

BUILDING PERFORMANCE SIMULATION
ARCH-753 Fall 2017



ASSIGNMENT 7

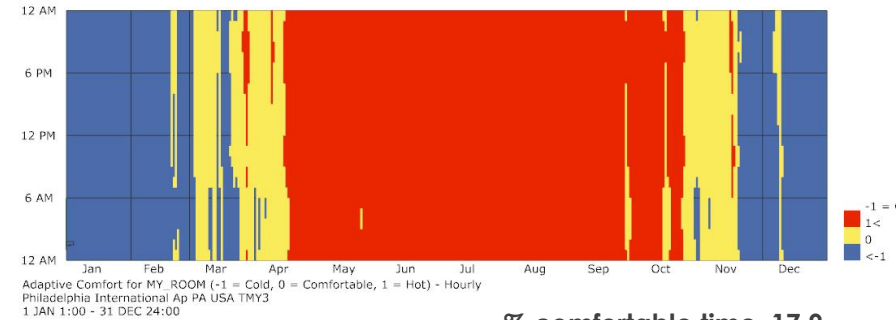
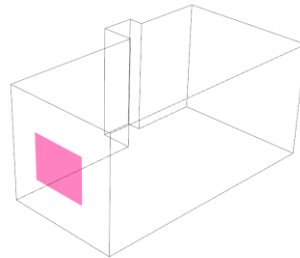
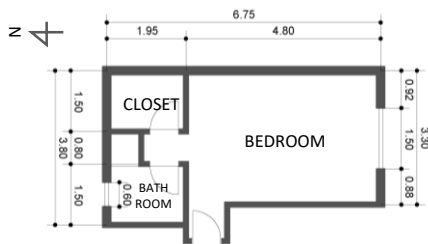
Hwang, Youngjin

| Energy Model for My Room |

1. Original Room VS Newly Designed Room |

From the beginning, the newly designed room which tried to optimize indoor daylight environment is compared with original room for energy evaluation. In this case, the simulation focuses on the indoor adaptive comfort without HVAC system. According to simulation, the newly designed room has lower comfortable time than original's one since cold stress rises almost 8% because of increased area of windows.

Original Room



Exterior wall R-VALUE: 2.18

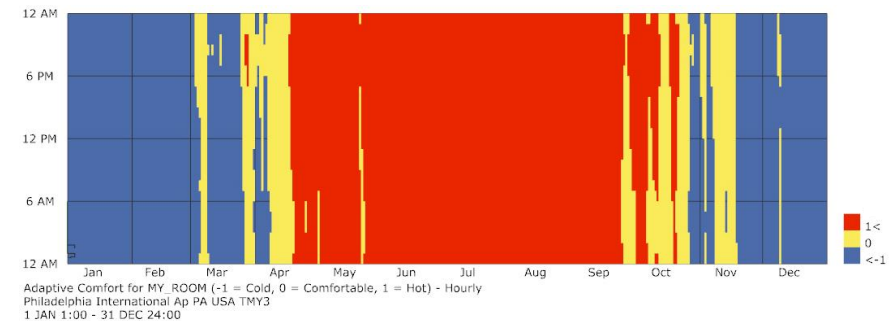
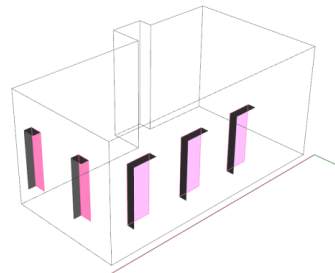
Window U-VALUE: 2.37

% comfortable time 17.9

Hot stress 52.2

Cold stress 29.9

Newly Designed Room



Exterior wall R-VALUE: 2.18

Window U-VALUE: 2.37

% comfortable time 15.3

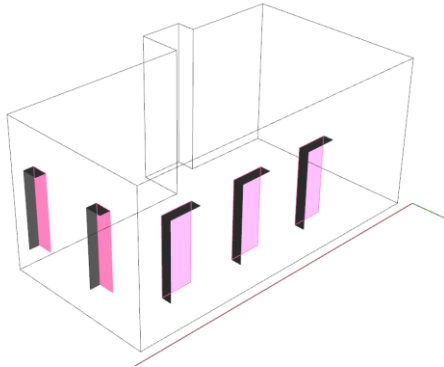
Hot stress 47.2

Cold stress 37.5

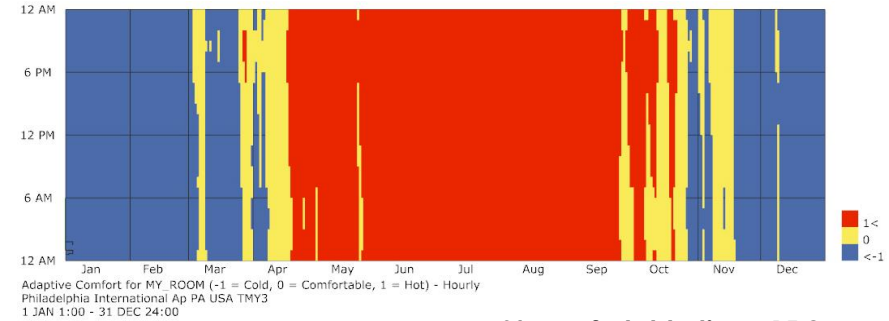
| Energy Model for My Room

2. Newly Designed Room VS increased R-Value material application to reduce cold stress in winter |

To increase indoor comfort level, firstly I have changed R-Value and U-Value of the room. Basically, these two values are related to thermal insulation property of building, so I altered these to reduce cold stress with the baseline from climate zone. Moreover, I have changed these two values to the highest one in honeybee material to maximize insulation property.



**Baseline of
Newly Designed Room**



Exterior wall R-VALUE: 2.18

Window U-VALUE: 2.37

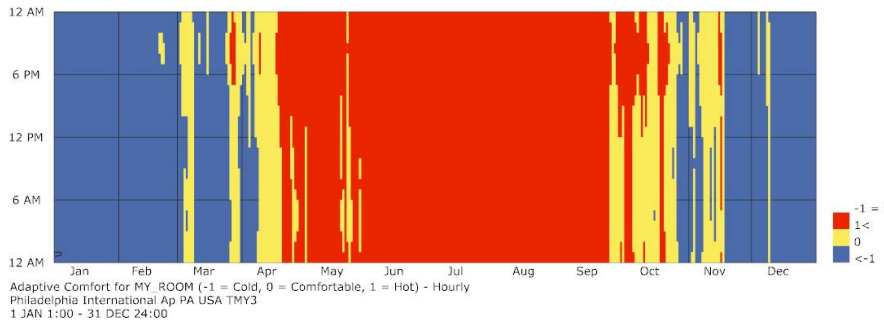
% comfortable time 15.3

Hot stress 47.2

Cold stress 37.5

1. Meet the Requirements of ASHRAE 90.1-2010 Baseline

ASHRAE 90.1-2010 EXTWALL WOODFRAME CLIMATEZONE 1-4
ASHRAE 90.1-2010 EXTWINDOW NONMETAL CLIMATEZONE 4



Exterior wall R-VALUE: 2.60

Window U-VALUE: 2.27

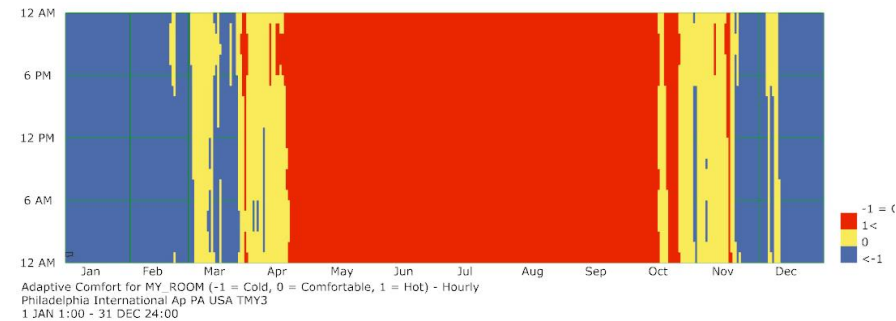
% comfortable time 16.4

Hot stress 45.9

Cold stress 37.7

2. Meet the Requirements of Highest ASHRAE 90.1-2010 Baseline

ASHRAE 90.1-2010 EXTWALL WOODFRAME CLIMATEZONE 8
ASHRAE 90.1-2010 EXTWINDOW NONMETAL CLIMATEZONE 5-6



Exterior wall R-VALUE: 4.74

Window U-VALUE: 1.99

% comfortable time 17.4

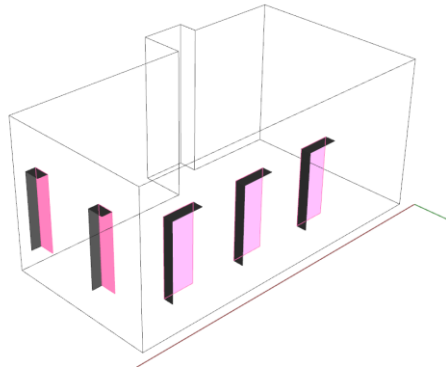
Hot stress 52

Cold stress 30.6

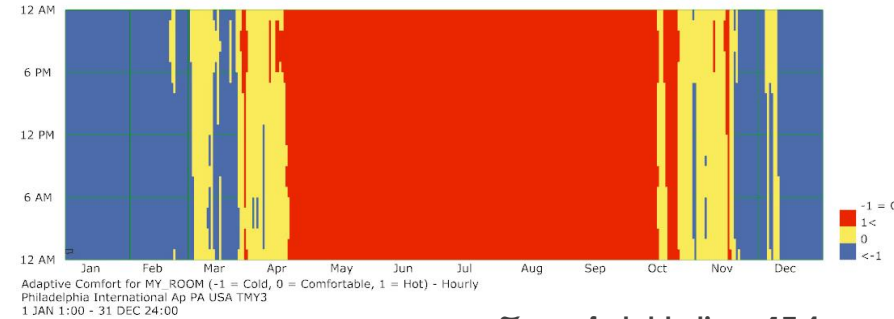
| Energy Model for My Room

3. Add Natural Ventilation Property to Reduce Hot Stress

The only passive way to reduce heat stress is a natural ventilation. Continuing from the previous step to reduce cold stress, the following step is adding natural ventilation to reduce heat stress. Moreover, infiltration rate is also added as a major factor.



**Baseline of
Newly Designed Room**



Exterior wall R-VALUE: 4.74

Window U-VALUE: 1.99

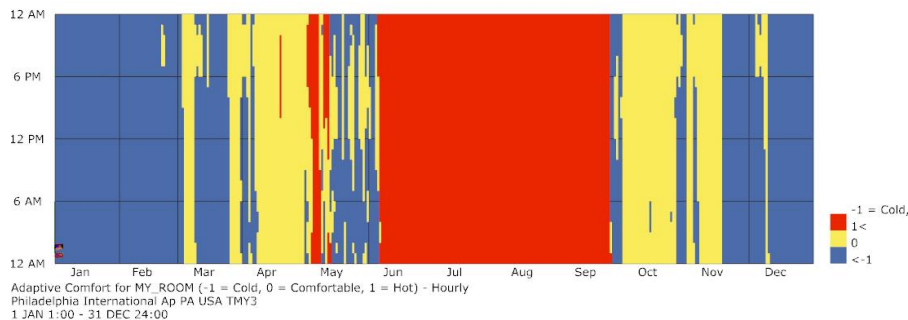
% comfortable time 17.4

Hot stress 52

Cold stress 30.6

1. Natural Ventilation Temperature Setting (1)

*Recommended setting by Chris Mackey (conditioned with HVAC)



Min. Indoor Temp for NV: 21°C
Max. Indoor Temp for NV: 27 °C
Min. Outdoor Temp for NV: 12 °C
Max. Outdoor Temp for NV: 28 °C
Infiltration rate: 0.0003(m³/s per m²)

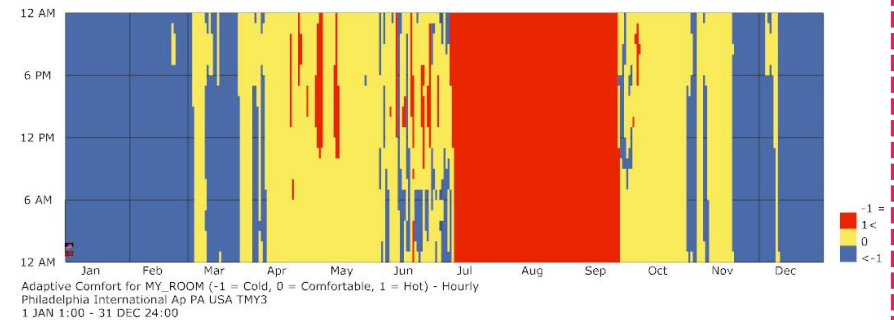
% comfortable time 26

Hot stress 32

Cold stress 42

2. Natural Ventilation Temperature Setting (2)

*Maximum temperature and minimum temperature for NV was re-organized to Reduce not only hot stress but also cold stress.



Min. Indoor Temp for NV: 21°C
Max. Indoor Temp for NV: 29 °C
Min. Outdoor Temp for NV: 17 °C
Max. Outdoor Temp for NV: 30 °C
Infiltration rate: 0.0001 (m³/s per m²)

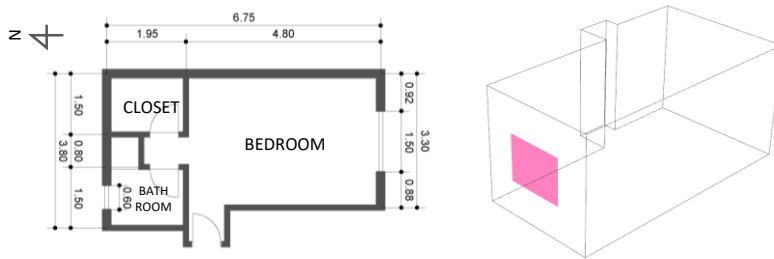
% comfortable time 38

Hot stress 24

Cold stress 38

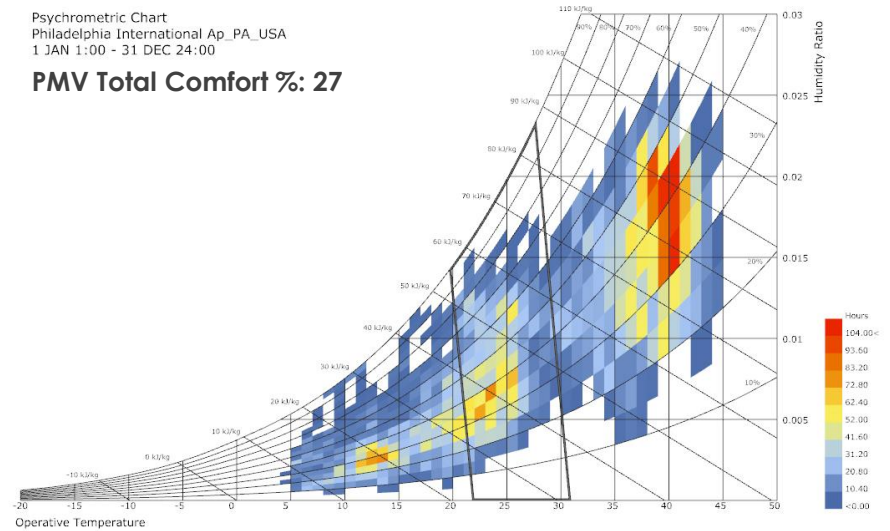
| Conclusion 1_Original Room

Original Room

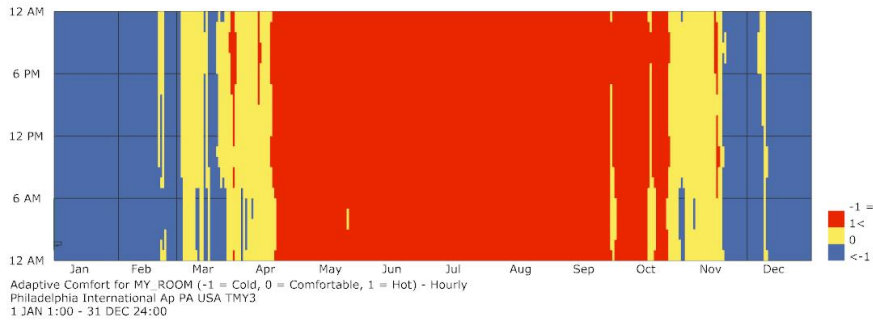


Psychrometric Chart

Psychrometric Chart
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00
PMV Total Comfort %: 27



Adaptive Comfort Graph



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

*No apply natural ventilation

% comfortable time 17.9

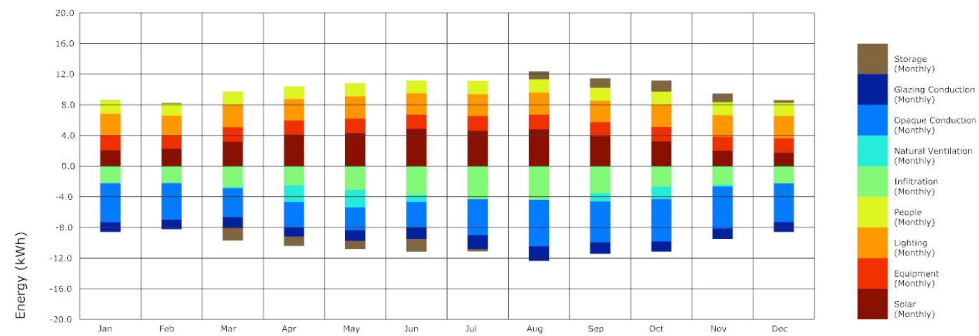
Exterior wall R-VALUE: 2.18

Hot stress 52.2

Window U-VALUE: 2.37

Cold stress 29.9

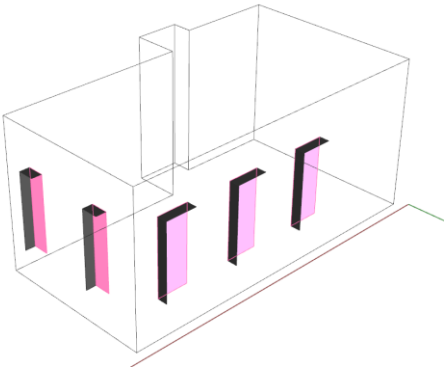
Energy Balance Chart



Conclusion 2_Newly Designed Room

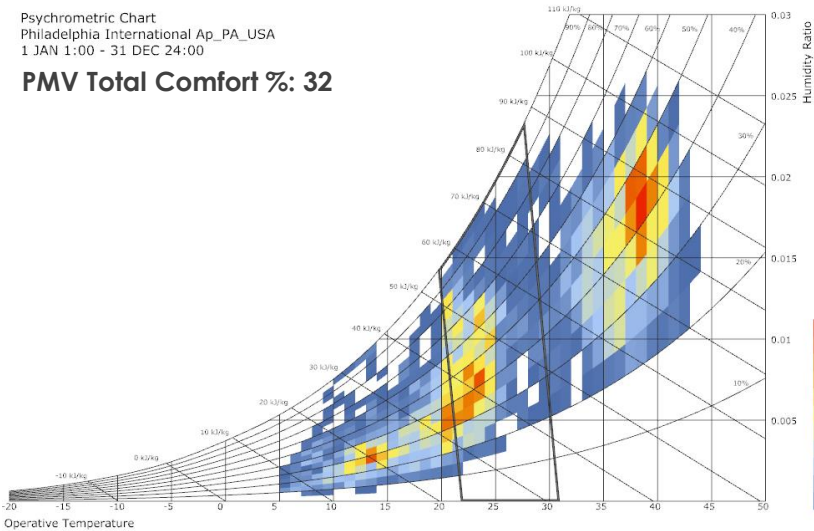
The considerable comfortable rate is increased from original design with these properties regarding energy performance. However, there are still high cold stress and also heat stress. In case of cold stress, it will be improved with higher U-Value, but to reduce more hot stress would be impossible without HVAC since if the room has more window for natural ventilation, it would have a negative effect on natural daylight environment and cold stress as well.

Newly Designed Room

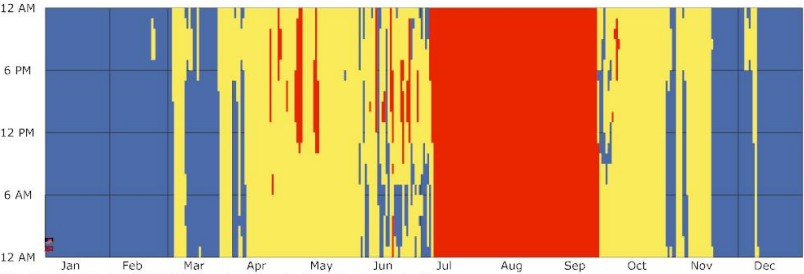


Psychrometric Chart

Psychrometric Chart
Philadelphia International Ap_PA_USA
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PMV Total Comfort %: 32



Adaptive Comfort Graph



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

Min. Indoor Temp for NV: 21°C
Max. Indoor Temp for NV: 29 °C
Min. Outdoor Temp for NV: 17 °C
Max. Outdoor Temp for NV: 30 °C
Infiltration rate: 0.0001 (m³/s per m²)

Exterior wall R-VALUE: 4.74

Window U-VALUE: 1.99

% comfortable time 38

Hot stress 24

Cold stress 38

Energy Balance Chart

