The Role of Structures in Daylighting Retrofits for Existing Buildings

Exploring an Iterative Workflow for the Schematic Design Phase in Building Retrofits

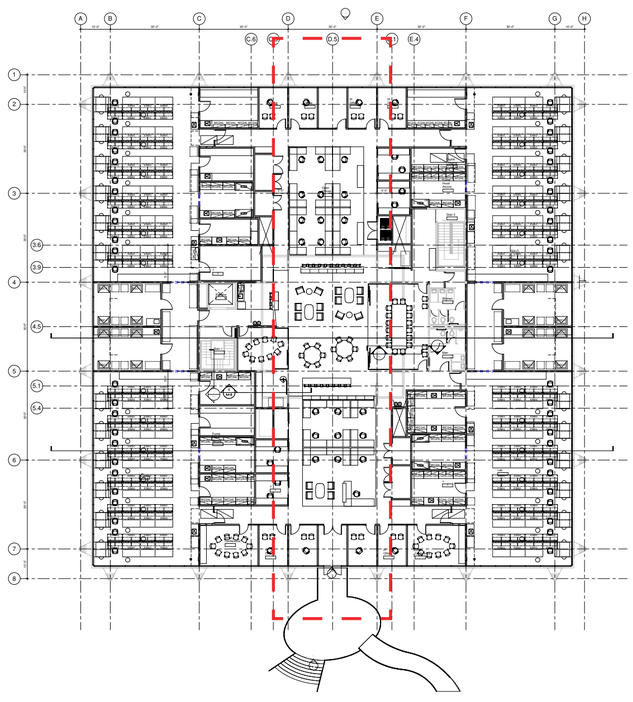
Existing buildings, particularly those with deep floor plates, must be retrofitted to reduce electricity consumption. The structural systems of existing buildings can both inhibit and support daylighting retrofits, specifically the use of skylights. This research explores the interactions of structural systems and daylighting through the use of simulation software, specifically the ability of structure to reduce glare by blocking direct sunlight and distributing light more evenly.

Developing an Iterative Workflow :

Generating a process for quick iterations to design options

_Evaluating the Existing Conditions :

The initial input parameters are based on existing conditions and design goals.



_Defining Design Goals and Metrics :

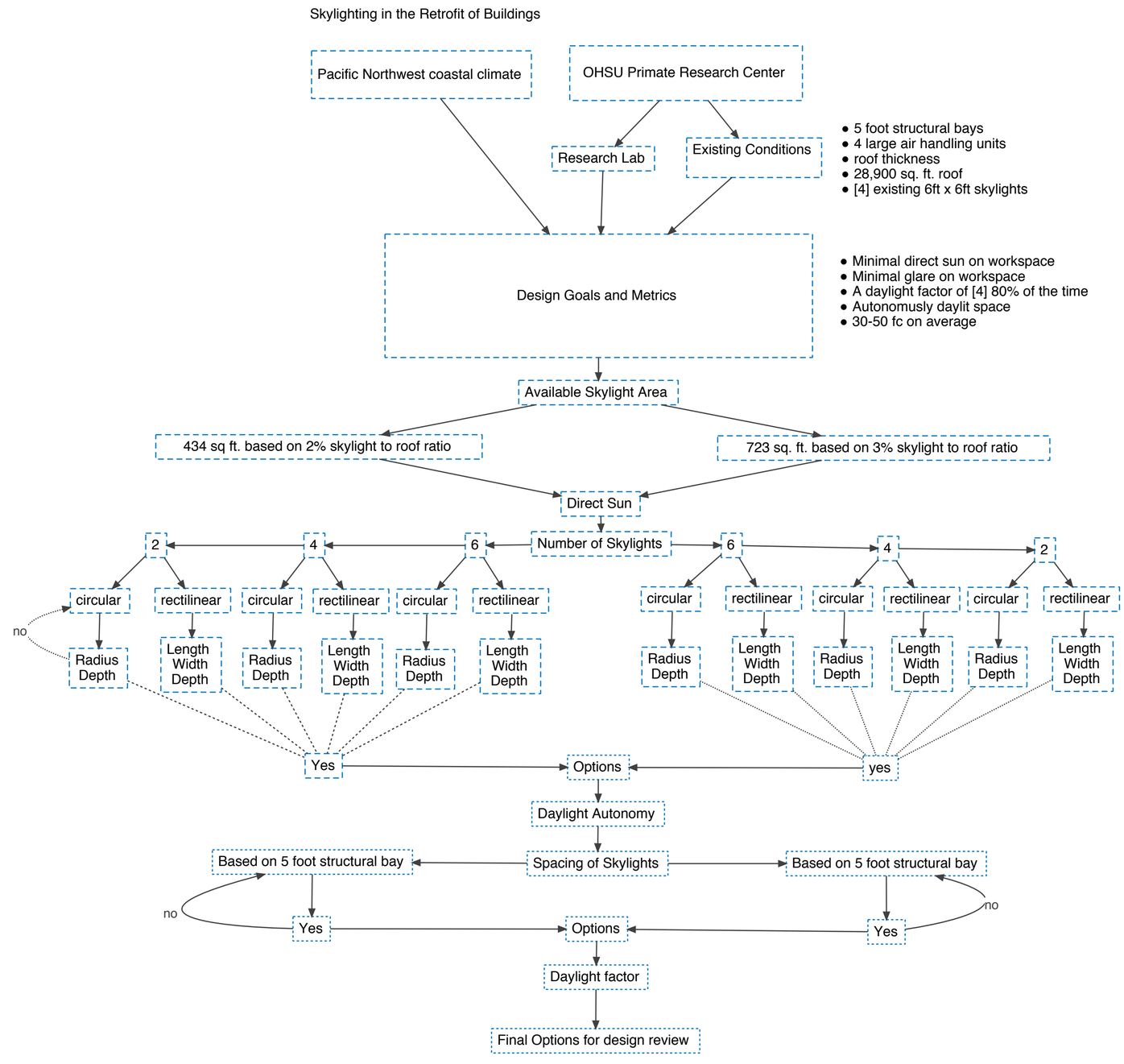
The next input parameters were the design teams goals and metrics, which include design parameters such as desired amount of direct sun on the workplane, acceptable amount of glare on the workplane as well as illuminance and daylight factor goals.

_Determining Available Skylight Real Estate :

Once these initial parameters have been established, a value would be found determining the amount of available daylighting “real estate”. This would determine a usable range of roof area for the integration of skylights.

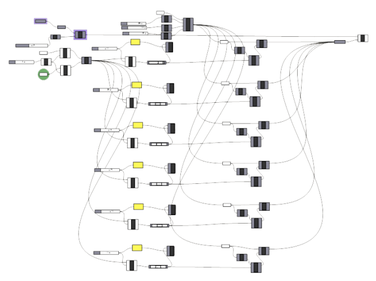
_Prioritizing Simulation Iterations :

Simulation iterations were prioritzed based on ease and quickness, providing agility within the workflow.



Running Simulations :

Utilizing the 3D Modeller Rhino 5 integrated with the Generative Modelling Plug-In Grasshopper and the Radiance/Daysim Plug-In DIVA



_Building the Parametric Model

Preparing the model for iterative analysis by defining parameters based on the existing structural system to holistically understand the existing system.

_First Iteration : Direct Sun Analysis and Glare Evaluation

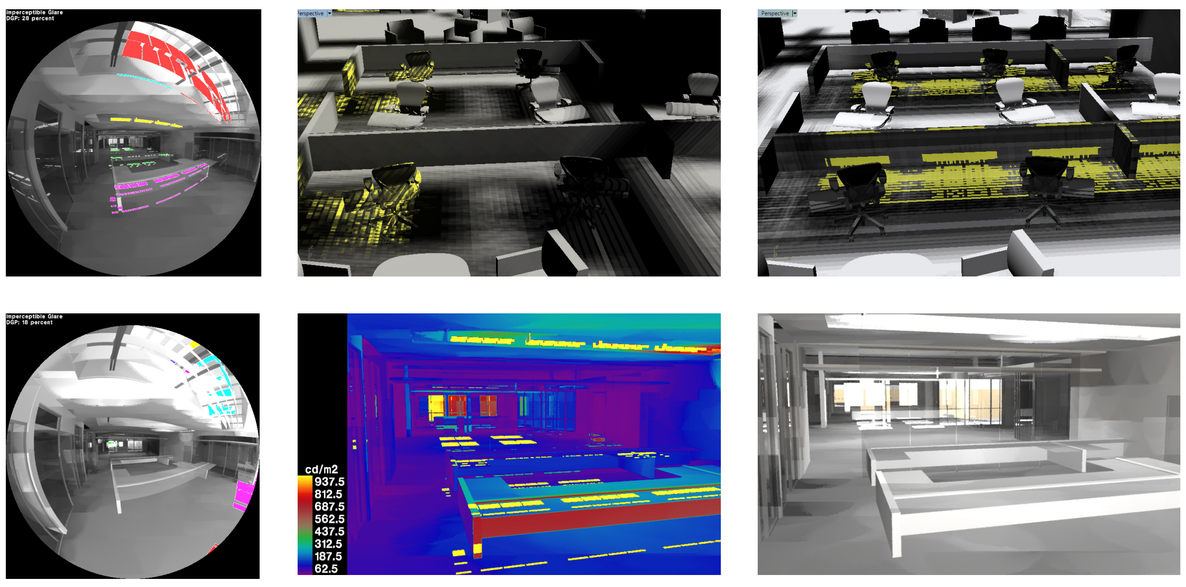
The first parametric iteration was the observation of the amount of time direct sun was present on the work plane throughout the day.

_Second Iteration : Observed Daylight Autonomy

The second parametric iteration was the observation of daylight autonomy based on design team goals.

_Third Iteration : Daylight Factor and Illuminance Simulation

The final parametric iteration was simulation of daylight factor and illuminance values based on the design teams goals. All options which make it to the third iteration are potential design implementations. The design team is given the quantitative information to inform the design of the daylight system.



Evaluating Options :

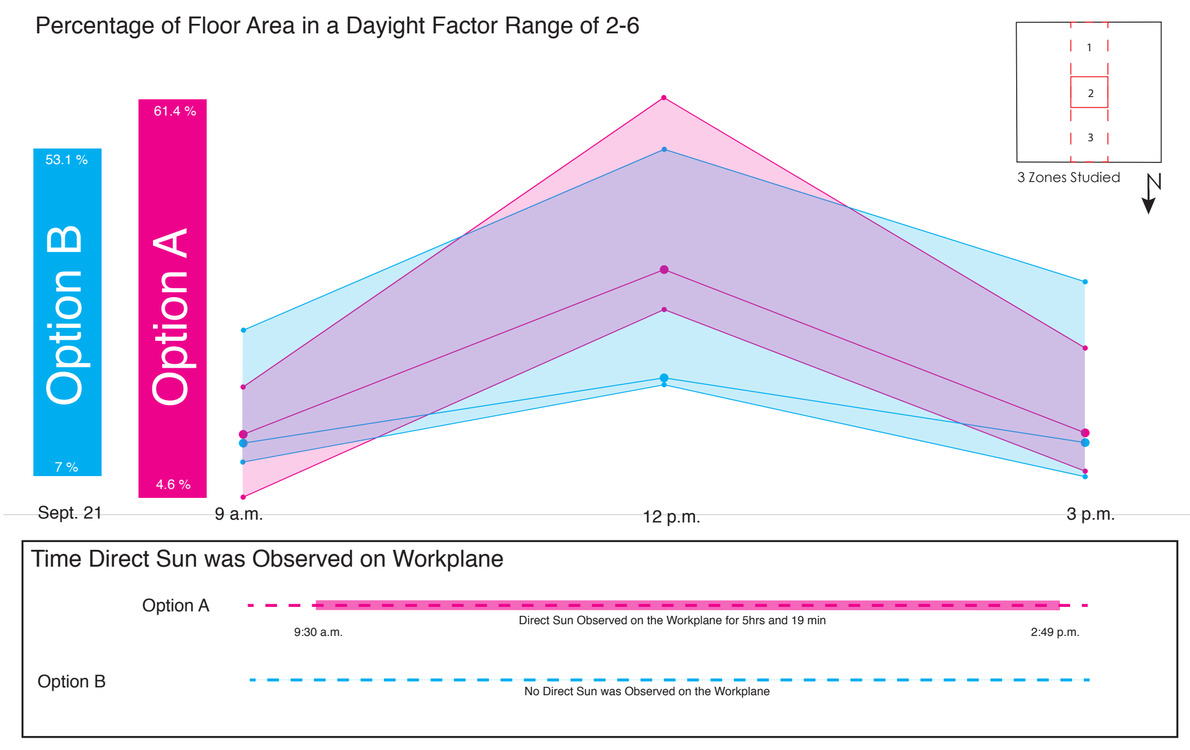
Comparing options to inform the design

_Option A and the role of structure

Option A consisted of [6] 4 foot by 4 foot skylights placed over the open office area. These skylights fit in between the structural bays, exemplifying how existing structure could inhibit the design process.

_Option B and the role of structure

Option B included (2) 4 foot by 17 foot skylights oriented on the east-west axis at 14 feet on center. The structure was used to act as natural baffles from early morning as well as afternoon sunlight. This option exemplified how structure could help promote a successful design solution.



Conclusion :

The role of structures

By combining this iterative workflow with the knowledge of existing conditions, specifically structural systems, the designer is offered a tool to intelligently inform design decisions. This particular scenario describes how an iterative workflow can inform design decisions for schematic design which can take advantage of the existing structural system.