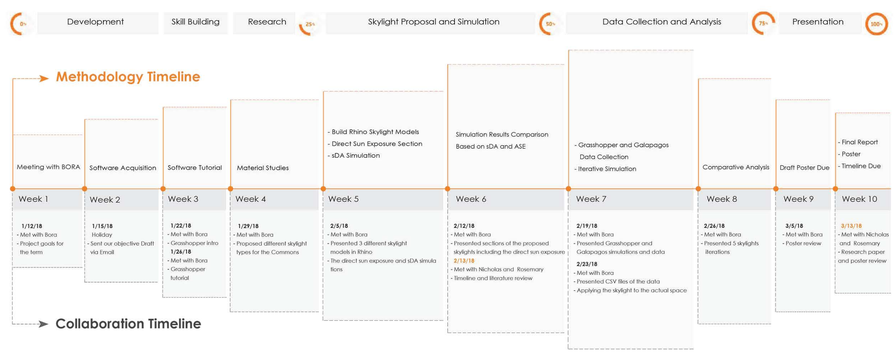
Annual Solar Exposure (ASE)
A percentage of regularly occupied floor area that receives 1000 lux or greater from the sun 250 hours or more annually.
• LEED v4 sets maximum ASE at 10%
• Objective: minimize ASE



Skylight Iterations



Timeline



Conclusion

The results of the study confirmed the use of these various programs helped in making informed design decisions. In this study, Rhino is used as the primary modeling environment, Diva simulates and analyses the daylighting and Grasshopper is utilized to edit an algorithm that automates geometric parameters and simulation inputs according to preferable analysis results. Galapagos produced a multitude of configurations for skylight design and daylighting options. Applying these parameters to the design narrows the scope of options, and provide the user direction, viability and possibility. The results from the research and simulations aid in the process of creating volumetric design and an engaging daylighting typology that is aesthetically appealing. The softwares enable the room to easily attain an adequate sDA value, but made it difficult to achieve an acceptable ASE value since the ASE values would have been higher than 10%. The initial purpose of the experiment was to optimize the design of the skylight shaft with the goal of providing the best distribution of daylight while minimizing potential for glare; however, it appears that this shaping may have negligible effects on how the skylight performs as long as sDA is greater than 55%. Based on the findings, it was concluded to use other means such a fritted glass to reduce the percentage of ASE.