PROBLEM : HOW TO IMPROVE COMFORT LEVELS IN AN EXISTING ROOM

LAYOUT OF THE EXISTING ROOM

Located in Philadelphia, United States. This room is a part of 5 bedroom apartment. Windows are located on the wall facing east side with an existing overhang. Two walls are attached to other rooms in the house.

Plan

Section

APPROACH

ROOM BASIC LAYOUT

CLIMATE ANALYSIS

DESIGNING THE SHADING FOR THE WINDOWS

CHANGE THE SIZE OF THE WINDOW

CHANGE THE ORIENTATION

RUNNING ENERGY MODELLING FOR THE DESIGN ..... TENTATIVE DESIGN

CHANGING THE MATERIAL OF THE WALLS, ROOF, CEILING AND WINDOW

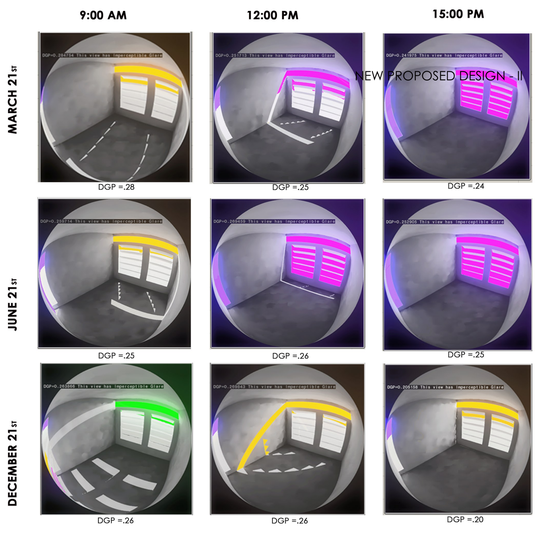
ADDING NATURAL VENTILATION, INFILTRATION RATES

ADD OCCUPANCY, VENTILATION , LIGHTING SCHEDULE

CHANGE THE MATERIALS

DAYLIGHT ANALYSIS

GLARE ANALYSIS



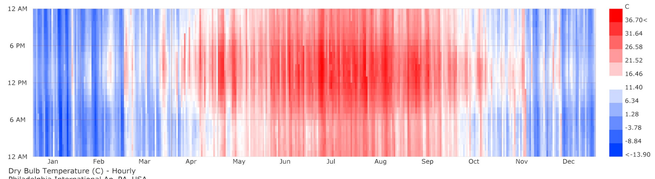
For 9-point image-based glare analysis, Daylight Glare Probability is less than .35 (imperceptible glare). There would be no visual discomfort to the occupant with the proposed shading.

Areas where, we are able to get direct sunlight, for few hours, the occupant can move his location or with the help of blinds, direct sunlight can be reduced depending on the occupant's will.

Maximum amount of direct sunlight is coming inside the during winter and morning 9:00 am, when the sun is not harsh and can be desired by some.

CLIMATE ANALYSIS

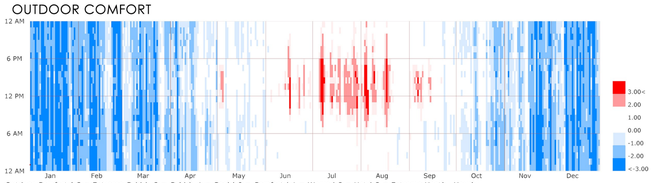
DRY BULB TEMPERATURE



Dry Bulb Temperature (C) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

The outdoor temperature in Philadelphia ranges from -14 degree Celsius to 37 degree Celsius. We generally have higher temperature from 10:00AM to 5:00PM.

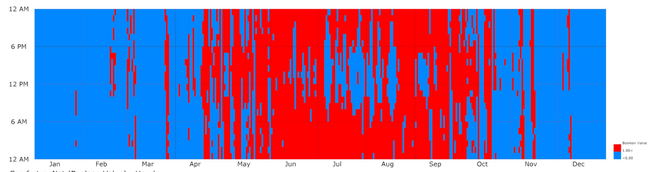
OUTDOOR COMFORT



Outdoor Comfort (-3 = Extreme Cold | -2 = Cold | -1 = Cool | 0 = Comfort | 1 = Warm | 2 = Hot | 3 = Extreme Heat) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

Outdoor is comfortable for 41 % of the hear. It has very less heat stress which mainly happening during the day in the hottest month. It has only 4 % of heat stress.

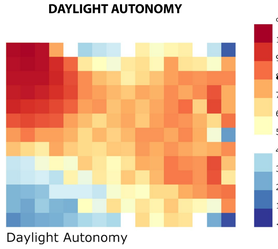
PHILADELPHIA IS COMFORTABLE FOR HOW MUCH TIME



Comfort or Not (Boolean Value) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

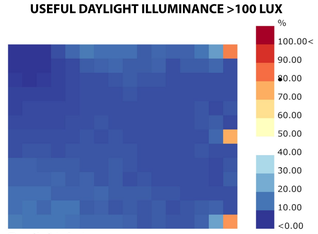
Red coloured area represents the times of year when Philadelphia is comfortable. Winter is not comfortable at all. Summer is mostly comfortable except the hottest months.

DAYLIGHT AUTONOMY



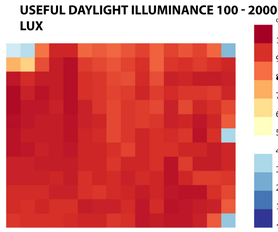
Daylight Autonomy

USEFUL DAYLIGHT ILLUMINANCE >100 LUX



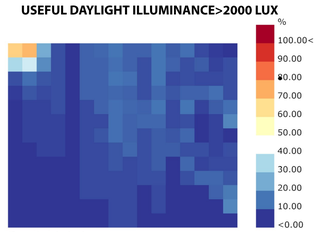
Daylight Autonomy

USEFUL DAYLIGHT ILLUMINANCE 100 - 2000 LUX



Daylight Autonomy

USEFUL DAYLIGHT ILLUMINANCE>2000 LUX



Daylight Autonomy

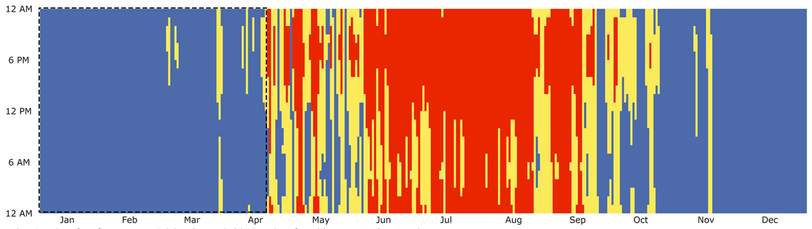
To increase the UDI of the room, a shade of upper slit and north window has been removed. More light enters the room.
This scenario is performing the best, as more than 85 % of the room is getting useful daylighting for more than 80% of the times.
The area which has light less than 100 lux is negligible. The area near north side of the window has more than 2000 lux of daylight.

Further, materials and ambient bounce have been changed, to increase the UDI in the room.

ENERGY MODELING OF THE EXISTING LAYOUT OF A ROOM, PHILADELPHIA

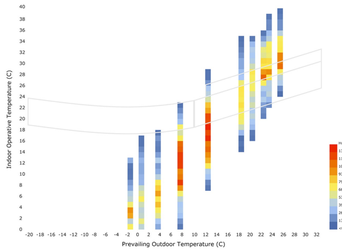
Existing Design with shading,
Percentage of time when it is comfortable : 17 %
Percentage of time when it is hot : 34 %
Percentage of time when it is cold : 49 %

It has higher percentage of cold stress. So we can increase the window size and remove the shading so more solar gain can happen during winter
We can also increase the R value of the walls and ceiling , which will provide a better insulation to the room, making it comfortable.



Adaptive Comfort for NAMAN_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

COMFORTABLE TIME ZONES FOR A YEAR IN PHILADELPHIA



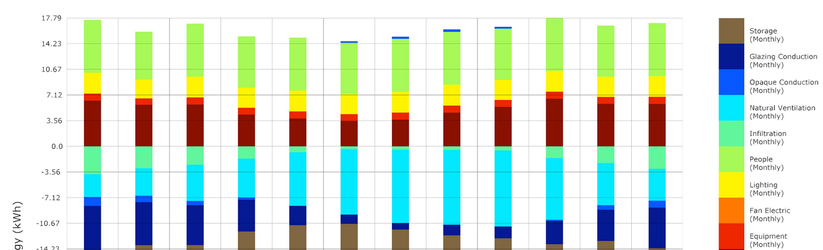
Adaptive Chart
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

ADAPTIVE COMFORT CHART

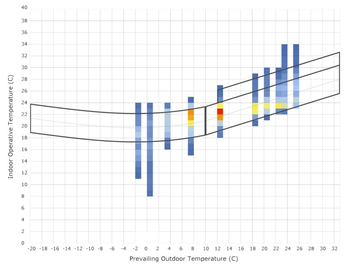
ENERGY MODELING OF THE PROPOSED LAYOUT OF A ROOM IN PHILADELPHIA

Percentage of time comfortable :82%
percentage of hot stress: 10%
Percentage of cold stress: 8%

COMFORT CHART



Adaptive Comfort for NAMAN_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00



Adaptive Chart
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

ADAPTIVE COMFORT CHART

ENERGY BALANCE

By changing the properties we are able to reduce the amount of solar gain. But we are not able to reduce the glazing conduction.
With the help of natural ventilation and infiltration we are able to reduce amount of heat gained inside the room.

CONCLUSION

There has been a significant increase in the level of comfort of the room It has gone up from 17 % to 18 %.
The entire problem was approached step by and re-running the simulations and analysis. Catering one problem at a time helped in understanding the nuances of the problem. and how it can be tackled in the real scenario.
A room can be made comfortable without the mechanical ventilation and heating if it is designed properly, my room is very cold in Winters especially during the night time, with some changes I have managed to make it comfortable for most of the times.
Natural ventilation is one of the things which has made a huge difference in the comfort levels. Using materials specified in the code. Various shading designs were tested before conducting the energy simulations. the design that performed the best in the daylighting analysis, did not perform well in energy simulation due to which window area had to remove from the north side. During the daytime, the occupant is not at home, because of which energy modeling is given more importance.
I had assumed that east facing windows perform better, for the daylight and energy modeling but it was south facing windows which work better in the case of my room. Materials specification of the construction made a difference as well. The idea was to warm up the room using different materials and shading device and then cool it down using infiltration and natural ventilation.
The time for which it has cold stress that is 8 %, a person can make it comfortable by adding more clothing layers