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Analyzing Daylight Autonomy: New Dining Hall at George Fox University

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THA

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NEW DINING HALL AT GEORGE FOX UNIVERSITY

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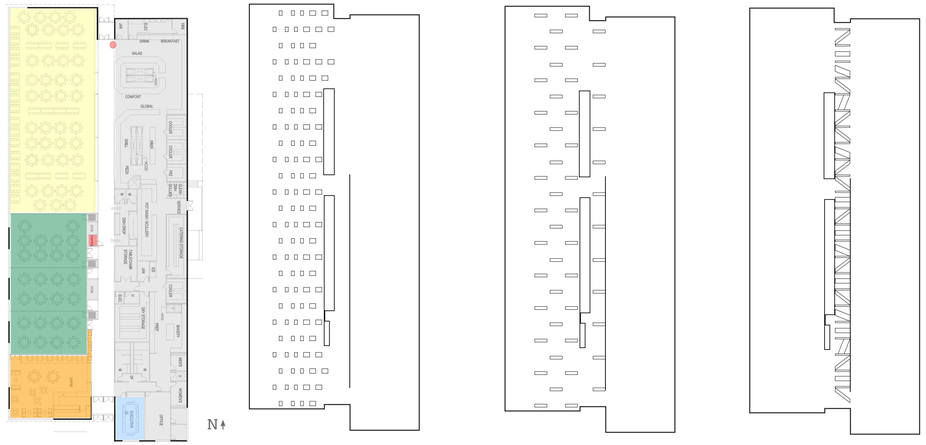
Portland State University
THA ARCHITECTURE
Rhinoceros

OVERVIEW

THA Architecture is designing a dining hall for George Fox University in Newberg, Oregon. The school has out-grown their current dining hall and is in need of a larger space. This is a new construction project of 30,000 sf and with a budget of $200 a square foot. The program includes; dining space, dining space that can be closed off with folding walls, a café, cafeteria food pick-up area, kitchen, bakery, offices, and restrooms. The building is split in half by the program, the west half is the dinning space (enclosed by window walls) and the east half is the service and mechanical space (enclosed by a low-cost wall type). The west window wall looks out into a forested area that diffuses the natural light coming inside but allows heat gain in the winter when the leaves have fallen off the trees. The dining hall is a deep space that needs natural lighting to reach the deep interior spaces and THA is interested in exploring the best skylight placement to allow light in.



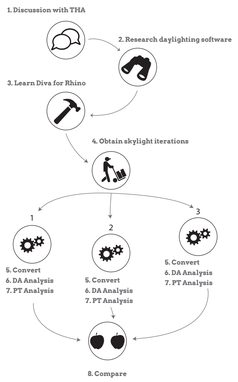
Floor plan **First Iteration** **Second Iteration** **Third Iteration**

METHODOLOGY

THA Architecture provided three design iterations that were used to create simulations of daylight autonomy using DIVA, a plug in to Rhino5. While building the model, close attention was paid to assigning specific materials to different layers. An example of this is; all the glass was on a glazing layer, the walls were on a wall layer, etc. This is important for later on when using DIVA because DIVA assigns materials to general layers.

The second step is now to assign a location to use climate files and sun angles and this can be done by clicking on the Location button. A choice of locations is given as to choose from. The closest weather file is Hillsboro, Oregon so that one was chosen. Next, nodes need to be placed on the floor plane that will analyse the sunlight that enters the space. By clicking the Nodes button, prompts are given as to where these nodes are placed. The next button is Materials which gives drop-down menus that provide selections for materials that will be used. The next step will be choosing a simulation and that can be accessed by clicking on the Metrics button. This main study used the Climate-Based simulation under the Daylight Grid-Based tab. The parameters of the simulation can be set here. Three skylight placement iterations were studied as well as the building with no skylights at all.

Another analysis that was run was the Point in Time Illuminance analysis which was set to analyse the exact illuminance set to 12PM on September 21st with overcast skies. This date was chosen because it is the most average day we experience. This analysis offered a Mean Illuminance value that was helpful to get a sense of how bright the room actually was.



DIVA PARAMETERS

Tool bars, Options, and Materials

There are a variety of options and parameters to set in DIVA as well as different types of analyses to run.

Location

The specific location of the building being analyzed is assigned here. Hillsboro/ Portland was the closest location.

Nodes

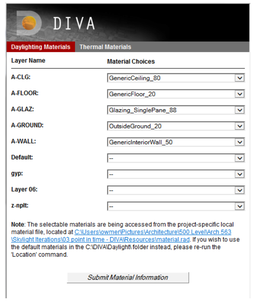
Here is where the surface to be analyzed is selected. Nodes were placed at 30 inches at task height and were spaced apart at 36 inch.

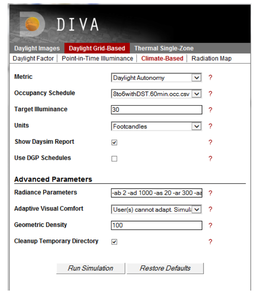
Materials

Generic materials were assigned to layers in Rhino that were analyzed.

Metrics

The Climate Based analysis was used to determine the Daylight Autonomy of the space for 30 footcandles.
Point in time illuminance is what was used to determine the mean illuminance for 12PM noon on the equinox.





Necessary dining illuminance is between **10-50 footcandles, 30 was chosen** as the target illuminance because it was an average of this range.

ANALYSIS WITH NO SKYLIGHTS

Daylight Autonomy

Daylight autonomy is the percentage of time when a building is in use and daylight illuminates the space at a specific footcandle about, throughout the year.

Parameters

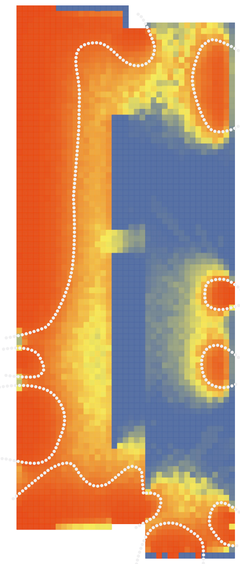
Occupancy hours 8AM-6PM
Target Illuminance 30 Footcandles

Analysis with No Skylights

Daylit Area 60% of floor area
Occupancy 3650 hrs/yr

Point in Time Illuminance

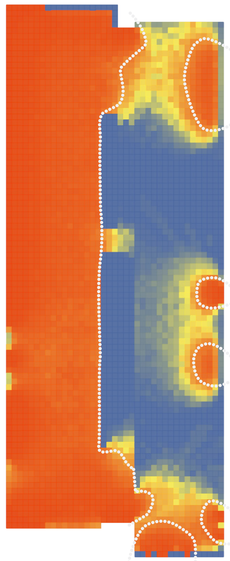
The mean illuminance for the dinning area at 12PM on September 21st, the equinox, is 69 foot candles.



ITERATION COMPARISON

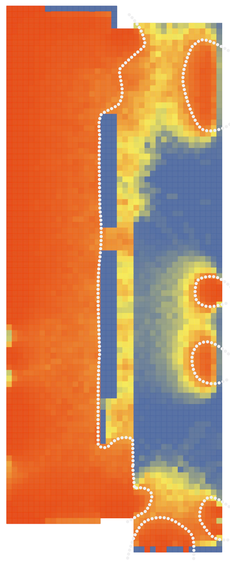
First Iteration

Daylit Area 62% of floor area
Occupancy 3650 hrs/yr
Skylights 117
Size: 12X12
MI 87 fc



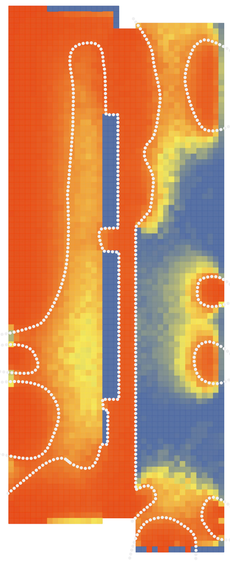
Second Iteration

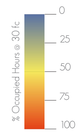
Daylit Area 69% of floor area
Occupancy 3650 hrs/yr
Skylights 50
Size 24X48
MI 89 fc



Third Iteration

Daylit Area 72% of floor area
Occupancy 3650 hrs/yr
Skylights 40
Size various
MI 87 fc





RESULTS

Iteration Results

Before any analyses were run on the skylight placements, an daylight autonomy analysis was run on the building with no skylights at all. Of the floor area, 60 percent received daylight at 30 fc or higher. The dining area received a minimum of 80 percent of the space being lit with at least 30 fc, this equates to 8 of the 10 hours it was being used to have a sufficient amount of daylight. The dining space on the equinox has a mean illuminance of 69 fc. The main area that needed lighting was the hallway.

The first iteration contained 117 skylights, each 12" X 12" in size. These skylights were only located in the dining area, 62 percent of the buildings floor area received daylight. This brought the percentage of time that the space was at least 30 fc up to 90 percent. The mean illuminance on the equinox came to 92 fc, making the dining hall a brightly lit space. The skylights had no effect on the hallway and the amount of skylights proved to be too expensive and THA had to design a new solution.

The second iteration contained 50 skylights each 24" X 48" in size. These skylights were located in the dining area as well as in the hallway which increased the floor area that received daylight to 69 percent. The dining hall remained at at least 30 fc for 90 percent of the time but the hallway increased in anywhere between 50-85 percent of illuminance being 30 fc. The mean illuminance for this space on the equinox decreased to 89 fc.

The third iteration contained 40 skylights with varying sizes. The skylights were only placed in the hallway where daylight was greatly needed. This increased the time in the hallway at least 30 fc to 90 percent. The dining space ranges between 80 and 90 percent of the time being at least 30 fc but the total floor area for the building that received daylight increased to 72 percent and the mean illuminance of the dining space only decreased to 87%.

Recommendation: Third Iteration

Daylit Area 72% of floor area
Occupancy 3650 hrs/yr
Skylights 40
Size various
MI 87 fc

Key Points

Covers the most floor area for the space and illuminates the dark hallway.

Has the least number of skylights.

Has the lowest mean illuminance at 87 fc during the equinox but that is still 47 fc above the targeted dining illuminance of 30 fc.