Dynamic Visualization and Simulation of Vertical And Horizontal Integrated Glare Control Blade System

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Introduction

Research Objectives

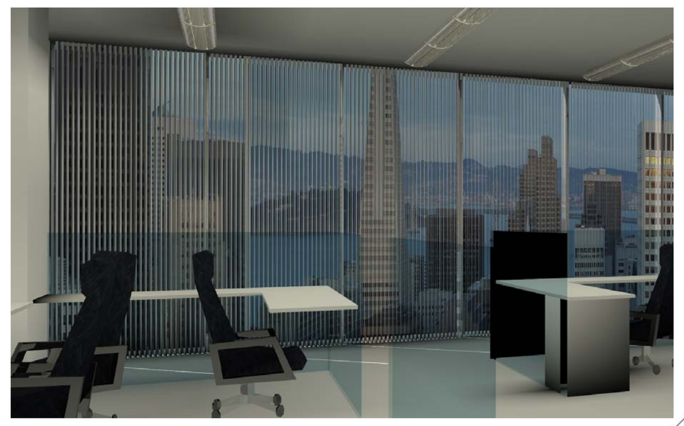
The objective of this presentation is to demonstrate a system for consistent blocking of direct sun while allowing natural light in and maintaining a comfortable exterior view. This sun tracking system will enhance the interior spatial quality as well as contribute to energy efforts.

Research Abstract

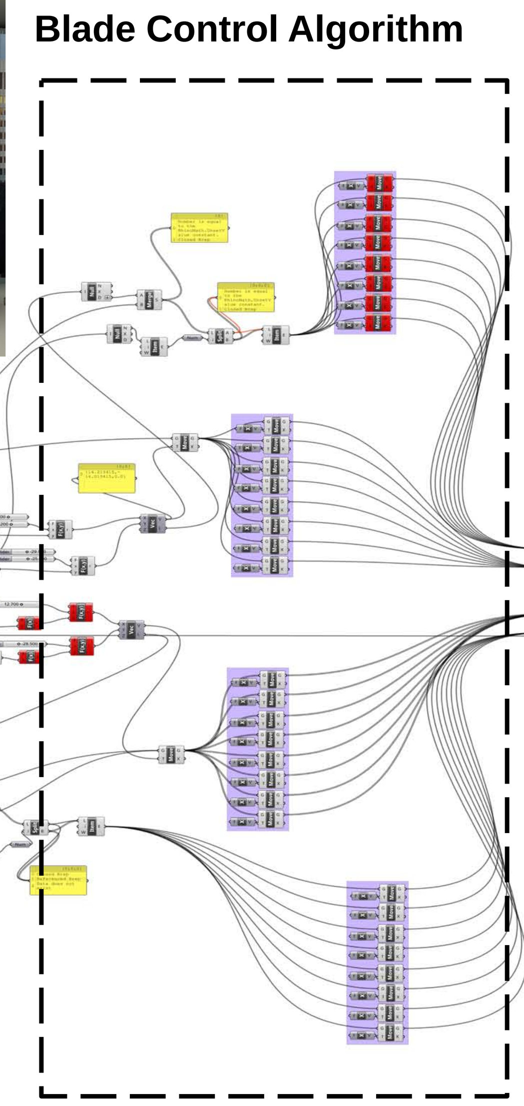
The benefits of having natural daylight within buildings is acknowledged by all architects and lighting designers. Most open office plan users do respond better when they can have access to an outside view, and consider their working environment to be better given the ability to control the natural daylight conditions. Lighting designers do their best to avoid glare from direct viewing of the sun's rays within the work place, and try to create buildings that evoke public interest and satisfaction by the occupants. There is a need for an automatic control shading system for buildings with large areas of glazing, that not only eliminates glare at all times, but also provides access to the outside view.

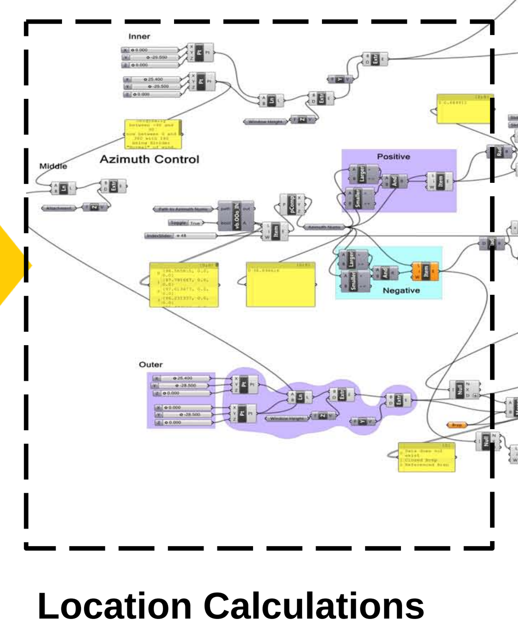
The proposed vertical and horizontal integrated blade system can be simple addition to an interior cavity of an exiting or a newly design window system. Through operating a newly developed algorithm for programming within the building automation system, the system allows the sun to be blocked in real time, while the outside view can be seen nearly everywhere within the office space. The capabilities of this integrated blade system are optimum performance by reducing glare or direct view of the sun rays while maintaining acceptable levels of natural daylight and view within the space. The associated benefits, if utilized and integrated with other building systems, are the reduction of cooling loads in summer and heating requirements in winter, the potential for creating aesthetic impact, and the integration of photovoltaic cells with opaque and or transparent materials.

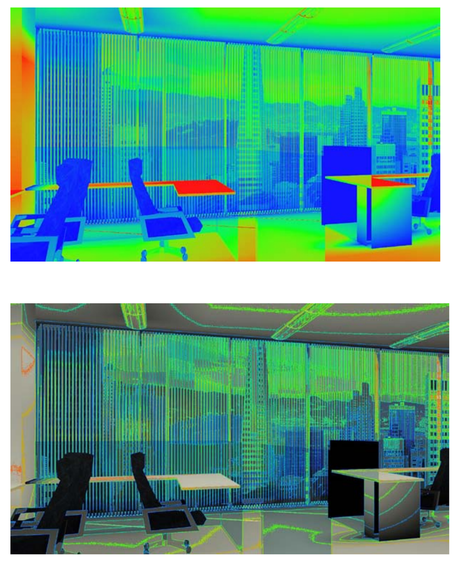
Methodology

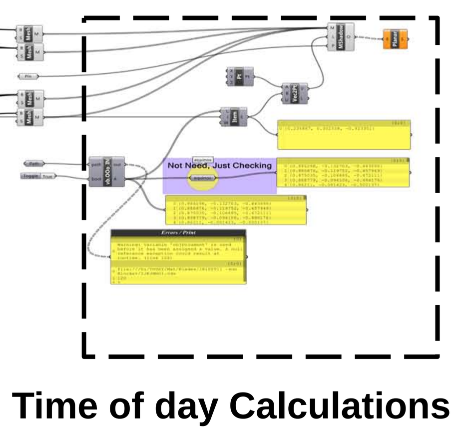


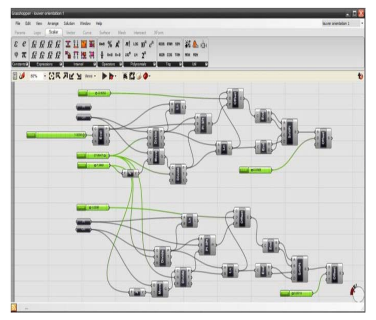
Using Grasshopper, a scripting plugin for Rhino3D, a system was created to visualize the blades movement. The azimuth or altitude, depending on the system, is the basis on how the blades move. When a time is selected, the simulated blade position creates a geometry capable of being brought into any modeling program.

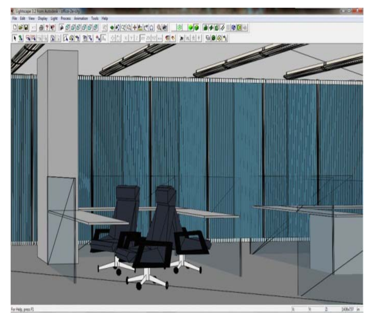




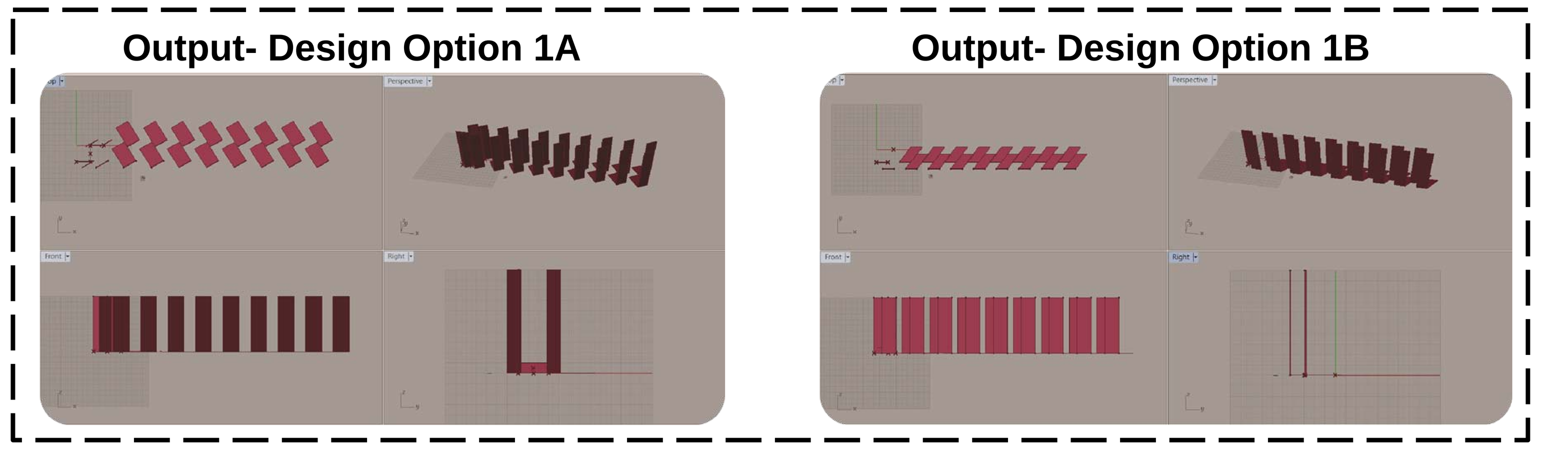








The geometries of the blades are brought into Lighscape, in which the lighting condition is simulated and interior light levels are calculated. Through iterations of different configurations, the lighting information is collected to create relative comparisons.



Date & Time → Algorithm → Geometry → Light Calculation → Rendered Image

Results: a. Form Study | b. Light Evaluation | c. Visual Study

Applications and Future Work

Sustainability Considerations

Further studies will turn to the sustainability analysis for the system. The energy efficiency can be calculated throughout a year with a dynamic system. These energy efficiency results can further develop the design of the system as well as show the most suitable setup for a specific location.

Material Selection

Material selection for the blades can be more thoroughly researched. The material properties such as transparency, color, reflectance and shape all factor into the lighting analysis.

System Mechanical Design

To make a mass produced system the mechanical design must allow for a variety of locations. The mechanical system must remain automated and would need only the orientation of the building.

Acknowledgements

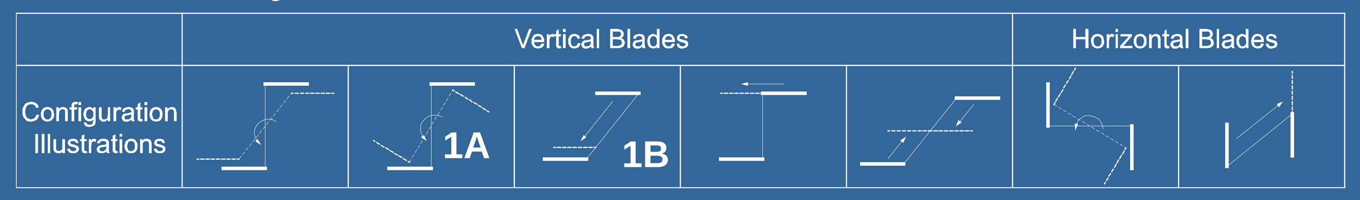
Special Thanks to Dr. Robert Clear from Lawrence Berkeley National Laboratory for his control Algorithm for the blades, and faculty advisor Dr. Mojtaba Navvab from TCAUP.
Thanks to Glenn Wilcox for his introduction to grasshopper.
Thanks to Live Architecture. net for its module on spreadsheet integration.

References

[1]Autodesk, Lightscape 3.2 User Guide;
[2]Issa, Raja. Essential Mathematics for Computational Design;
[3]Meeus, Jean. 1998. Astronomical algorithms. 2nd ed. Richmond Va.: Willmann-Bell;
[4]Rhino 4.0 User's Guides;
[5]http://www.coltgroup.com/projects/offices/sbl

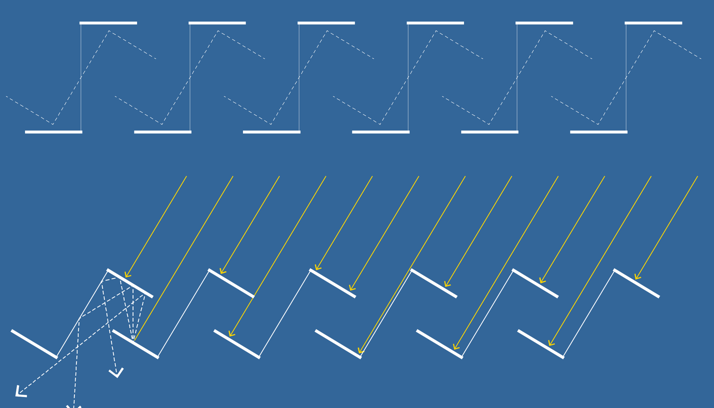
Results

a. Form Study

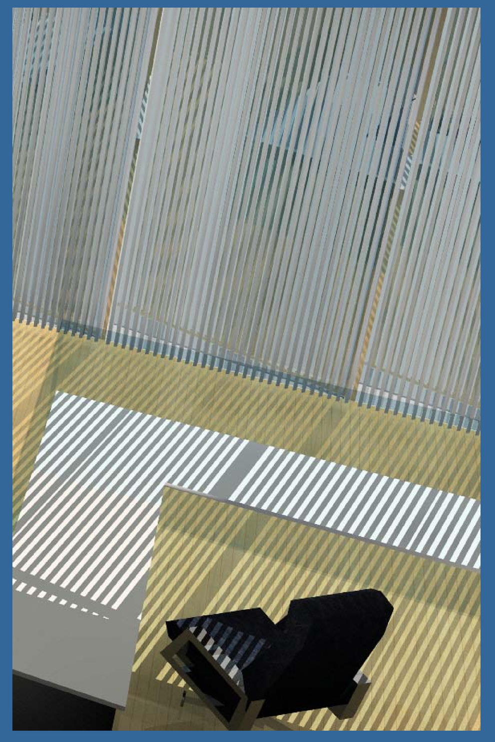


Several iterations are studied, both horizontal and vertical solutions are considered.

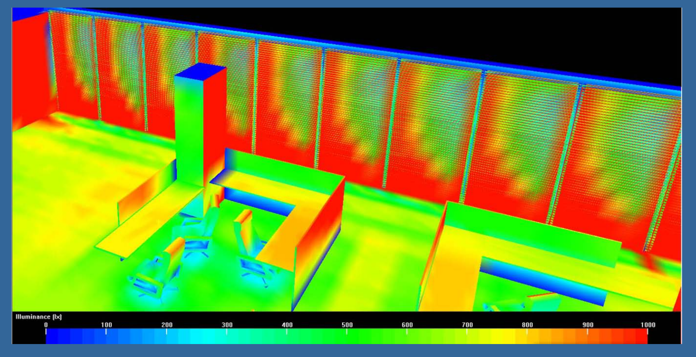
For example, the diagram on the right shows how the system works to track the sun path so as to shade the sunlight.

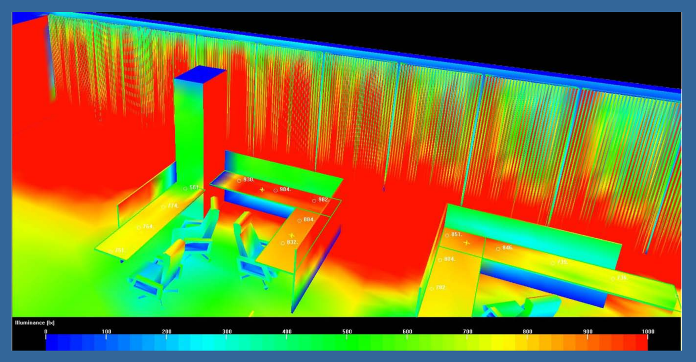


b. Light Evaluation



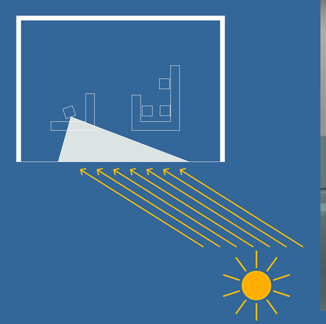
System not applied

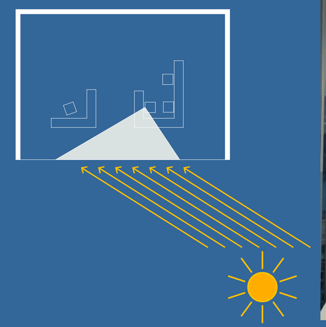




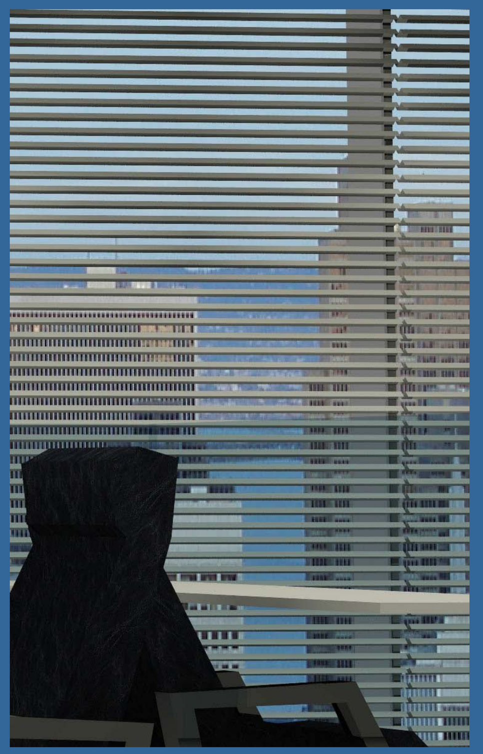
System applied, no patterned shadow, providing enough interior light

c. Visual Study





View to outside city from different directions



View for horizontal blades