Lighting Simulation and Visualization
Elektra House
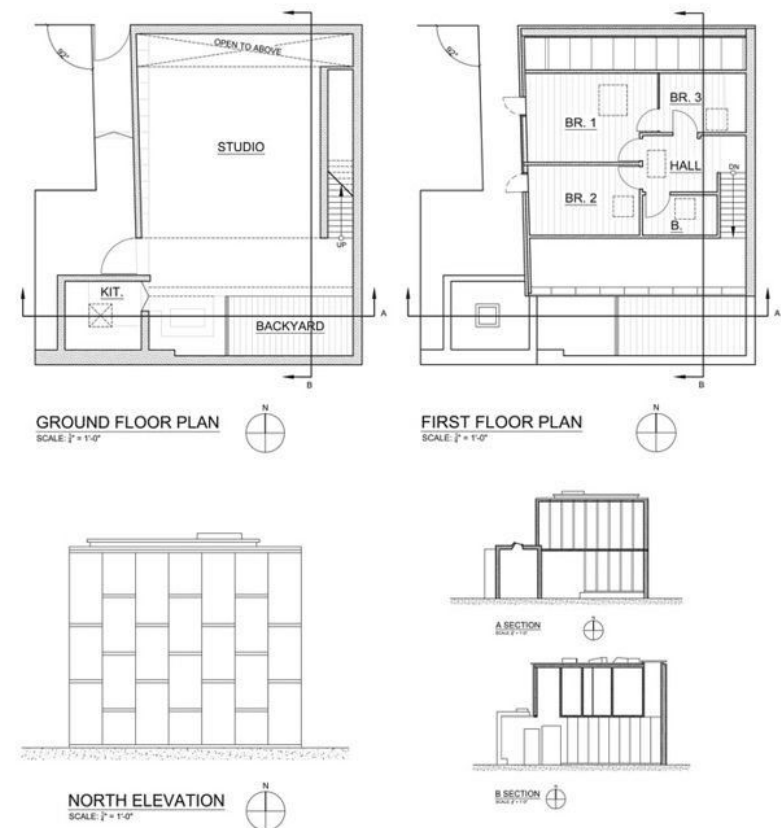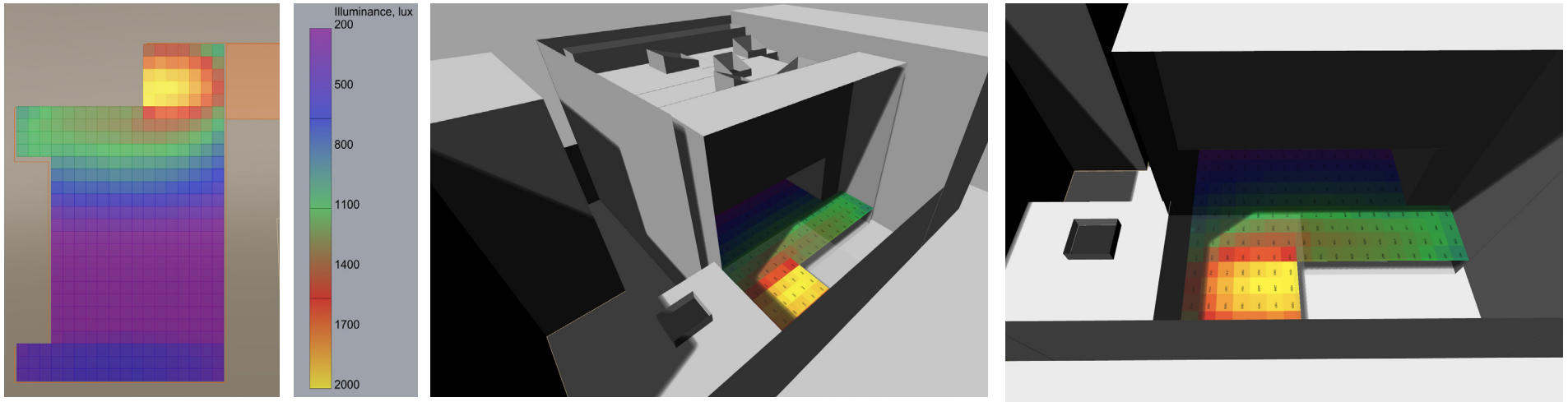Doaa Alsharif

Elektra House

A Brief

David Adjaye
Elektra House in London, England
Date completed: 2000

A budget-conscious project built on the site of a former shoe factory, the two-story, 1,400-square-feet Elektra House, named after the clients' daughter, was conceived of as both a live/work space and a theoretical lightbox, a means to maximize space and allow for an art display inside a multi-story home.

From these plans and sections we can sense the openness of space in the live/work space located on the ground level,while it's more private on the first floor for the bedrooms. The above pictures expose how the designer put an effort in the choice of materials and their textures. He also revealed his sensitivity in the way he designed the glazing and the way he played with light.

In this study, a lighting simulation and visualization is conducted to evaluate the effectiveness of daylighting strategies.

GROUND FLOOR PLAN
SCALE: 1" = 1'-0"

OPEN TO ABOVE

STUDIO

KIT.

BACKYARD

FIRST FLOOR PLAN
SCALE: 1" = 1'-0"

BR. 3

BR. 1

HALL

BR. 2

NORTH ELEVATION
SCALE: 1" = 1'-0"

A SECTION

B SECTION

Daylight Simulations:

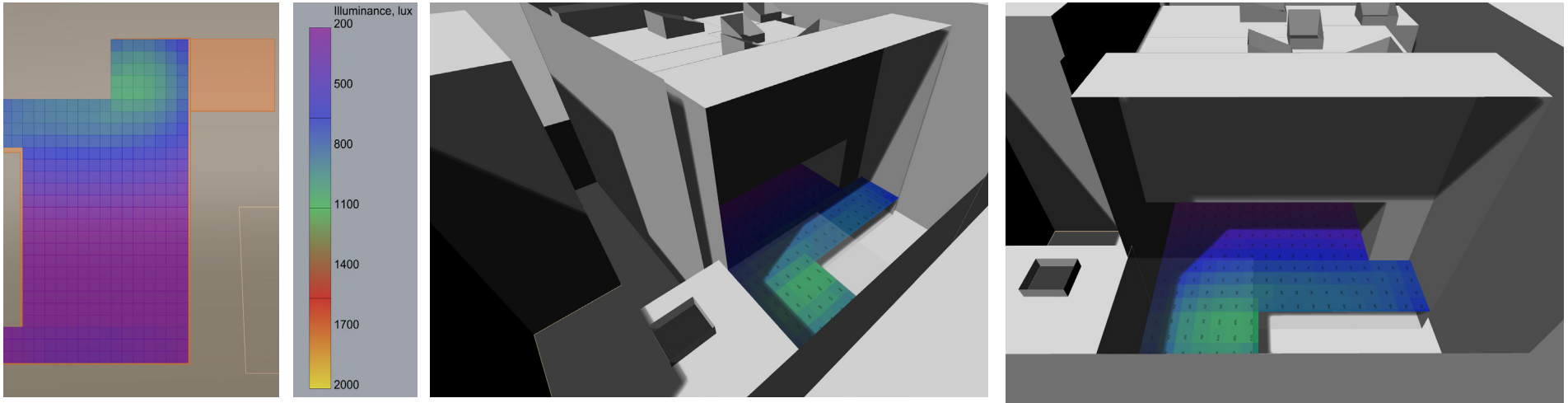A. Point in time illuminance for the live/work space:
Dec 21, Overcast sky at noon:

The illuminance analysis for December 21 at noon with an overcast sky shows that darkness covers most of the house.

The nodes values show the highest illuminance found in the space that is 2044 lux and the lowest is 71 lux. The mean illuminance is 628.22 lux and 71% of the area is between 200 and 2000 lux while 28.5% of it is less than 200 lux.

My perception is on winter days the day is short and the sun is low, and even lower in the winter solstice from the southern sky. And since this day has an overcast sky, the problem area is only on the south side of the building which has a maximum illuminance value of 2044 lux and minimum value of 1951 lux which causes glare. Daylight gradually fade from the green area to the blue area leaving a very dark space in the purple area where the lowest luminance is 77 lux. Furthermore the skylight on the of the north side lightens up the space with a maximum illuminance of 522lux.
Due to constantly changing cloud cover and the sun movement every 4 minutes, the amount of illumination varies and it's hard to predict the exact region of visual discomfort so a shading device must be provided only on the southern part and electrical lighting of the dark area.
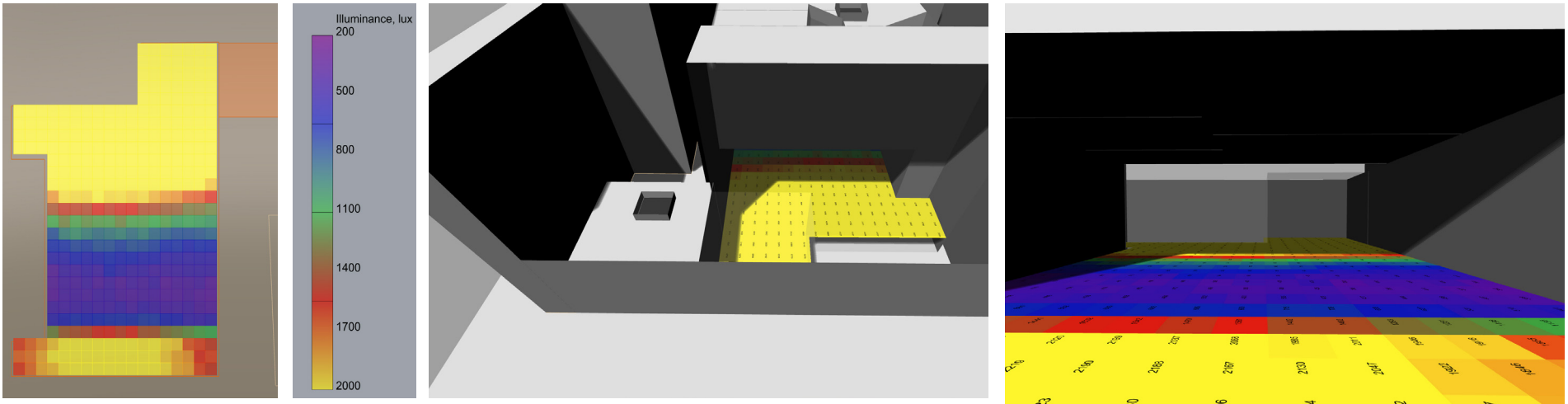
Daylight Simulations:

A. Point in time illuminance for the live/work space:
Dec 21, Clear sky at noon:

The illuminance analysis for December 21 at noon on a clear day shows that darkness covers house.

The nodes values show the highest illuminance found in the space that is 1029 lux and the lowest is 77 lux. The mean illuminance is 412.46 lux and 68% of the area is between 200 and 2000 lux while 32% of it is less than 200 lux.

My perception is on a clear day, the sun should be bright a visible and comparing this with the previous analysis ,this does not make sense. There should be glare on the north and south sides of the house and these areas shouldn't be comfortable to sit or work in.

Daylight Simulations:
A. Point in time illuminance for the live/work space:
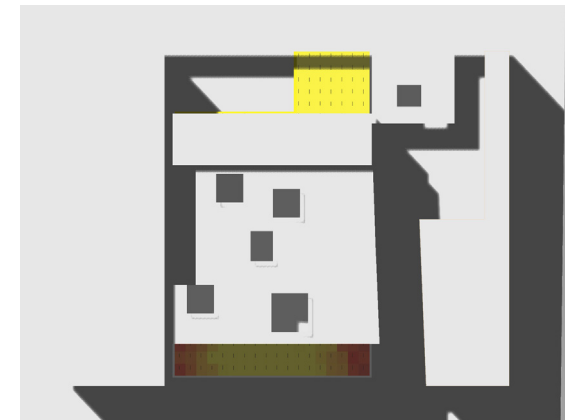Mar 21, Perez sky at noon:

The illuminance analysis for March 21 at noon with a perez sky shows interesting and rational variations.
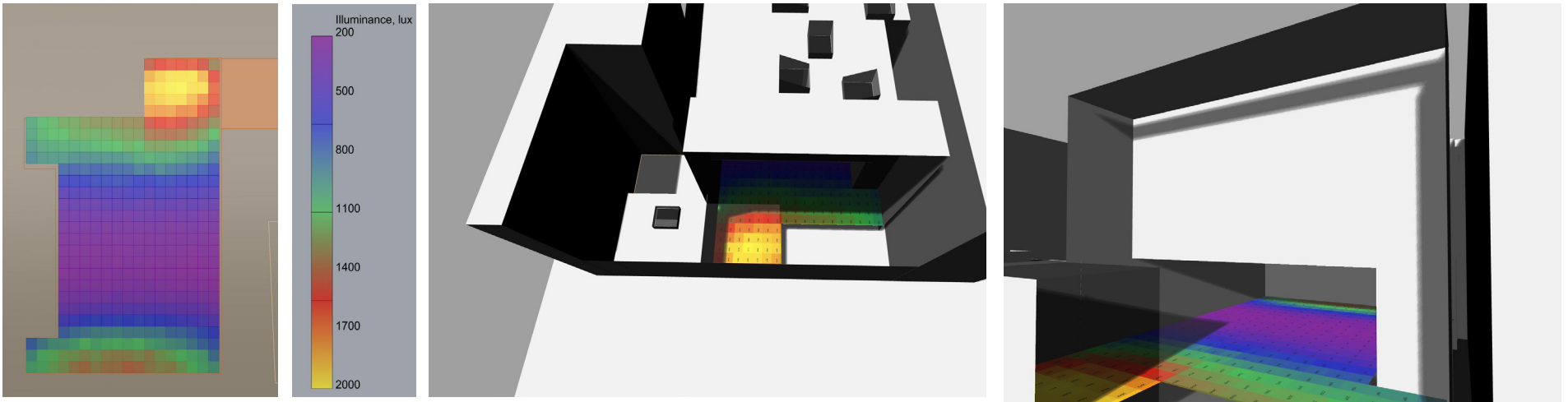
The nodes values show the highest illuminance found in the space that is 6319 lux and the lowest is 363 lux. The mean illuminance is 2238 lux and 54% of the area is between 200 and 2000 lux while 46% of it is less than 200 lux.

My perception is on a modeled sky on March 21, it is very rational to get areas with over 2000lux of luminance which is uncomfortable.

The south side of the building has the most glazings which makes it the most uncomfortable space to be in. Unlike the north facing side which is also high in luminance but not as high as south. The light falling on these areas lighten up the middle of the floor plan with useful light with the minimum of 363 lux and the maximum of 1561 lux.

Shading devices must be provided vertically on the south face and horizontally on the skylight at the north of the building.
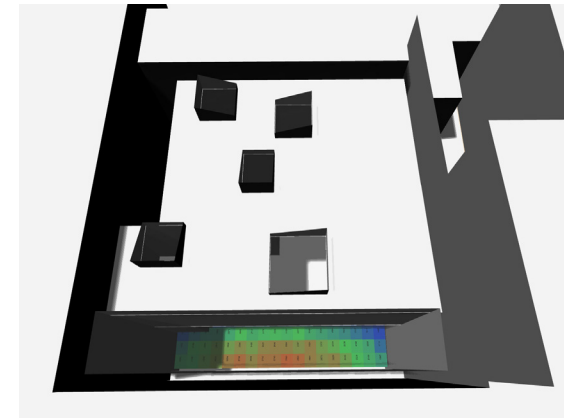
Daylight Simulations:
A. Point in time illuminance for the live/work space:
June 21, Clear sky at noon:

The illuminance analysis for June 21 at noon with a clear sky shows similar analysis to the overcast sky on December 21 which is suspicious.

The nodes values show the highest illuminance found in the space that is 4171 lux and the lowest is 365 lux. The mean illuminance is 1564lux and 99.7% of the area is between 358 and 4117 lux.

My perception is on a clear sky on June 21, when the sun is high and summer is starting, I expected to see more sun and glare on both sides of the building.

From the analysis, glare can be seen on the north side of the building with the highest illuminance of 2863 lux and lowest of 2039lux which fade in the center of the plan to 370lux and gradually rises until it reaches the peak of 41711lux which is the most uncomfortable area in the south facing direction.
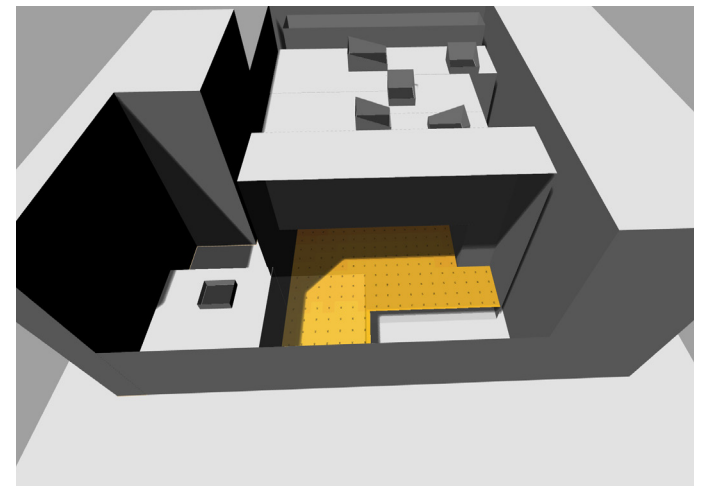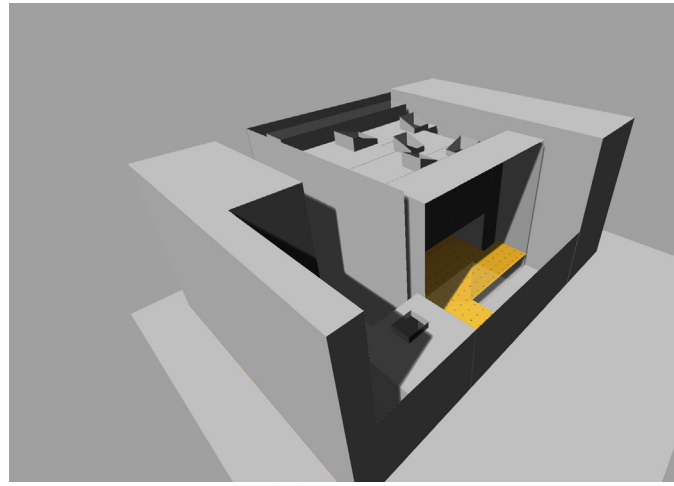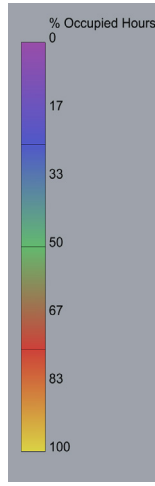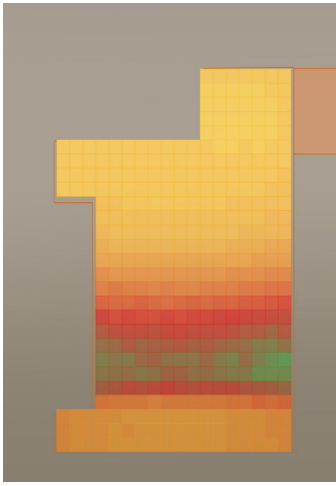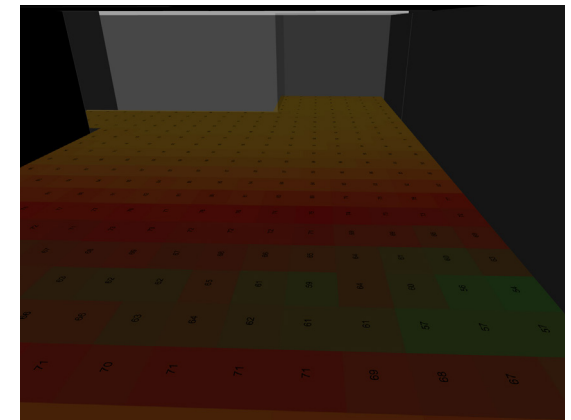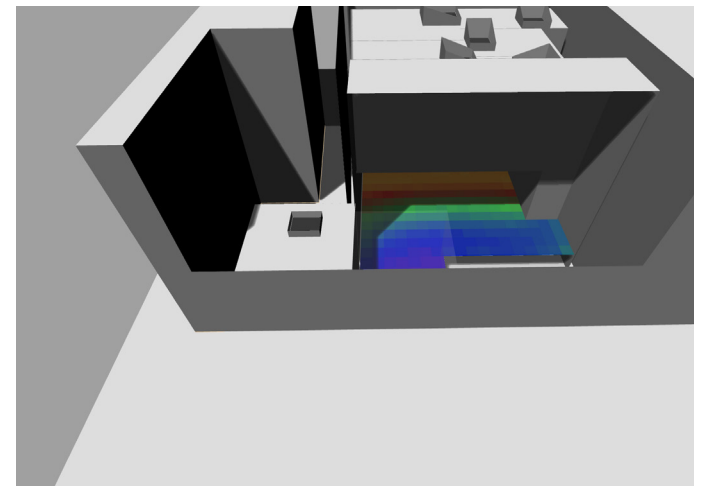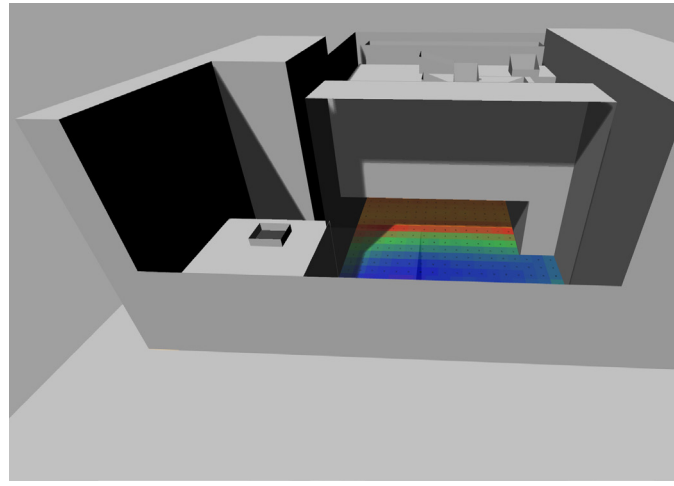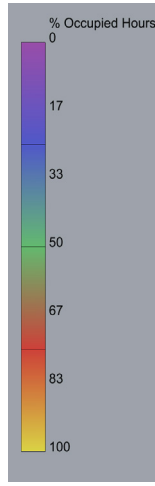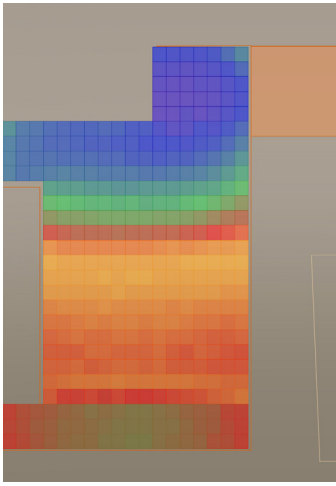
Daylight Simulations:
B. Climate Based Simulations for the live/work space:
Daylight Autonomy with a target illuminance of 200 lux

The daylight autonomy is the percent of occupied hours in a year where illuminance is equal to or above a set threshold based on climate data. In this case the mean daylight autonomy is 84.59% of the time occupied and 100% of the floor area is lit.

Given that this house has a lot of glazings, the floor plan is lit by daylight from the south glazed wall and the north skylight. The green area is 50% lit which can be visually more comfortable that the rest of the floor plan.
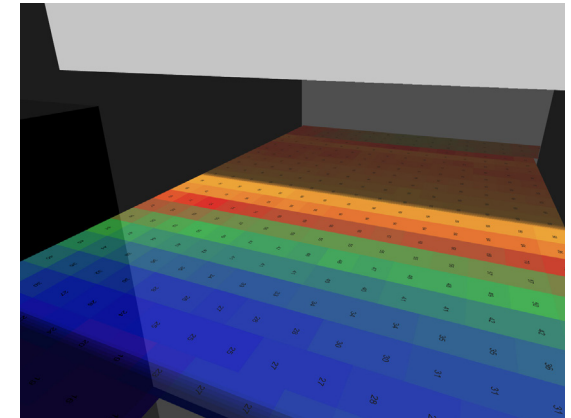
Daylight Simulations:

B. Climate Based Simulations for the live/work space:
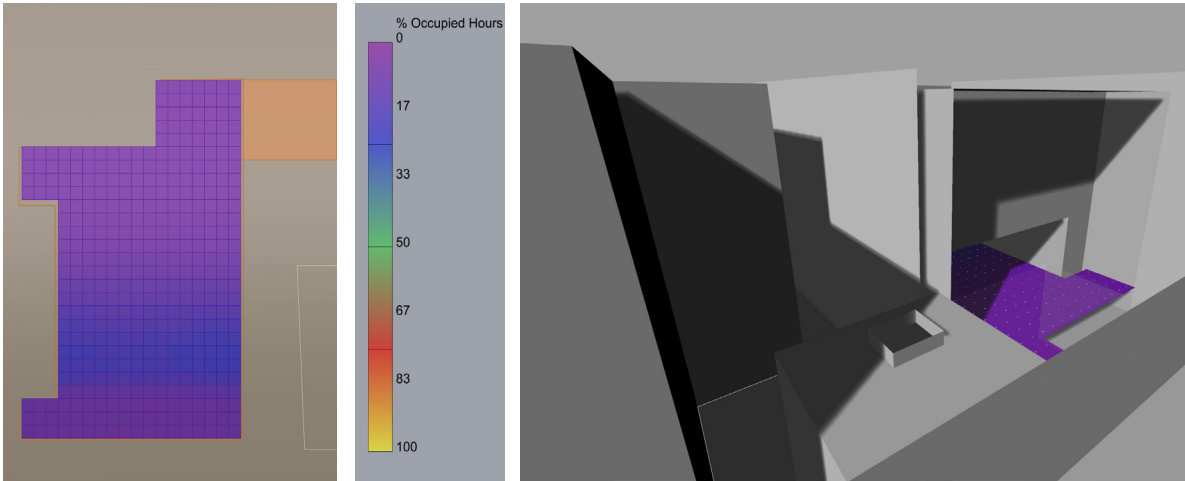Useful Daylight Index (UDI) for
>100 and <2000lux

The useful daylight index (UDI) splits the illuminance data into useful light, no light and glare based on climate data.

This analysis analyse the area for the percentage of illuminance that is greater than 100 lux and less that 2000 lux which is the useful daylight that lits this space. The mean value of useful daylight illumination is 61.4% of the time occupied.

From reading the nodes values and comparing these values with the previous analysis, this climate based simulation is very reasonable because the south glazed wall enters glare which makes this area unuseful therefore unoccupied. In addition to the north skylight which is less of problem compared to the south yet only 60% occupied. The center however has the best useful daylight and occupied almost 90% of the time.
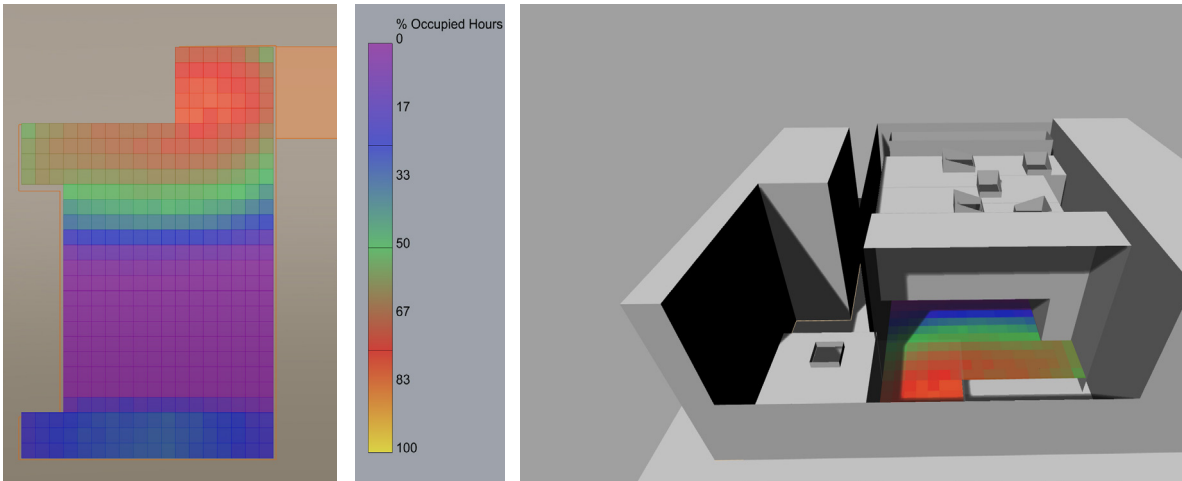
Legend: % Occupied Hours — 0, 17, 33, 50, 67, 83, 100

Daylight Simulations:

B. Climate Based Simulations for the live/work space:
Useful Daylight Index (UDI) for
<100

The useful daylight index (UDI) splits the illuminance data into useful light, no light and glare based on climate data.

This analysis analyse the area for the percentage of illuminance that is less than 100 lux which is basicly no light in the space. The mean value of useful daylight illumination is 9.74% of the time occupied.

Again it makes sense that this floor plan is not dark and only 10% of the space is considered dark. The glazed walls and skylight provide light the ceiling provided darkness 20% of the time occupied in the blue area.

% Occupied Hours
0
17
33
50
67
83
100

Daylight Simulations:
B. Climate Based Simulations for the live/work space:
Useful Daylight Index (UDI) for
>2000

The useful daylight index (UDI) splits the illuminance data into useful light, no light and glare based on climate data.

This analysis analyse the area for the percentage of illuminance that is greater than 2000 lux which are the problem areas that have visual discomfort, and glare. The mean value of useful daylight illumination is 28.91% of the time occupied.

The problem areas are on the south glazed wall and the north skylight and it reasonable to get high values on the south wall that range from 62% to 79%, whereas the south skylight brings 30% of glare and no glare on the rest of the floor plan.

From these previous analysis the best area for working is under and around the north skylight while the south facing wall is not the most desirable place to be in and shading devices are required.
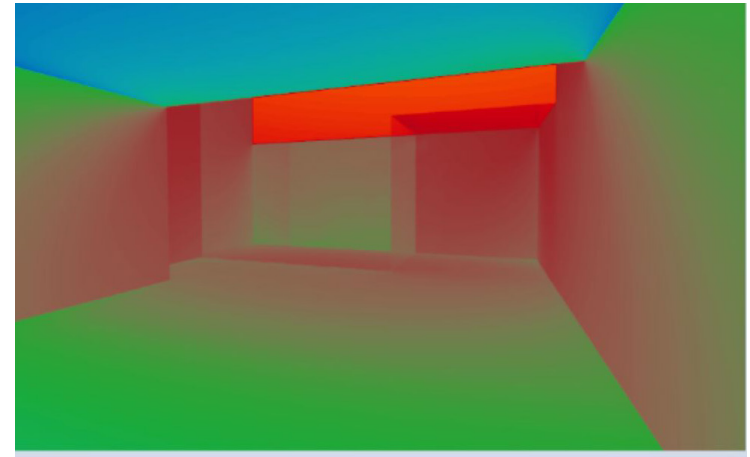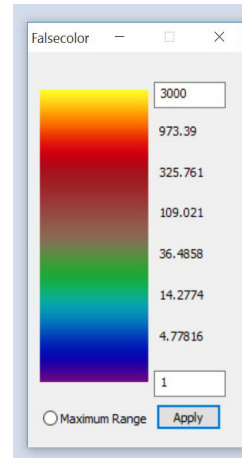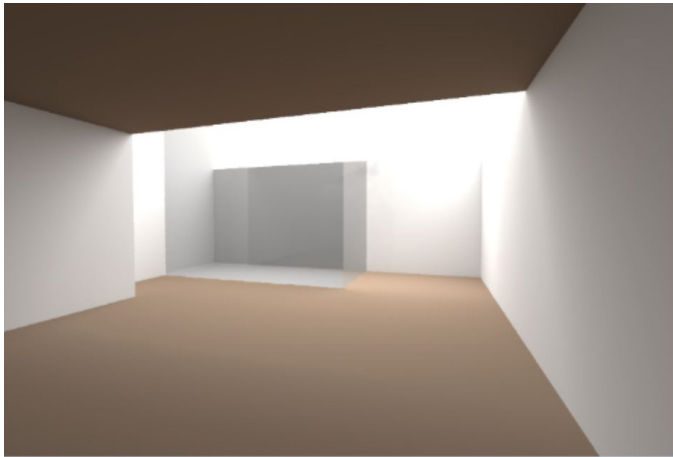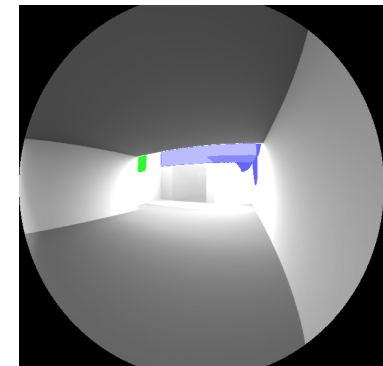
Daylight Simulations:
C.Point in Time Visualization for the live/work space
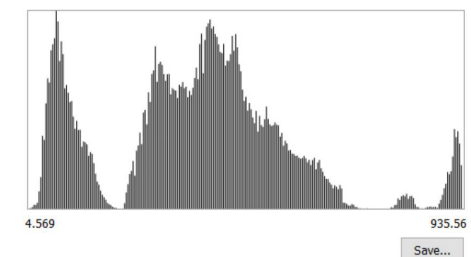### Dec 21, Overcast Sky at noon:

These visualizations confirm and prove the previous analysis. As mentioned before, the south glazed wall luminates the most glare and discomfort. The false color image shows that the upper area of the window brings glare.

The fisheye images highlights the two areas that causes this discomfort. The histogram which analyse one pixel at a time has a variation of light and dark spaces but mostly normal exposure to light. The average value of this scene is 79cd/m2 which means that there are different luminance values as shown in the histogram. Looking at the histogram,
We see varying luminance values but most are under 3000cd/m2, which is supposed to be not glary. However the fisheye analysis show there are two sources of glare.
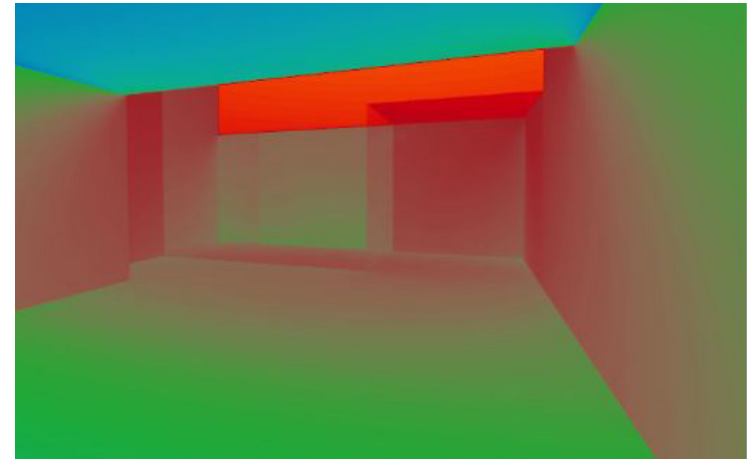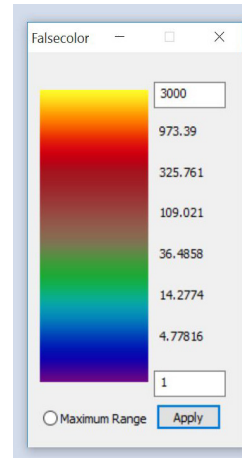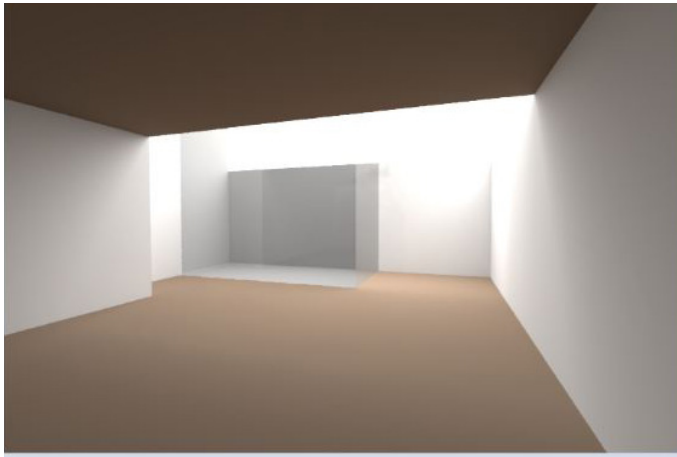
From the previous notes and this visual analysis, a shading device that covers this area to block the sun's glare will be the most beneficial for the home owners.

istical Results

Minimum	4.569	Percentile Ratio:	70.89
Maximum:	935.56	Criteria Result:	100% pixels are lesser than 3000 cd/m²
Mean:	79.19		
Median:	38.25		
Standard Deviation:	158.04		

Daylight Simulations:
C.Point in Time Visualization for the live/work space
March 21, Perez Sky at noon:

For this analysis, I did the simulation repeatedly until I gave up. It makes no sense that this visualization has the exact analysis as the previous one.
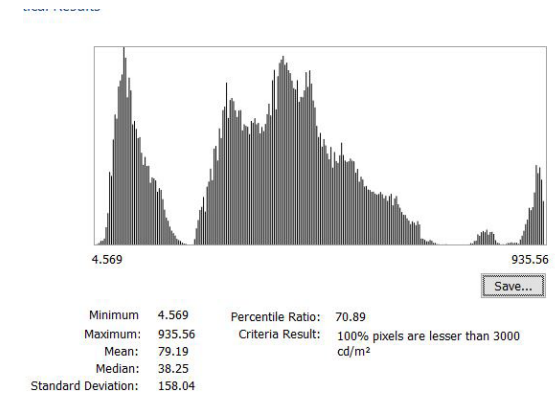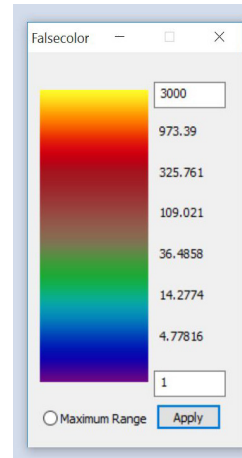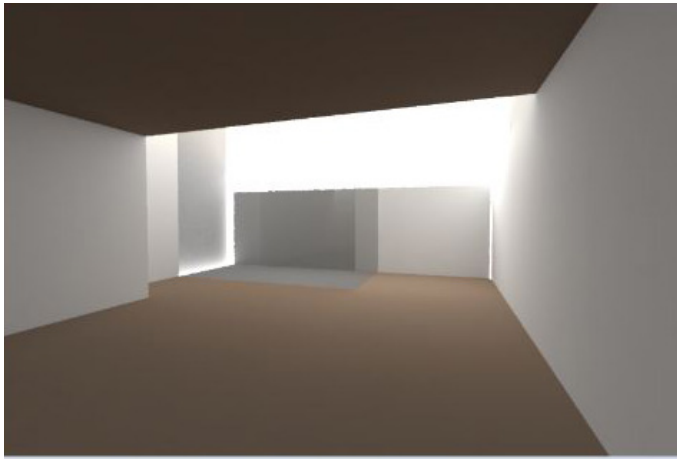
4.569		935.56

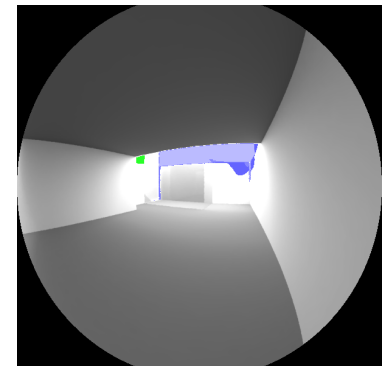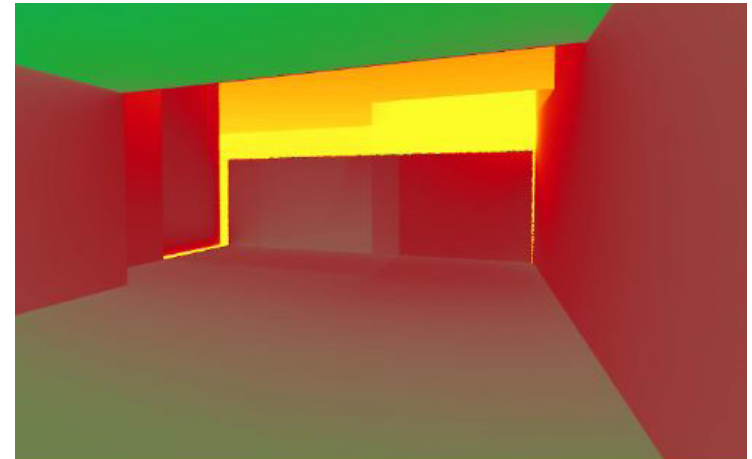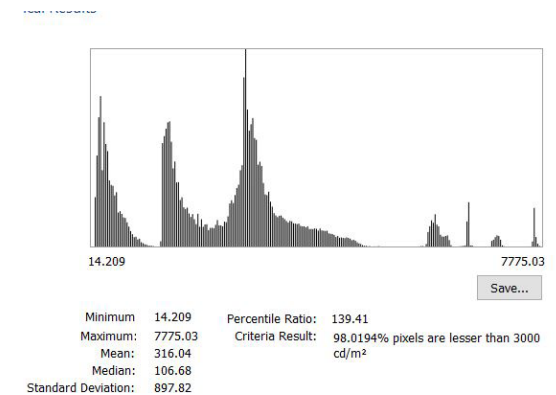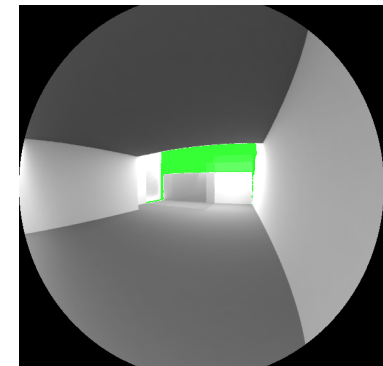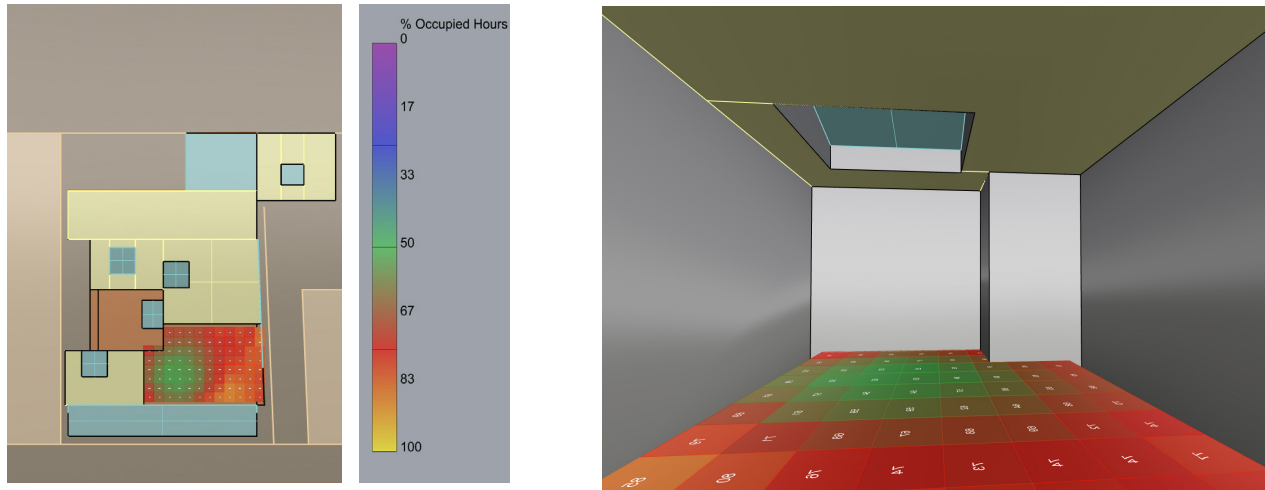|				
Minimum	4.569	Percentile Ratio:	70.89	
Maximum:	935.56	Criteria Result:	100% pixels are lesser than 3000 cd/m²	
Mean:	79.19			
Median:	38.25			
Standard Deviation:	158.04			

Daylight Simulations:
C.Point in Time Visualization for the live/work space
June 21, Clear Sky at noon:

This visual analysis compliment the previous analysis. As mentioned before, the south glazed wall luminates the most glare and discomfort. The false color image shows that the upper area of the window brings glare.

The fisheye images highlights one area that causes this discomfort. The histogram which analyse one pixel at a time has peaks of dark spaces yet some very light areas. The average value of this scene is 316 cd/m2 which is too high which means that there is glare. Looking at the histogram, We see peaks of dark area and some light areas.

From the previous notes and this visual analysis, a shading device that covers this area to block the sun's glare is strongly recommended.

Minimum	14.209	Percentile Ratio: 139.41
Maximum:	7775.03	Criteria Result: 98.0194% pixels are lesser than 3000 cd/m²
Mean:	316.04	
Median:	106.68	
Standard Deviation:	897.82	

Daylight Simulations:
D. Skylights
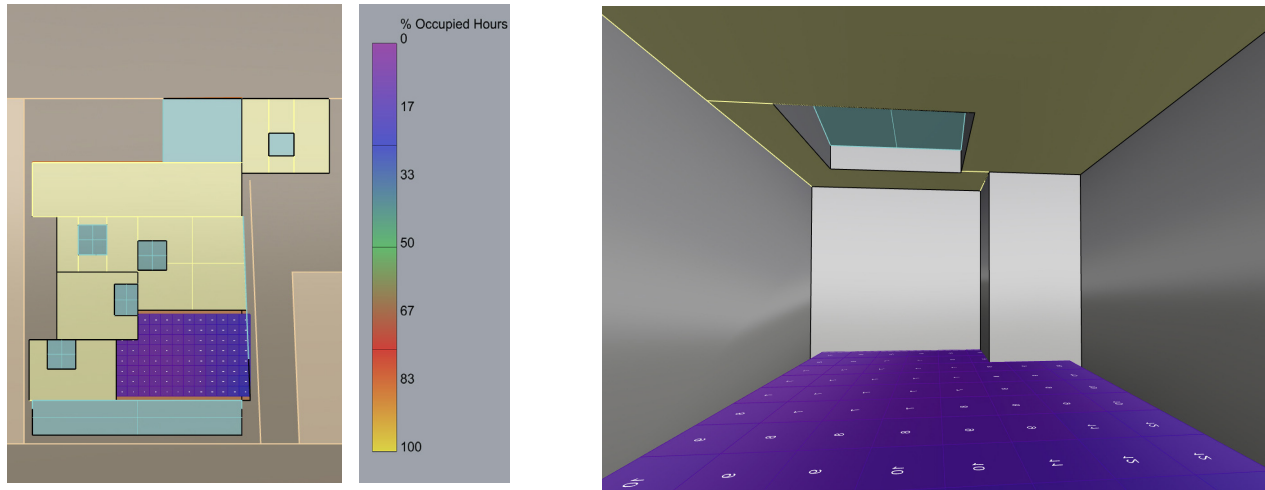### Useful Daylight Index (UDI) for
>100 and <2000lux

The top floors of Elektra House consists of the bedrooms lit by skylights. This analysis is for the north facing bedroom.

The useful daylight index (UDI) splits the illuminance data into useful light, no light and glare based on climate data.

This analysis analyse the area for the percentage of illuminance that is greater than 100 lux and less that 2000 lux which is the useful daylight that lits this space. The mean value of useful daylight illumination is 70% of the time occupied.

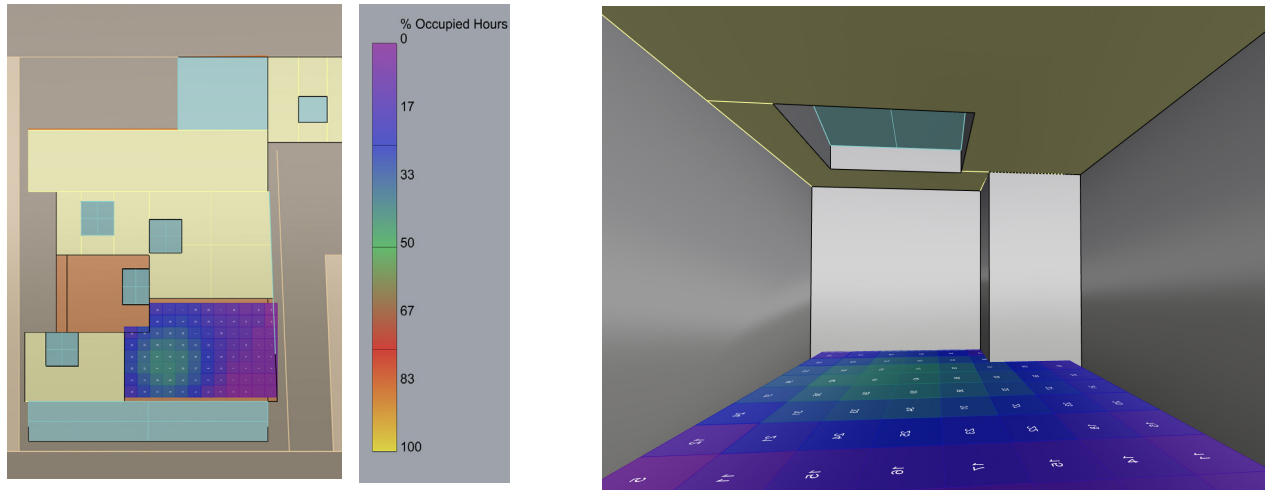50% of the year, the room achieves the required illuminance.

Daylight Simulations:

D. Skylights
Useful Daylight Index (UDI) for
<100 lux

The useful daylight index (UDI) splits the illuminance data into useful light, no light and glare based on climate data.

This analysis analyse the area for the percentage of illuminance that is less than 100 lux which is basicly no light in the space. The mean value of useful daylight illumination is 10.6% of the time occupied.

Daylight Simulations:
D. Skylights
Useful Daylight Index (UDI) for
>2000 lux

The useful daylight index (UDI) splits the illuminance data into useful light, no light and glare based on climate data.

This analysis analyse the area for the percentage of illuminance that is greater than 2000 lux which is the glare areas. The mean value of useful daylight illumination is 19% of the time occupied.

This high illuminance cause glare in the green area which is around half of the year as show in the analysis result.

Elektra House
Conclusion

Based on the previous analysis, Electra house needs proper shading at certain rooms.

The live/work space needs blinds or movable shades around the areas close to the kitchen in December, while in March it needs movable shades to control the glazed wall as well as the skylights on both ends.

In addition to the second floor bedroom, it need proper movable shading device for the skylight to maximize the period of the useful daylight autonomy.

GROUND FLOOR PLAN
SCALE: ⅛" = 1'-0"

FIRST FLOOR PLAN
SCALE: ⅛" = 1'-0"

NORTH ELEVATION
SCALE: ⅛" = 1'-0"

A SECTION

B SECTION