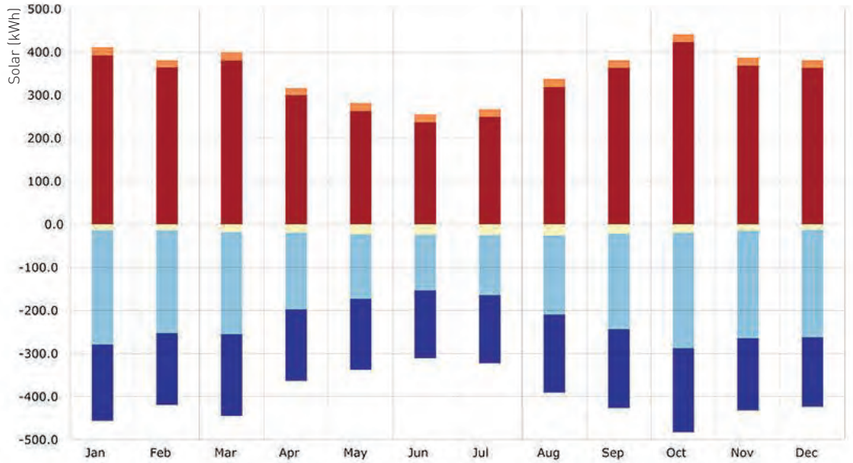
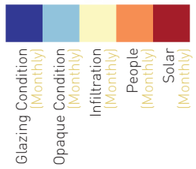
Energy Simulation II:
Dream Room Application

DYAN CASTRO

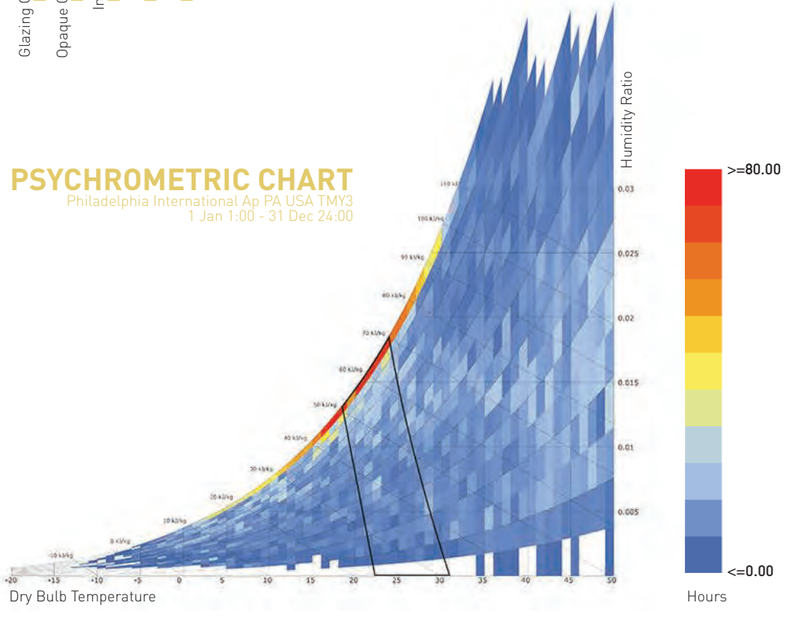
PENNDesign | Fall 2016 | ARCH 753 | Mostapha Sadeghipour

Energy Simulation: Base Case/Existing Room

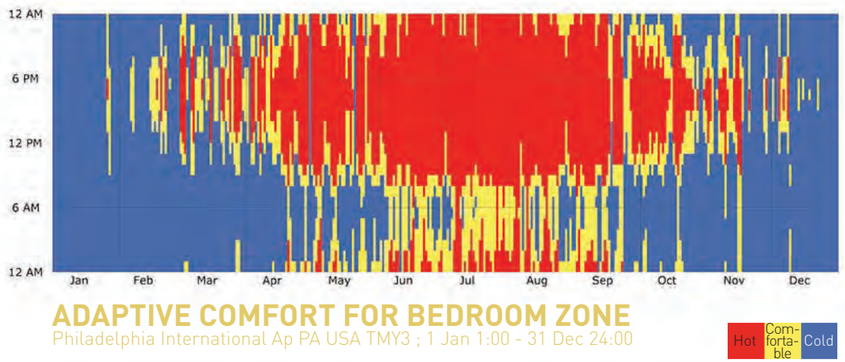




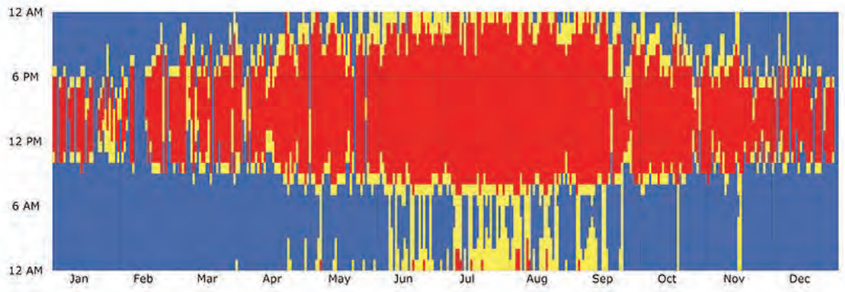
ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



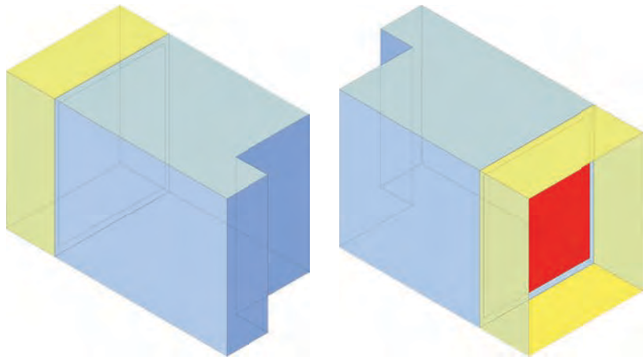
PSYCHROMETRIC CHART
Philadelphia International Ap PA USA TMY3
1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BALCONY ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



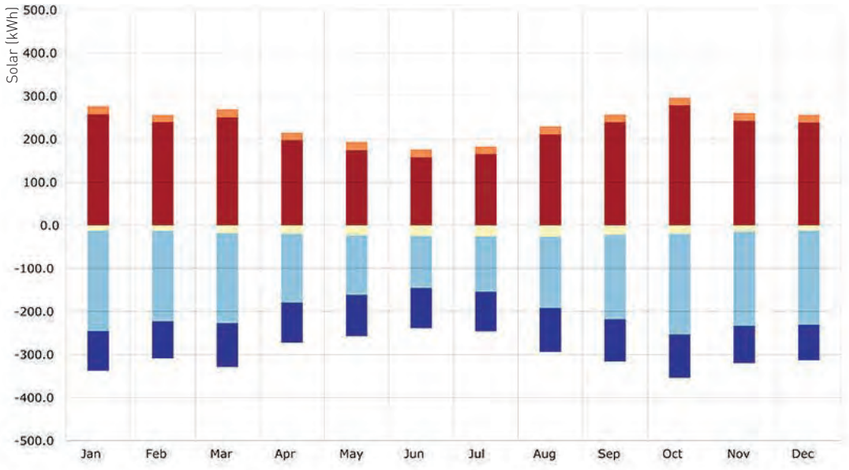
AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

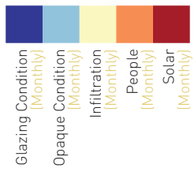
Comfortable(%): **18.38**
Hot (%): **32.66**
Cold (%): **48.95**

BASE CASE (EXISTING)

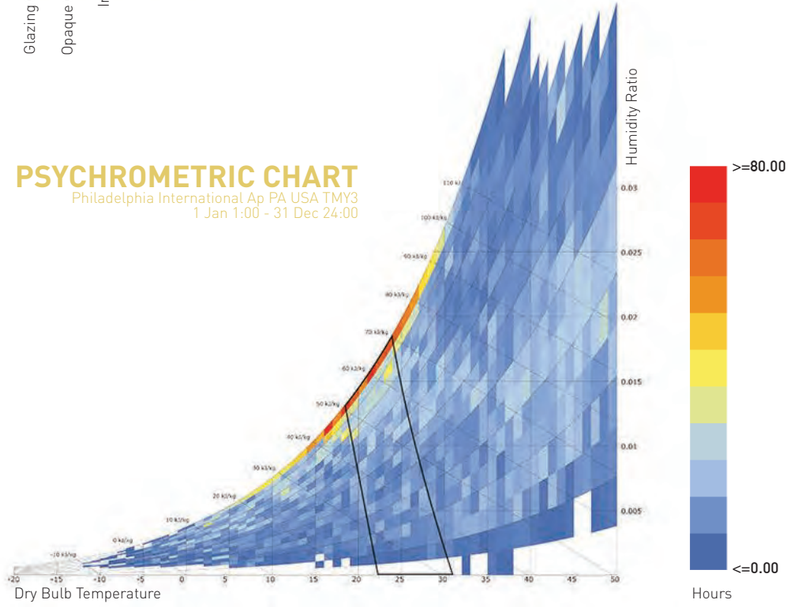
wall to window ratio: 0.84 South Facing
rotation angle: 0
blinds: no
    shading depth: n/a
    number of blinds: n/a
construction
    exterior wall: R5.5
    exterior window: R1.0, SHGC 0.7
    exterior roof: R9.2
    air change hours: 2.00
thermal mass: existing slab construction

Energy Simulation: Window Size Alteration A

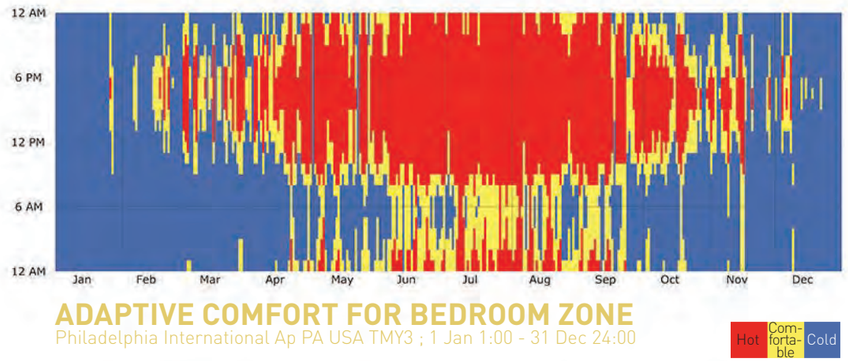




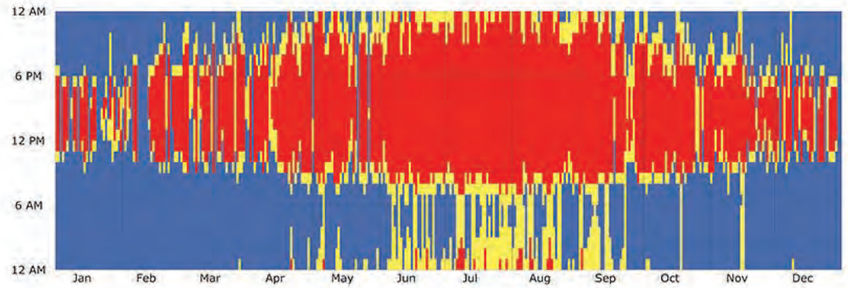
ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



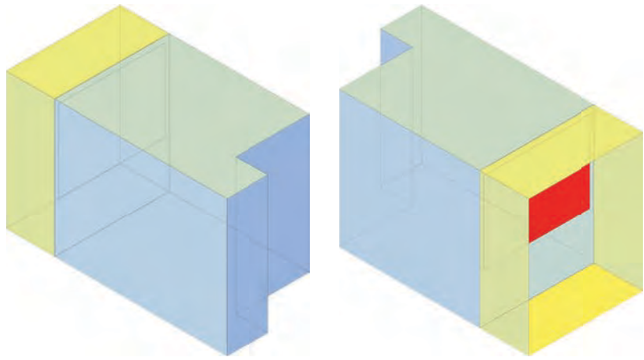
PSYCHROMETRIC CHART
Philadelphia International Ap PA USA TMY3
1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BALCONY ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



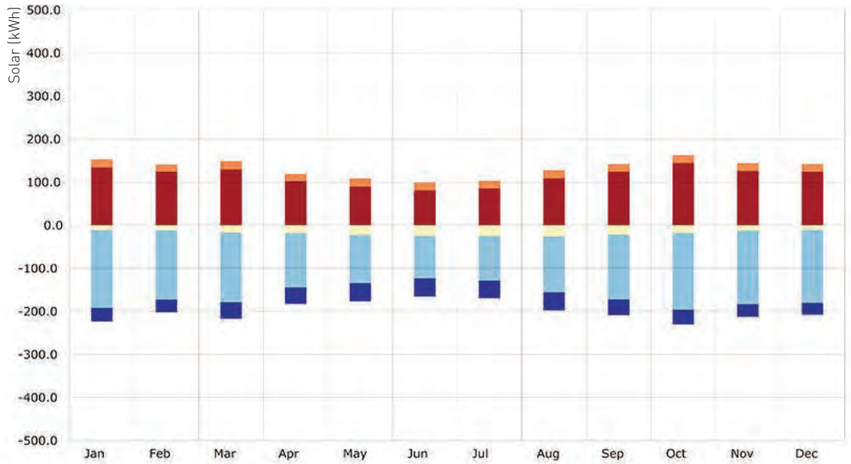
AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

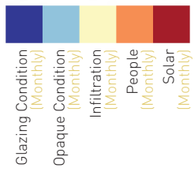
Comfortable(%): **18.38**
Hot (%): **32.67**
Cold (%): **48.95**

WINDOW REPLACES DOORS

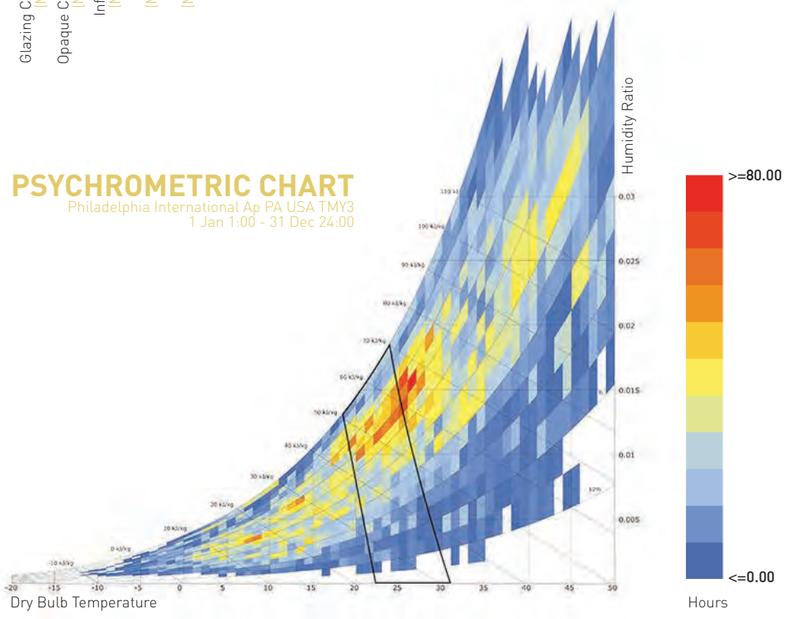
wall to window ratio: 0.55 South Facing
rotation angle: 0
blinds: no
    shading depth: n/a
    number of blinds: n/a
construction
    exterior wall: R5.5
    exterior window: R1.0, SHGC 0.7
    exterior roof: R9.2
    air change hours: 2.00
thermal mass: existing slab construction

Energy Simulation: Window Size Alteration B

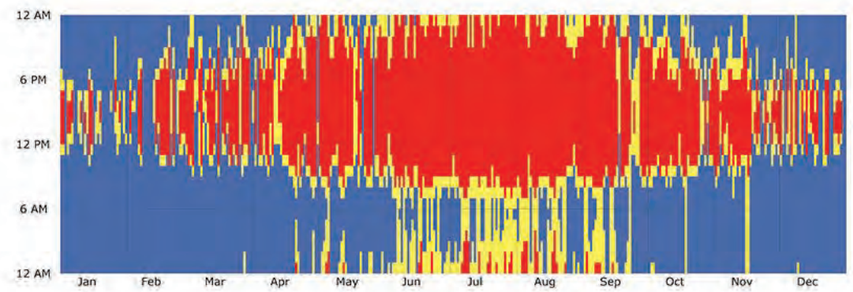




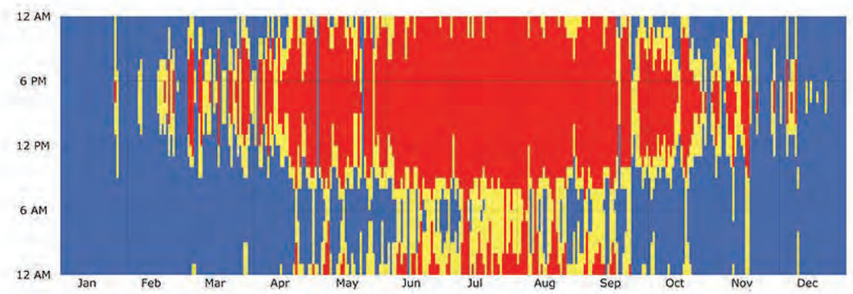
ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



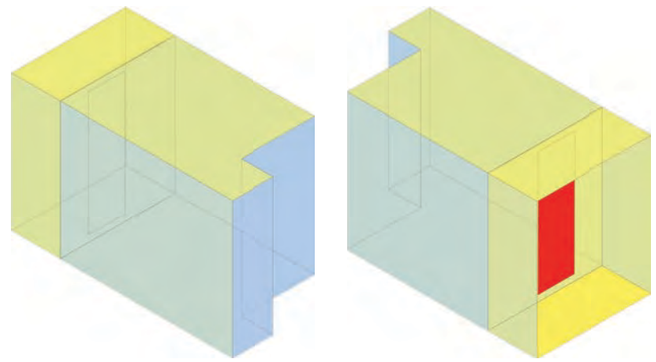
PSYCHROMETRIC CHART
Philadelphia International Ap PA USA TMY3
1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BALCONY ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



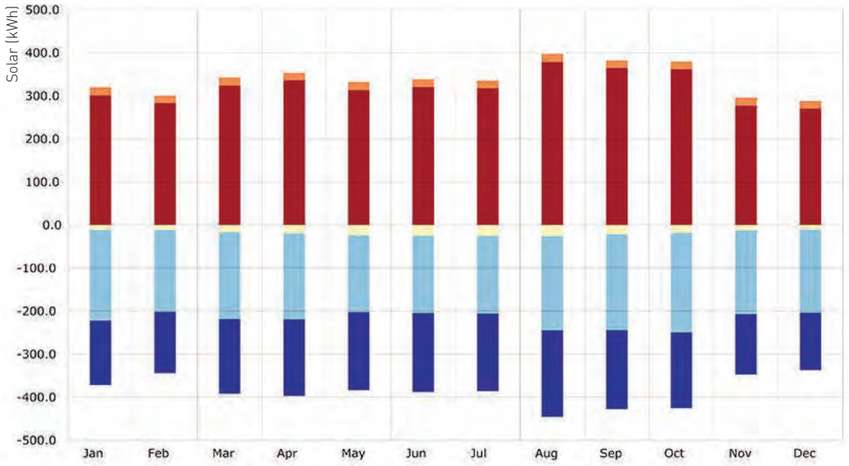
AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

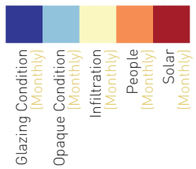
Comfortable(%): **16.94**
Hot (%): **35.39**
Cold (%): **47.67**

ONE DOOR INSTEAD OF TWO

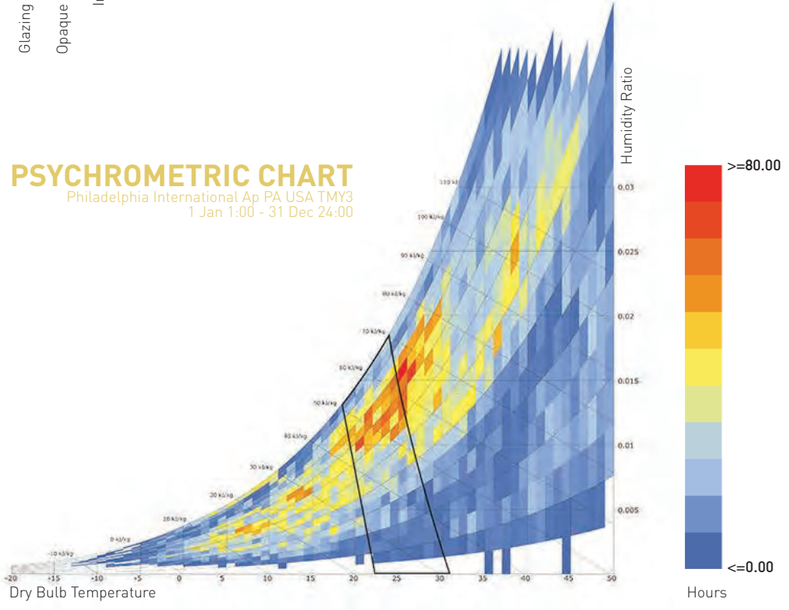
wall to window ratio: 0.29 South Facing
rotation angle: 0
blinds: no
    shading depth: n/a
    number of blinds: n/a
construction
    exterior wall: R5.5
    exterior window: R1.0, SHGC 0.7
    exterior roof: R9.2
    air change hours: 2.00
thermal mass: existing slab construction

Energy Simulation: Rotation Alteration A





ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



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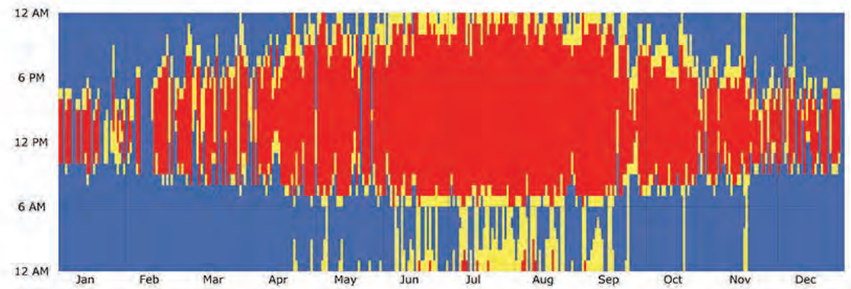
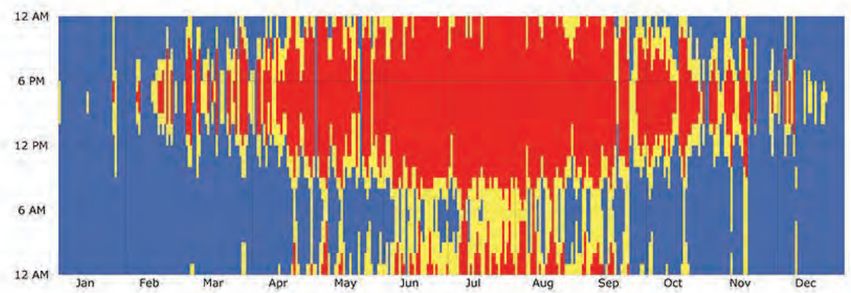


ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



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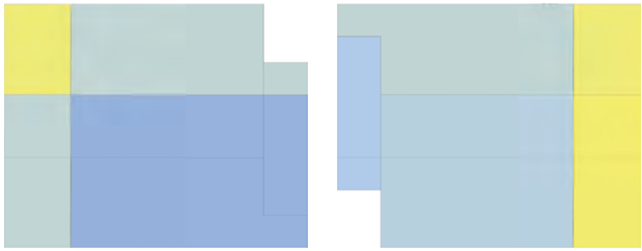


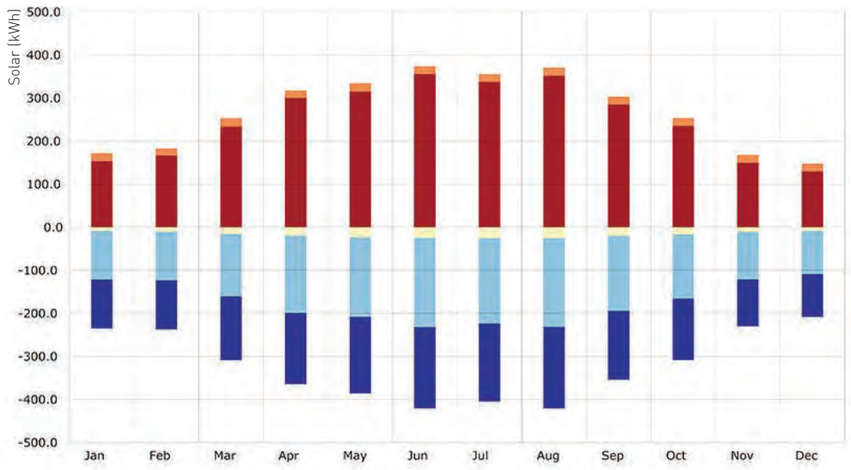
AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

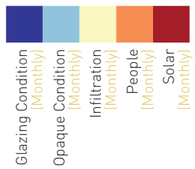
Comfortable(%): **14.14**
Hot (%): **39.75**
Cold (%): **46.11**

ORIENTED 45 DEGREES

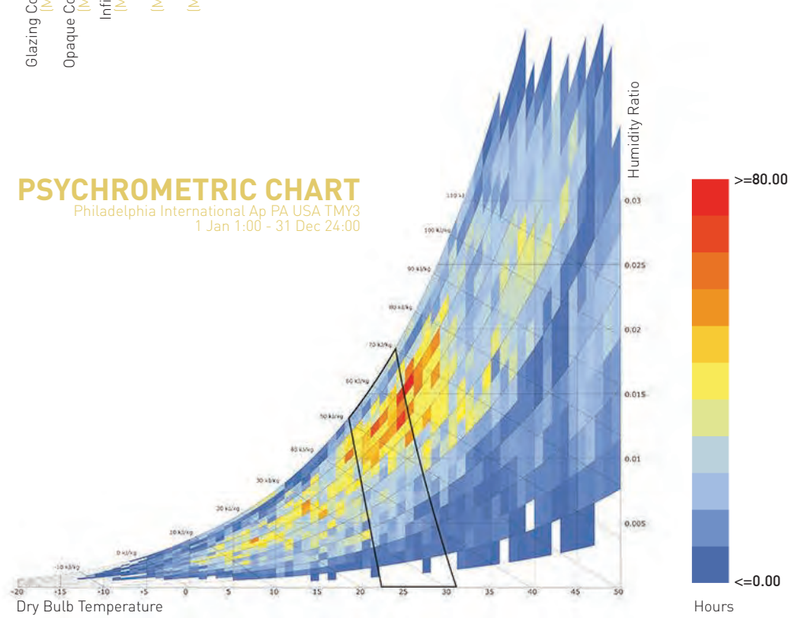
wall to window ratio: 0.84 South Facing
rotation angle: 45
blinds: no
    shading depth: n/a
    number of blinds: n/a
construction
    exterior wall: R5.5
    exterior window: R1.0, SHGC 0.7
    exterior roof: R9.2
    air change hours: 2.00
thermal mass: existing slab construction

Energy Simulation: Rotation Alteration B

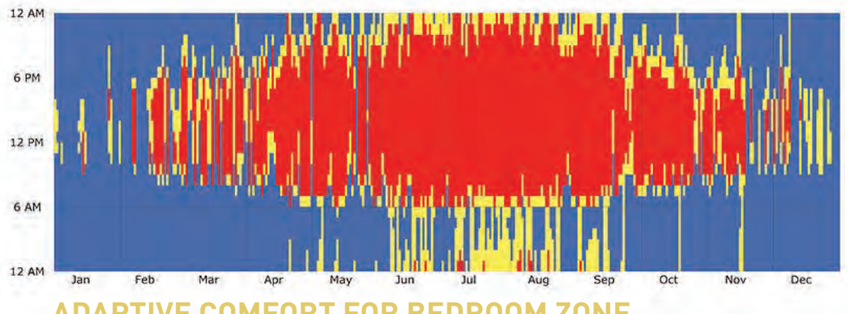




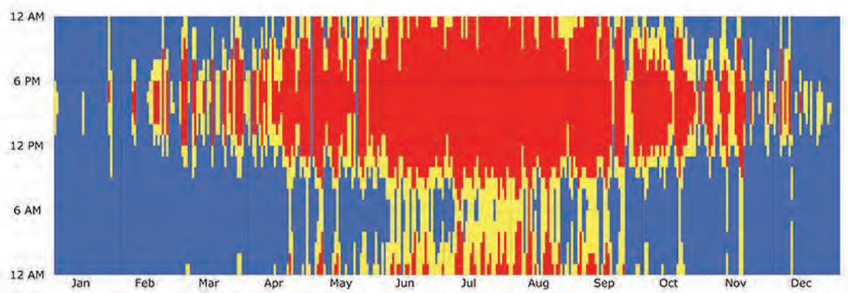
ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



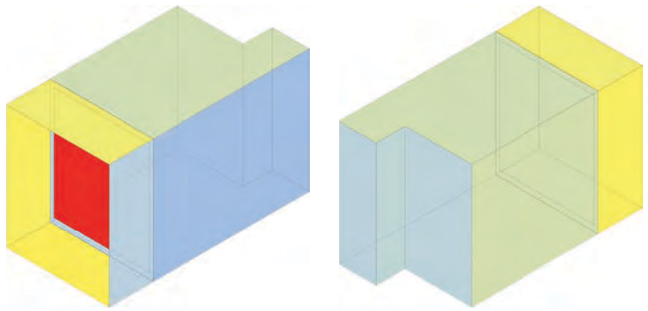
PSYCHROMETRIC CHART
Philadelphia International Ap PA USA TMY3
1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BALCONY ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



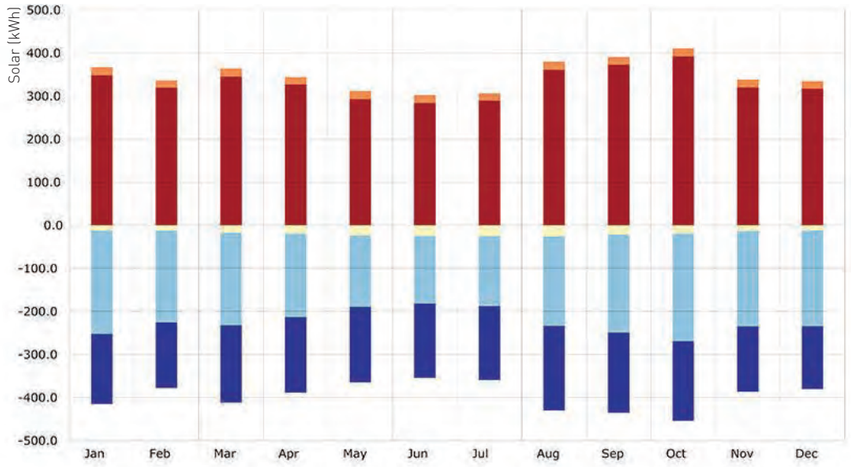
AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

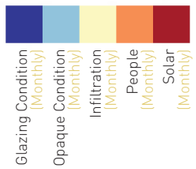
Comfortable(%): **14.63**
Hot (%): **35.95**
Cold (%): **49.42**

ORIENTED 90 DEGREES

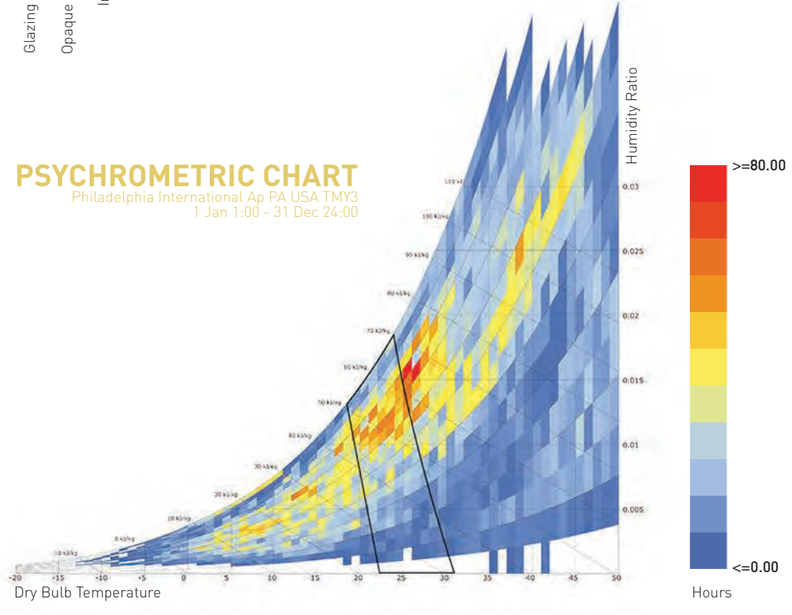
wall to window ratio: 0.84 South Facing
rotation angle: 90
blinds: no
    shading depth: n/a
    number of blinds: n/a
construction
    exterior wall: R5.5
    exterior window: R1.0, SHGC 0.7
    exterior roof: R9.2
    air change hours: 2.00
thermal mass: existing slab construction

Energy Simulation: Rotation Alteration C





ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



PSYCHROMETRIC CHART
Philadelphia International Ap PA USA TMY3
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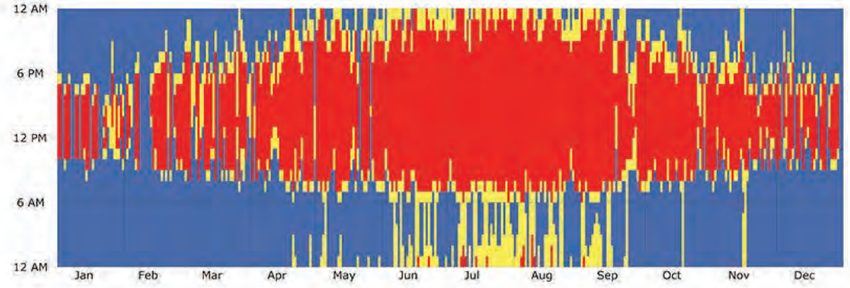
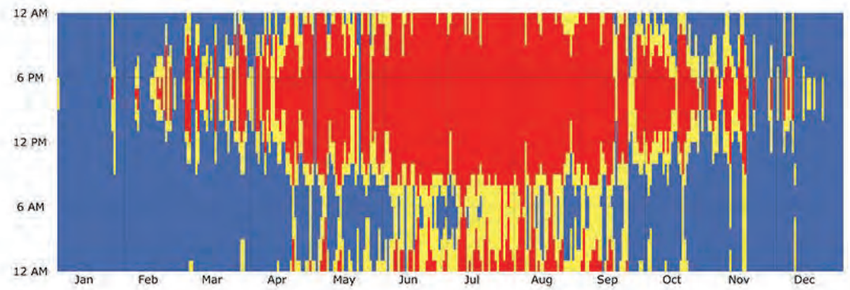


ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00

Hot | Com-forta-ble | Cold



ADAPTIVE COMFORT FOR BALCONY ZONE
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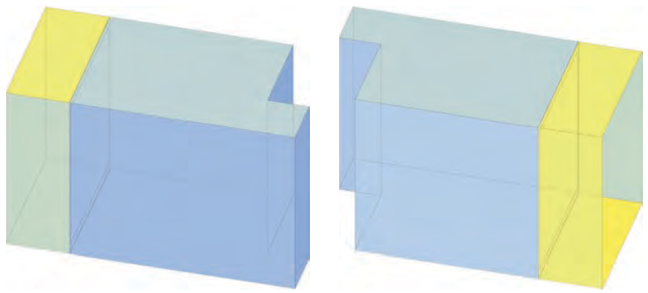


AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

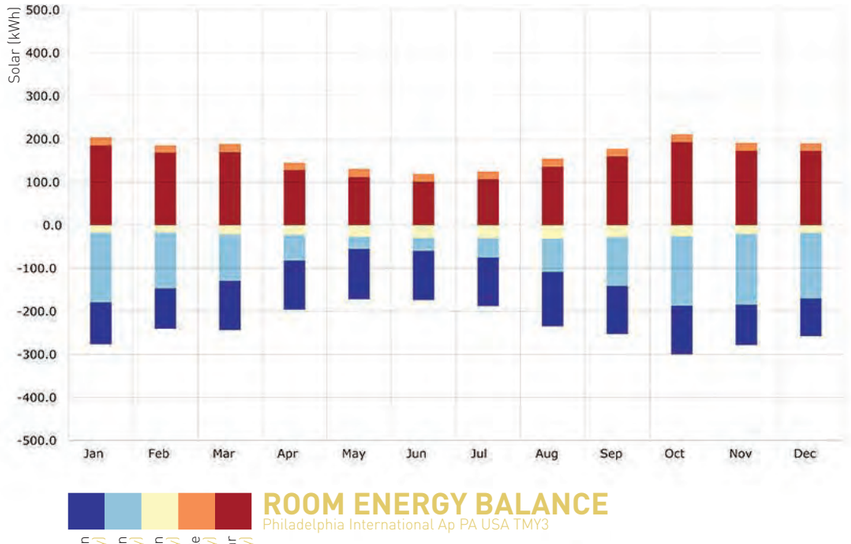
kWh/m^2 <=100 >=-100

Comfortable(%): **14.02**
Hot (%): **40.25**
Cold (%): **45.73**

ORIENTED 30 DEGREES

wall to window ratio: 0.84 South Facing
rotation angle: 30
blinds: no
    shading depth: n/a
    number of blinds: n/a
construction
    exterior wall: R5.5
    exterior window: R1.0, SHGC 0.7
    exterior roof: R9.2
    air change hours: 2.00
thermal mass: existing slab construction

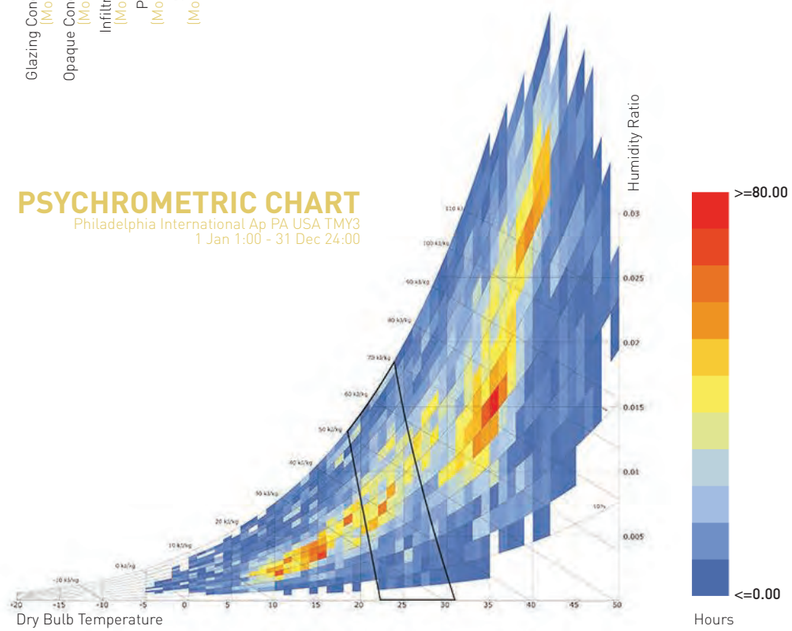
Energy Simulation: Construction Alteration A



ROOM ENERGY BALANCE

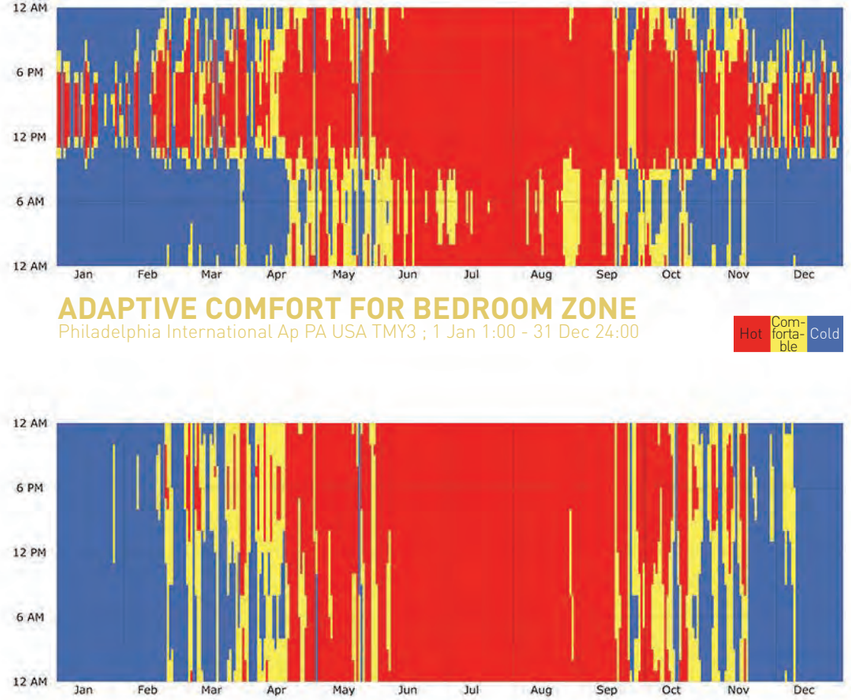
Philadelphia International Ap PA USA TMY3

Glazing Condition (Monthly)
Opaque Condition (Monthly)
Infiltration (Monthly)
People (Monthly)
Solar (Monthly)



PSYCHROMETRIC CHART

Philadelphia International Ap PA USA TMY3
1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BEDROOM ZONE

Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00

Hot | Com-forta-ble | Cold

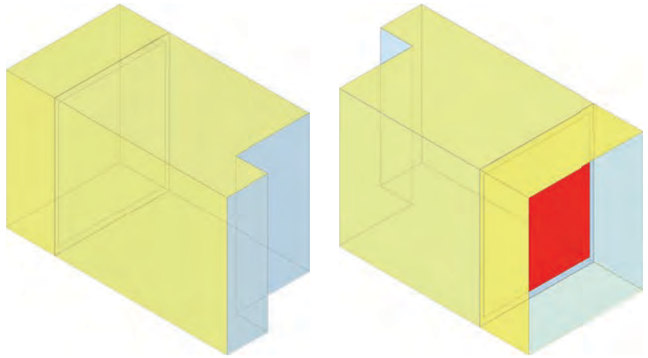
ADAPTIVE COMFORT FOR BALCONY ZONE

Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00

Comfortable(%): **18.02**

Hot (%): **47.08**

Cold (%): **34.92**



AREA NORMALIZED SURFACE ENERGY LOSS/GAIN

01 Jan 1:00 - 31 Dec 24:00

kWh/m^2 <=100 >=-100

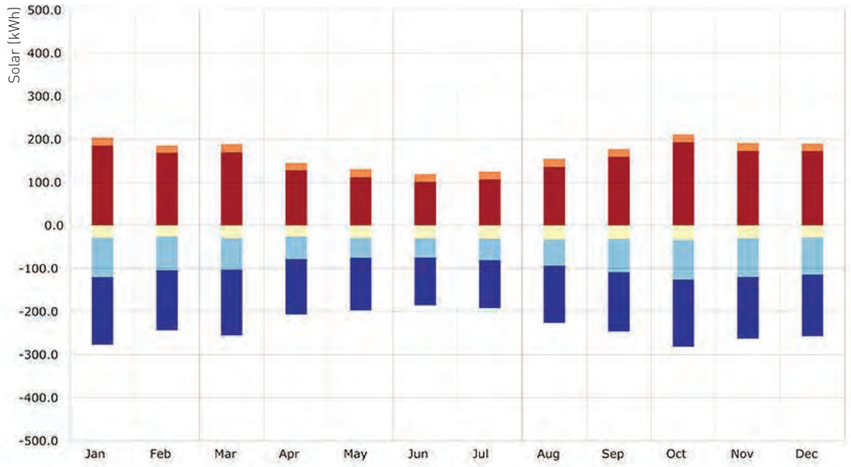
CONSTRUCTION ALTERNATIVE A

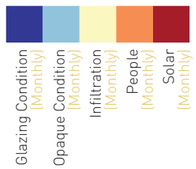
wall to window ratio: 0.84 South Facing
rotation angle: 0
blinds: no
- shading depth: n/a
- number of blinds: n/a

construction
- exterior wall: R8.7
- exterior window: R1.9, SHGC 0.39
- exterior roof: R14.8
- air change hours: 4.00

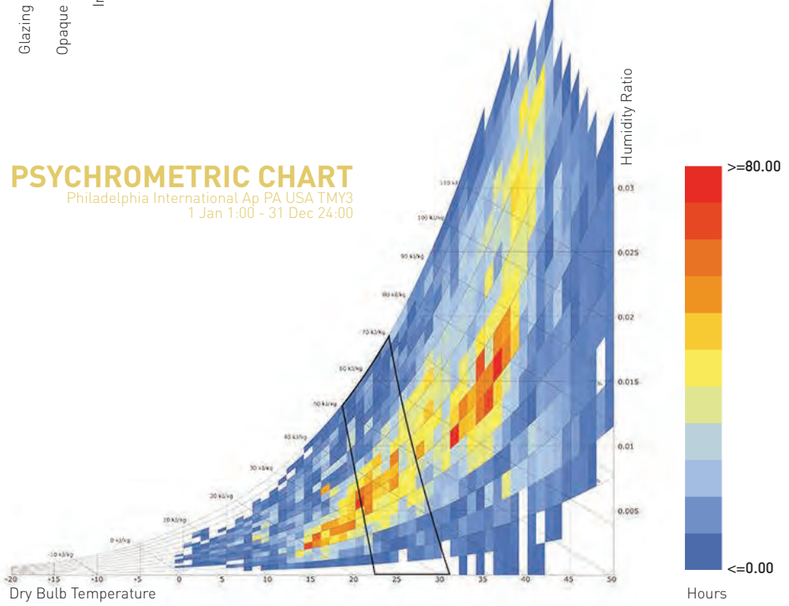
thermal mass: existing slab construction

Energy Simulation: Construction Alteration B





ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



PSYCHROMETRIC CHART
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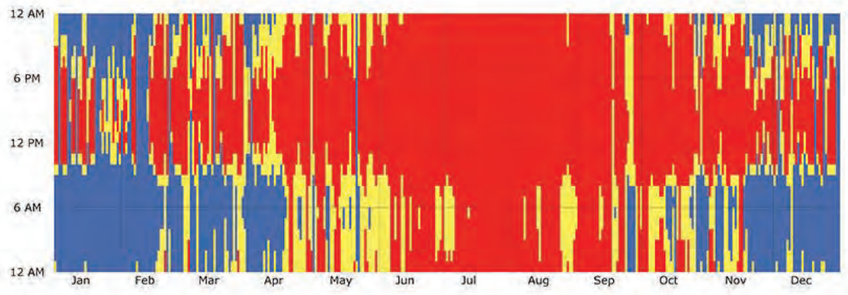
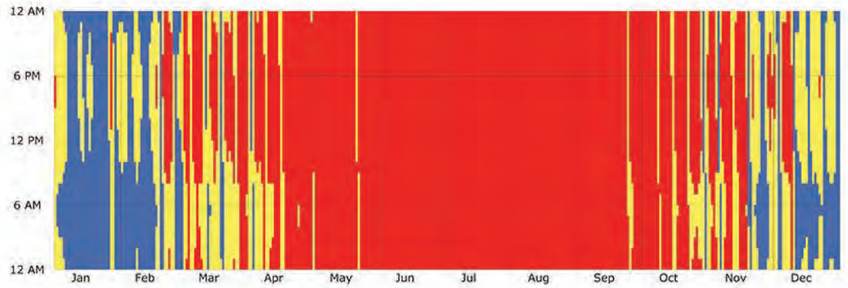
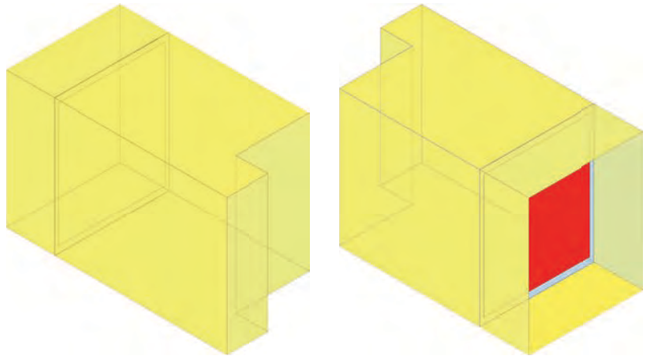


ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BALCONY ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00

Comfortable(%): **19.22**
Hot (%): **56.05**
Cold (%): **24.74**



AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

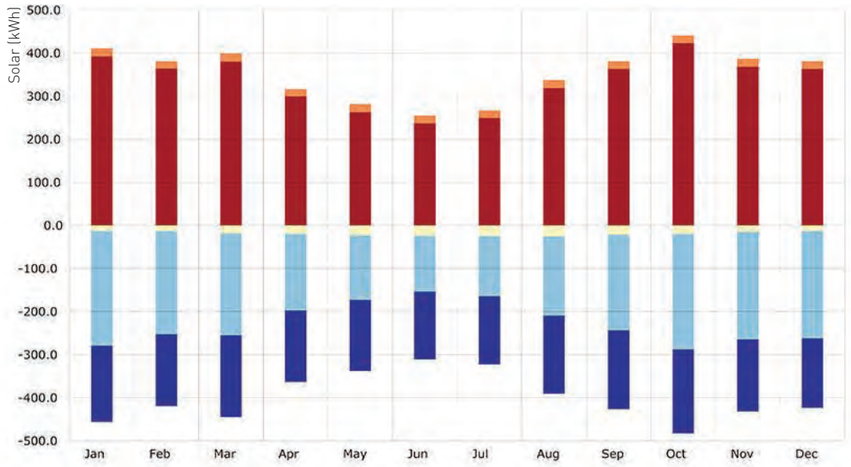
CONSTRUCTION ALTERNATIVE B

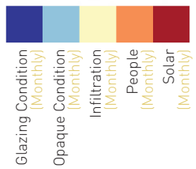
wall to window ratio: 0.84 South Facing
rotation angle: 0
blinds: no
- shading depth: n/a
- number of blinds: n/a

construction
- exterior wall: R34.4
- exterior window: R1.9, SHGC 0.39
- exterior roof: R34.4
- air change hours: 8.00

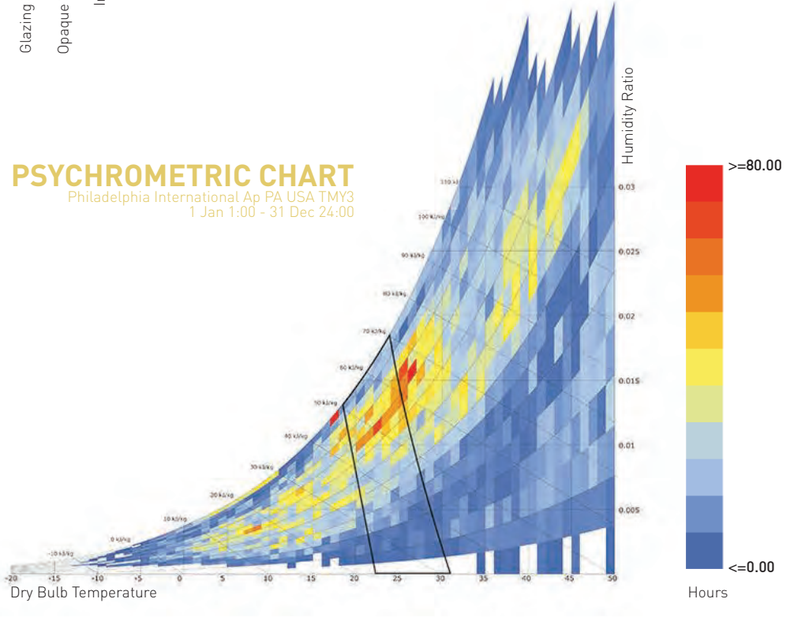
thermal mass: existing slab construction

Energy Simulation: Construction Alteration C

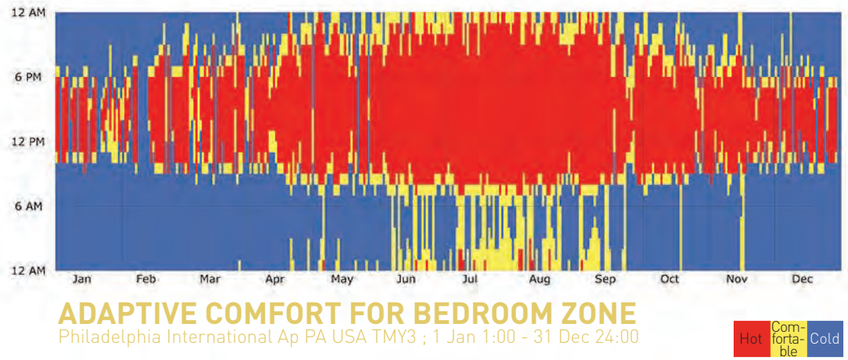




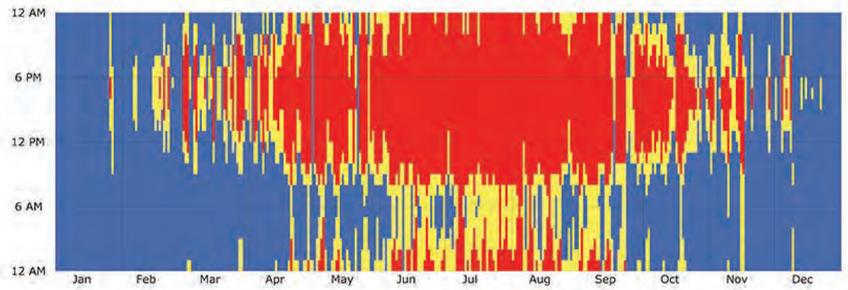
ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



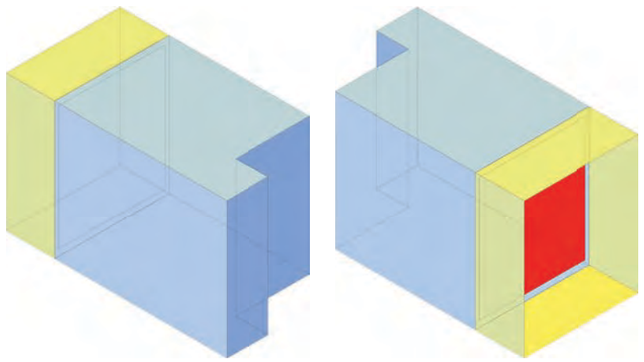
PSYCHROMETRIC CHART
Philadelphia International Ap PA USA TMY3
1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BALCONY ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



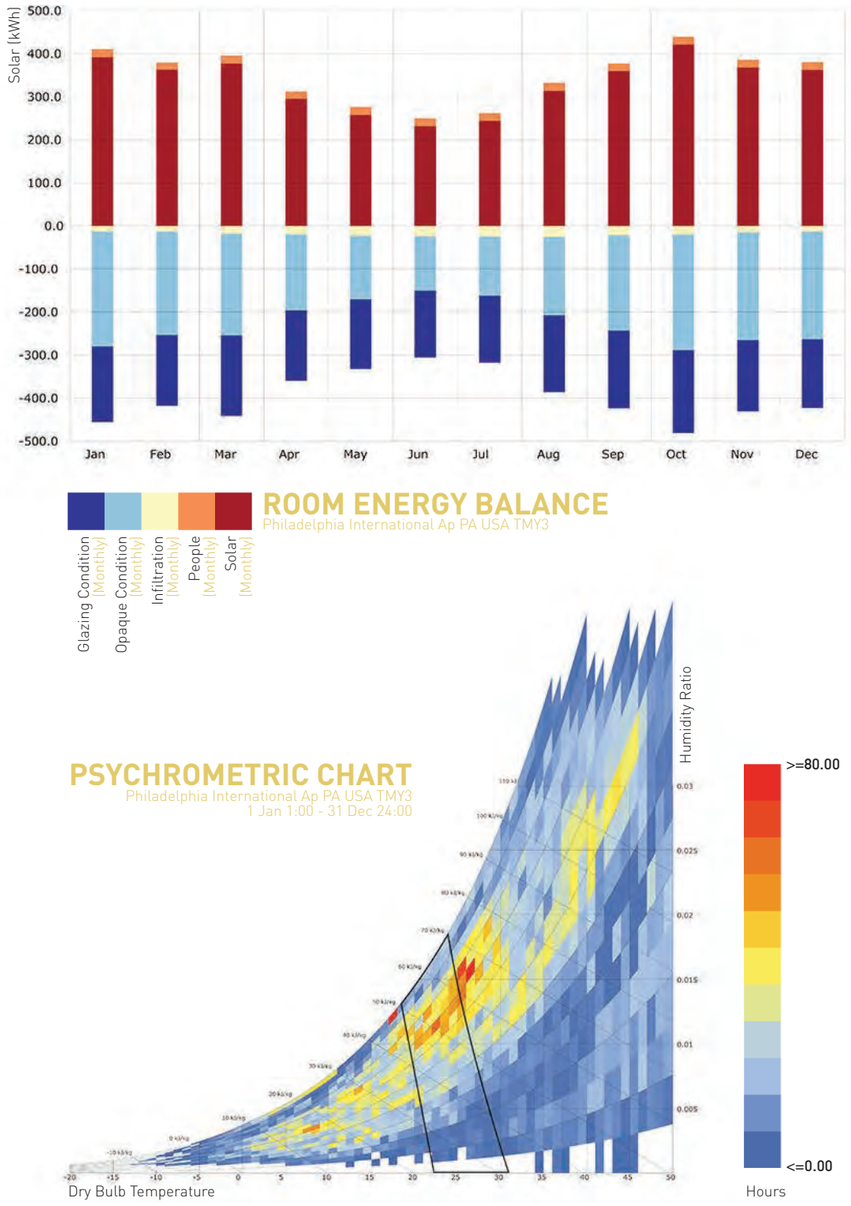
AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

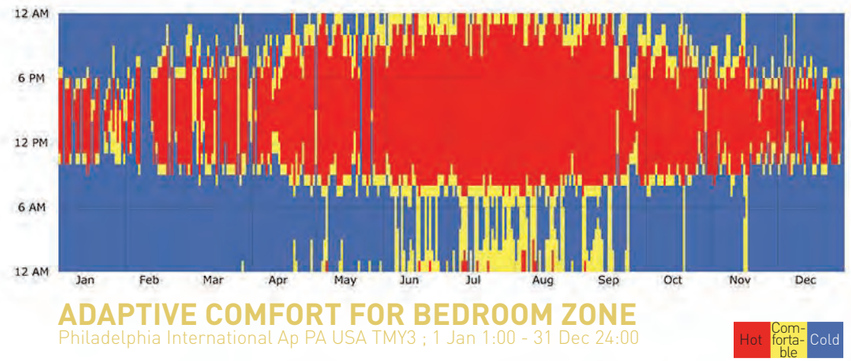
Comfortable(%): **14.39**
Hot (%): **39.66**
Cold (%): **45.95**

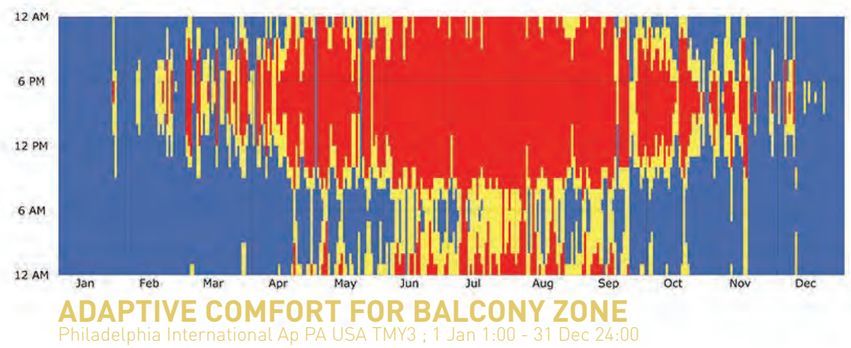
CONSTRUCTION ALTERNATIVE C

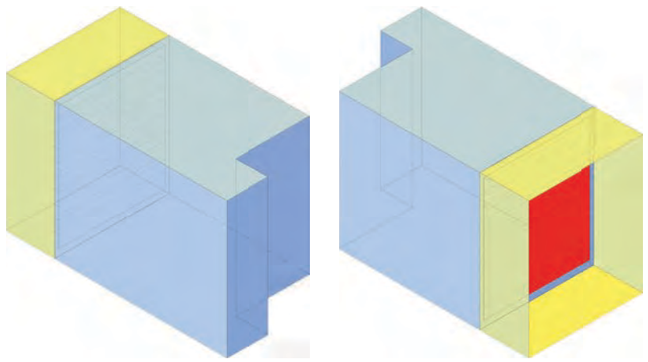
wall to window ratio: 0.84 South Facing
rotation angle: 0
blinds: no
    shading depth: n/a
    number of blinds: n/a
construction
    exterior wall: R5.5
    exterior window: R1.0, SHGC 0.7
    exterior roof: R9.2
    air change hours: 0.00
thermal mass: existing slab construction

Energy Simulation: Blinds Application A









Comfortable(%): **14.47**

Hot (%): **39.49**

Cold (%): **46.04**

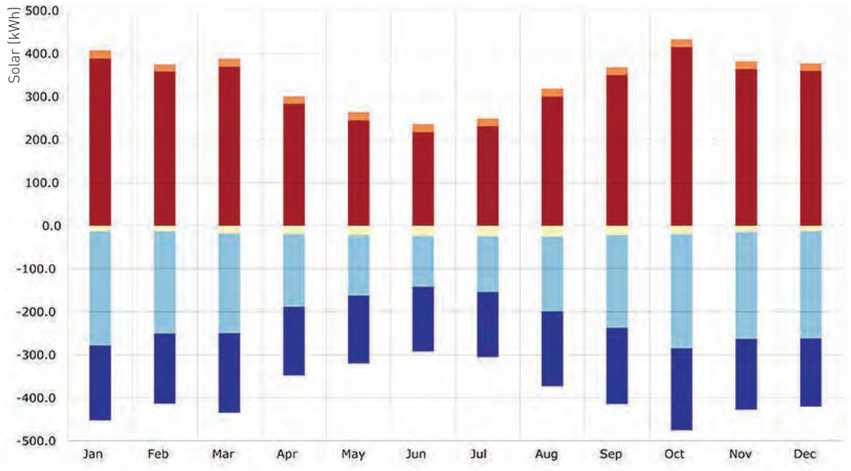
BLINDS SMALL BUT MANY

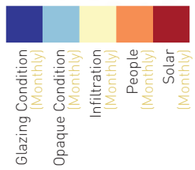
wall to window ratio: 0.84 South Facing
rotation angle: 0
blinds: yes
- shading depth: 0.1
- number of blinds: 10

construction
- exterior wall: R5.5
- exterior window: R1.0, SHGC 0.7
- exterior roof: R9.2
- air change hours: 2.00

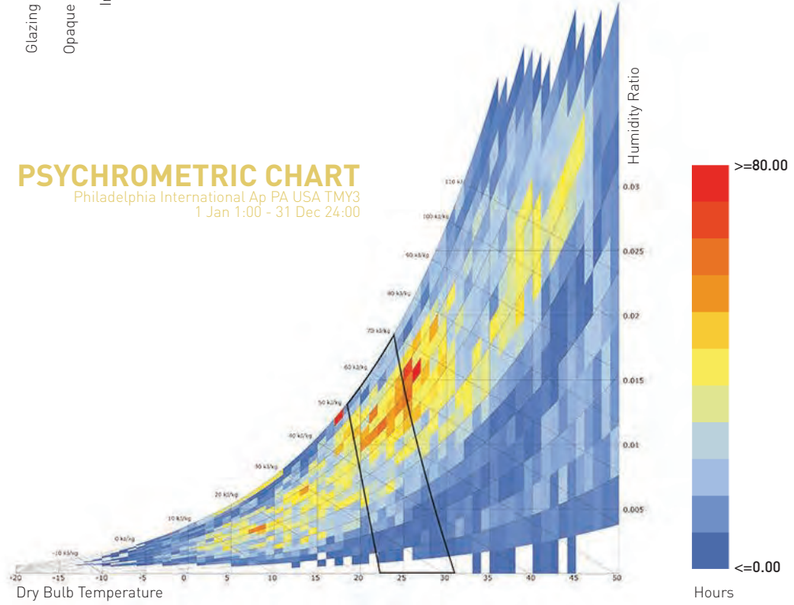
thermal mass: existing slab construction

Energy Simulation: Blinds Application B

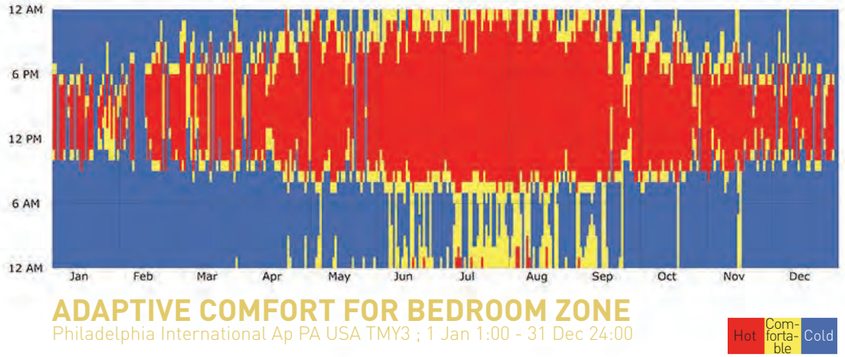




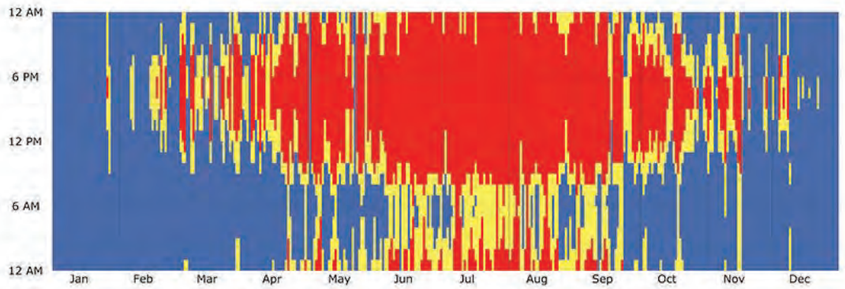
ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



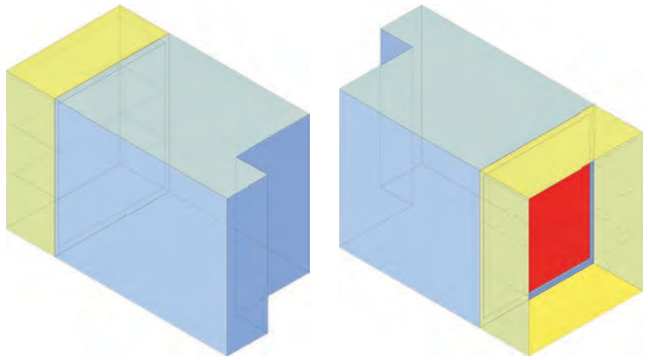
PSYCHROMETRIC CHART
Philadelphia International Ap PA USA TMY3
1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BEDROOM ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



ADAPTIVE COMFORT FOR BALCONY ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

Comfortable(%): **14.53**
Hot (%): **39.14**
Cold (%): **46.32**

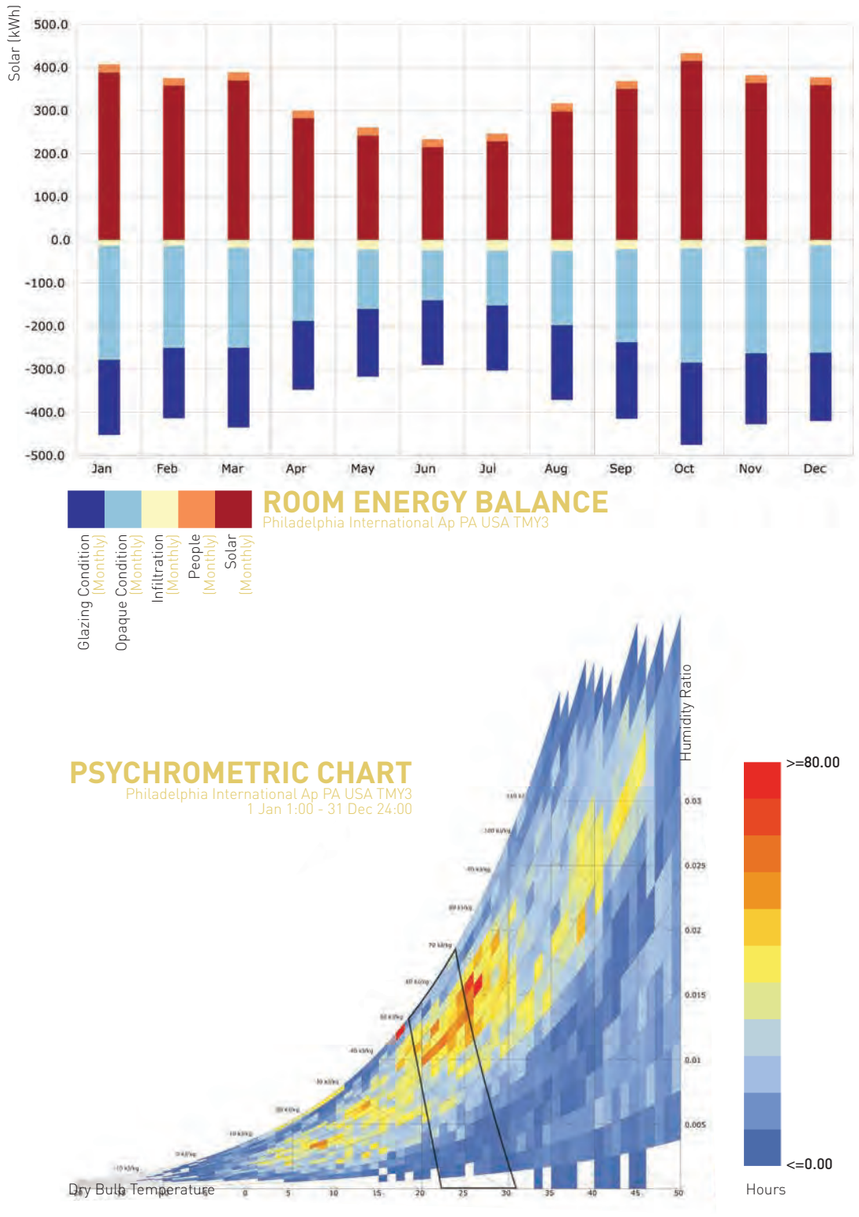
BLINDS LARGE BUT FEW

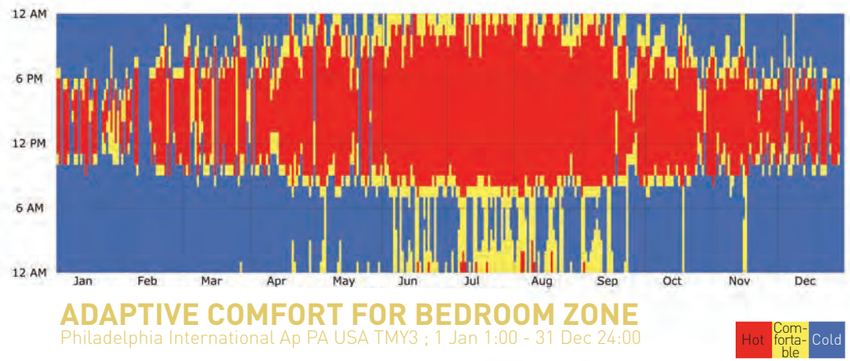
wall to window ratio: 0.84 South Facing
rotation angle: 0
blinds: yes
- shading depth: 1.0
- number of blinds: 3

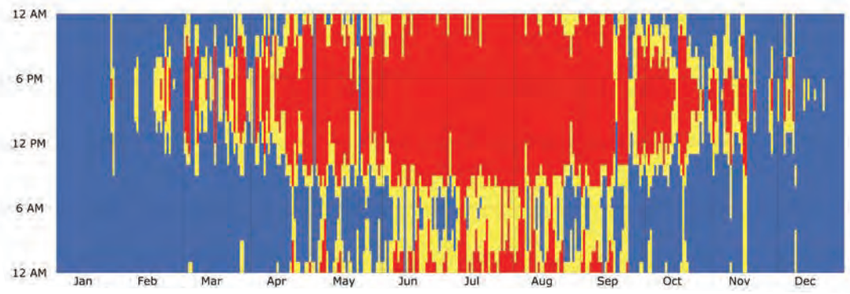
construction
- exterior wall: R5.5
- exterior window: R1.0, SHGC 0.7
- exterior roof: R9.2
- air change hours: 2.00

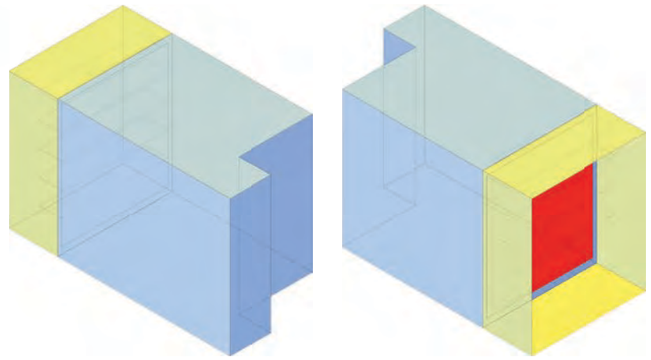
thermal mass: existing slab construction

Energy Simulation: Blinds Application C









Comfortable(%): **14.58**

Hot (%): **39.13**

Cold (%): **46.32**

BLINDS AVERAGE

wall to window ratio: 0.84 South Facing
rotation angle: 0
blinds: yes
- shading depth: 0.5
- number of blinds: 5

construction
- exterior wall: R5.5
- exterior window: R1.0, SHGC 0.7
- exterior roof: R9.2
- air change hours: 2.00

thermal mass: existing slab construction

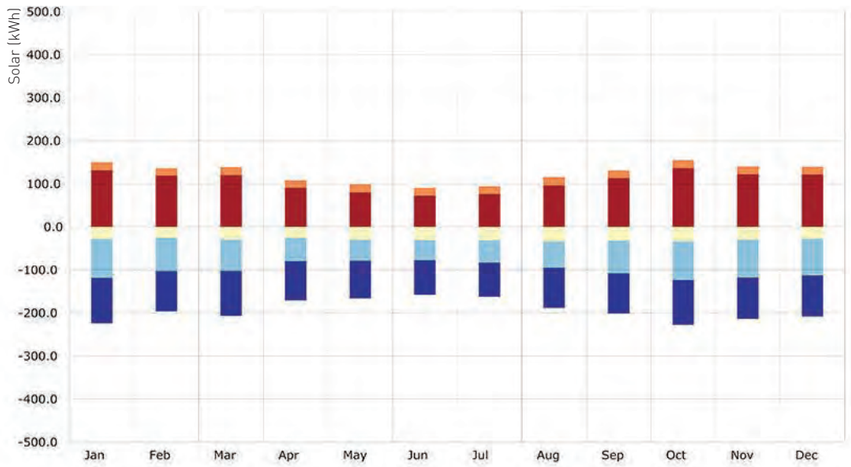
Energy Simulation: Analysis of Alteration/Appilcation

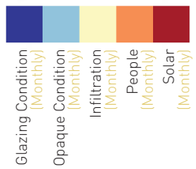
GENETICS APPROACH

The method in which this study undergoes more or less follows the theory of natural selection, in which traits of a single category are taken side by side and based on which trait has better results, it will be the one inherited by the new design. In this case, the same energy simulations are run while keeping all but one aspect of the design constant; three instances of window sizing, rotation, construction, and blind applications are tested. Whichever change ends up with the best results is then matched up against the base case. The end result, after combining all of the "victorious" traits are: having the door replaced by a window 2' above the floor level, with the existing orientation, with the qualities of Construction Alternative B and no blind additions.

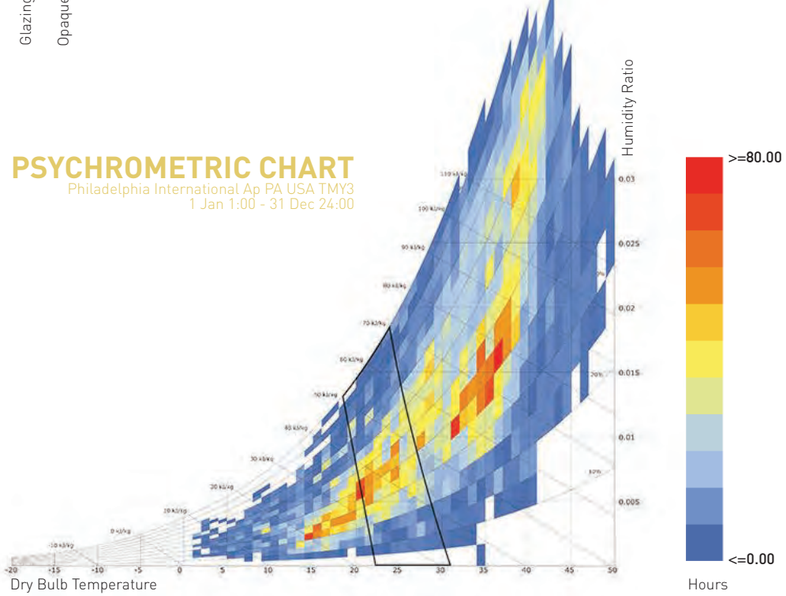
The resulting data shows a +1.46% rise in comfort, a +24.87% rise in heat, and a -26.31% drop in coldness. While this intervention is successful in terms of providing comfort in colder situations, it does fail in that heat stress is significantly heightened. A large shortcoming of this particular application of the genetics approach is the lack of traits tested: clearly testing only three of each characteristic does not suffice for an effective design.

Energy Simulation: Final Result

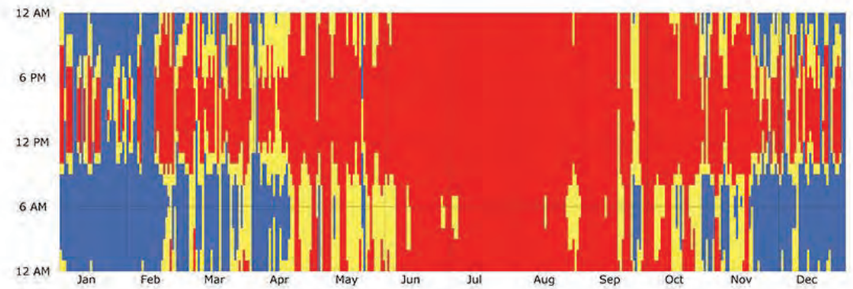




ROOM ENERGY BALANCE
Philadelphia International Ap PA USA TMY3



PSYCHROMETRIC CHART
Philadelphia International Ap PA USA TMY3
1 Jan 1:00 - 31 Dec 24:00



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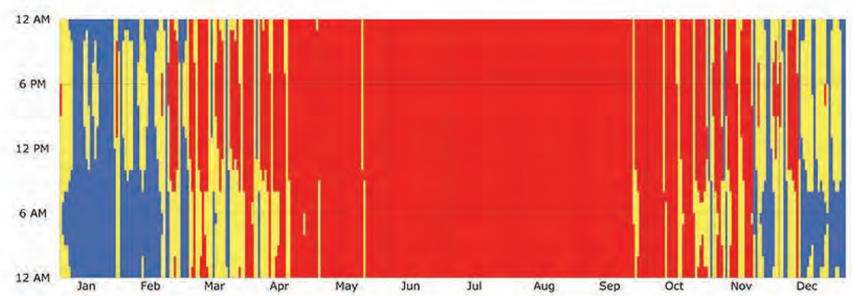
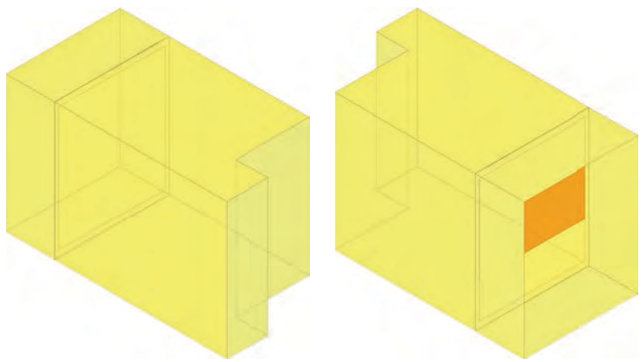


ADAPTIVE COMFORT FOR BALCONY ZONE
Philadelphia International Ap PA USA TMY3 ; 1 Jan 1:00 - 31 Dec 24:00



AREA NORMALIZED SURFACE ENERGY LOSS/GAIN
01 Jan 1:00 - 31 Dec 24:00

Comfortable(%): **19.84**
Hot (%): **57.53**
Cold (%): **22.64**

ALTERATION COMBINATIONS

wall to window ratio: 0.55 South Facing
rotation angle: 0
blinds: no
- shading depth: n/a
- number of blinds: n/a

construction
- exterior wall: R34.4
- exterior window: R1.9, SHGC 0.39
- exterior roof: R34.4
- air change hours: 8.00

thermal mass: existing slab construction