

ARCH633 Environmental Systems I

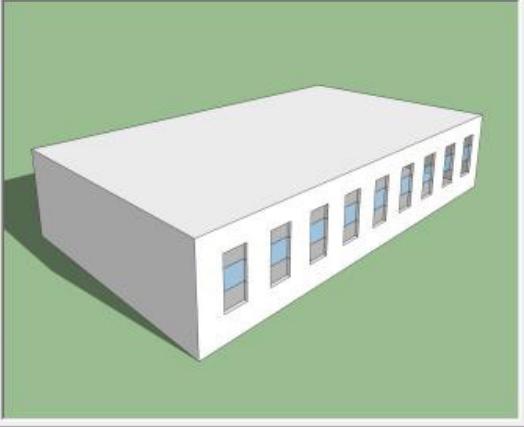
Assignment 7: Meyerson Hall Natural Ventilation

Yefan Zhang

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Simulation type
 Transient (24 hour) Steady state (snapshot)

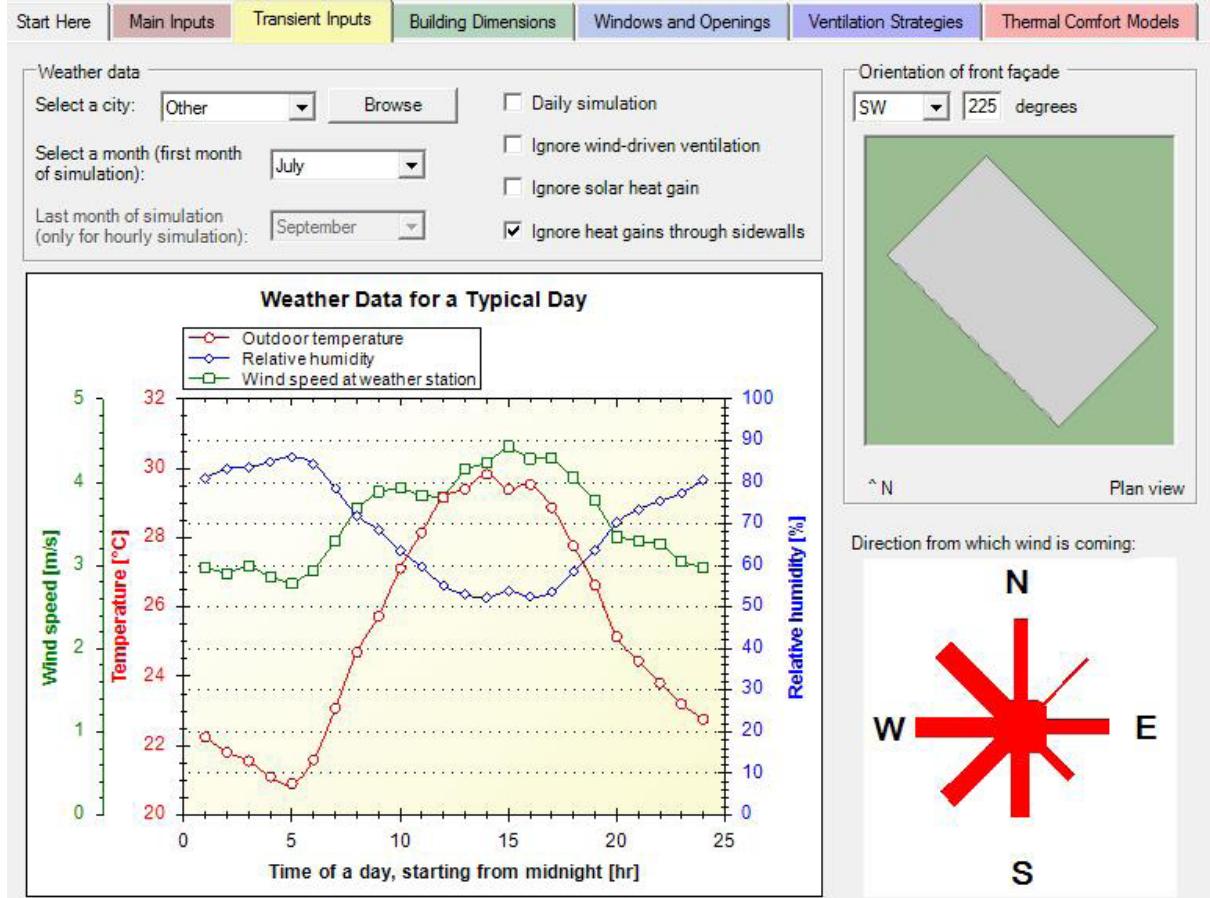
Building type
Single sided



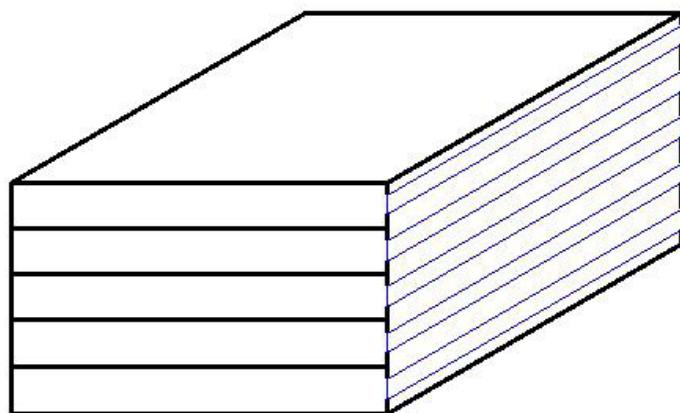
Internal heat loads
Heat source level: Educational 40 W/m² Occupancy schedule: From 0 hours to 24 hours
All zones but the atrium zones (if any) are assigned heat loads. Off peak equipment load fraction: 0.2

Terrain properties
Terrain type: Urban, industrial or forest area

Basic Geometry Simulation of Meyerson Hall



Weather Data of Philadelphia in July



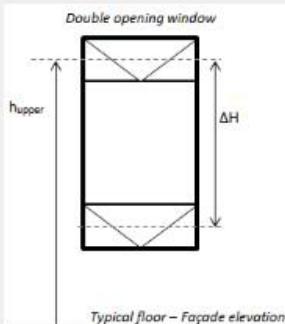
Building dimensions

Help:

Number of floors: ?
 Floor length: m
 Floor width: m
 Floor-to-floor height: m
 Floor-to-ceiling height: m

Floor Numbers & Dimension Simulation

Side windows dimensions



In each floor, there is only one opening per window (see schematic)

In each floor, there are two openings separated vertically per window (see schematic). REQUIRED for single-sided ventilation

Window glazing area per floor per facade, fixed and operable (to calculate solar gains through windows): m²

Operable upper window area per floor (used to calculate air flowrate): m²

Height from floor to upper opening (hupper): m

Operable lower window area per floor per facade: m²

Height difference between upper and lower opening (Delta H in figure): m

Roof opening dimensions

Roof operable area for chimney 1: m²

Note: CoolVent does not account for solar heat gains through the roof opening(s)

Internal opening dimensions

Internal opening area per floor: m²

Advanced internal opening options:

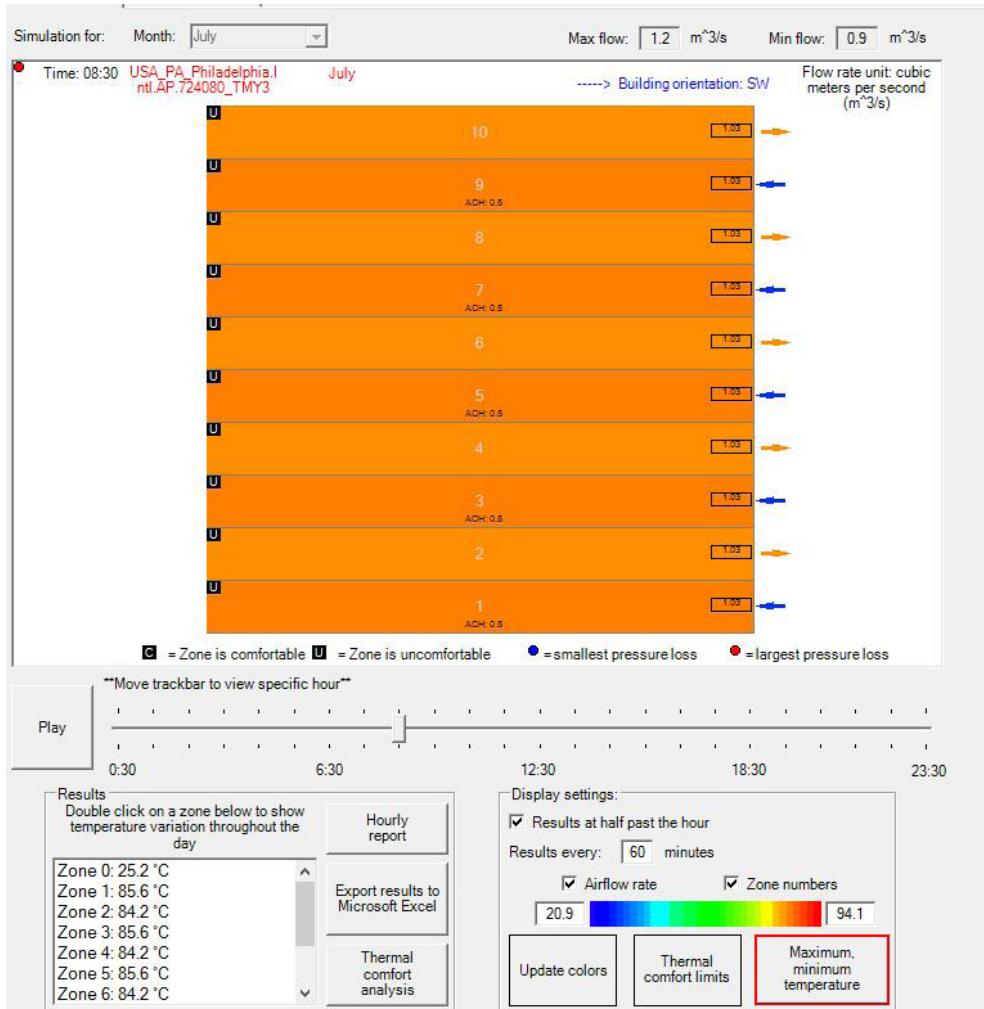
[Advanced...](#)

Additional opening options

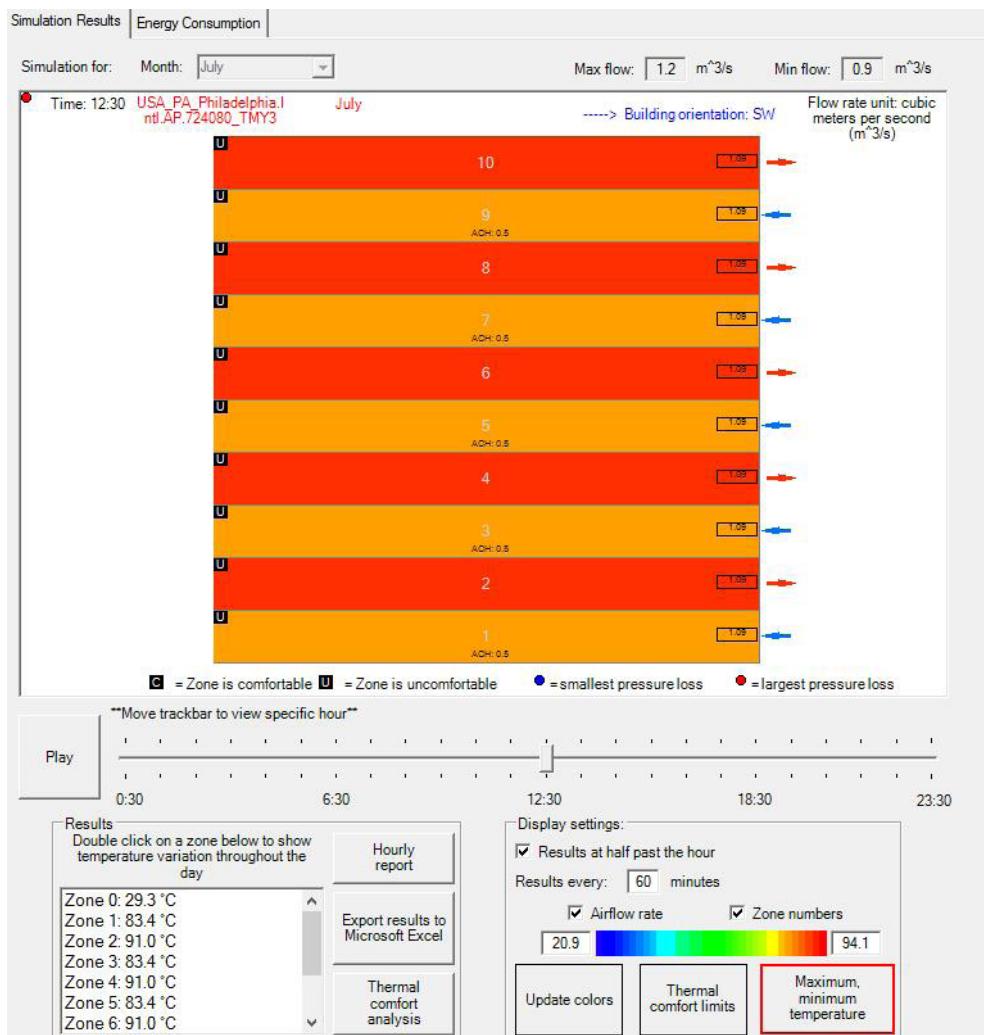
More window options and opening specifications: [Advanced...](#)

Window Size & Area Simulation

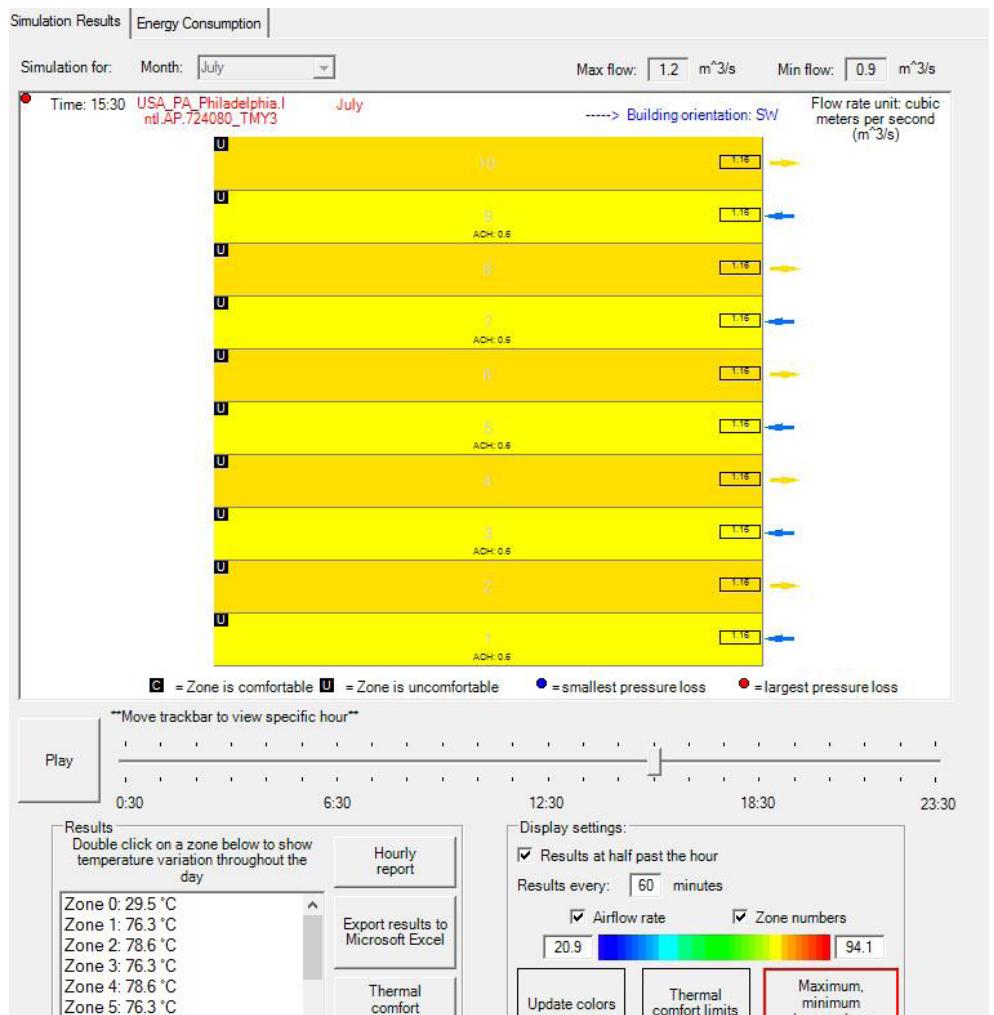
Original Simulation



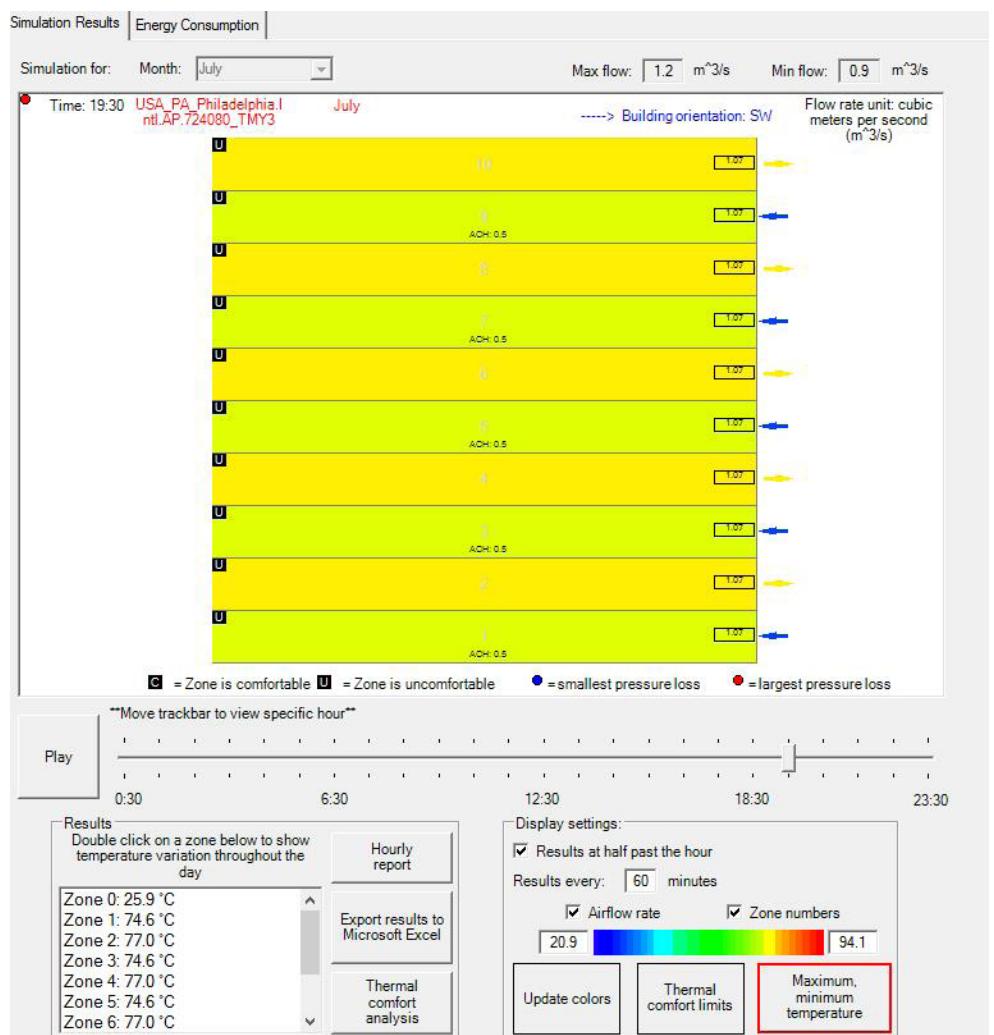
Time1 8:30



Time2 12:30

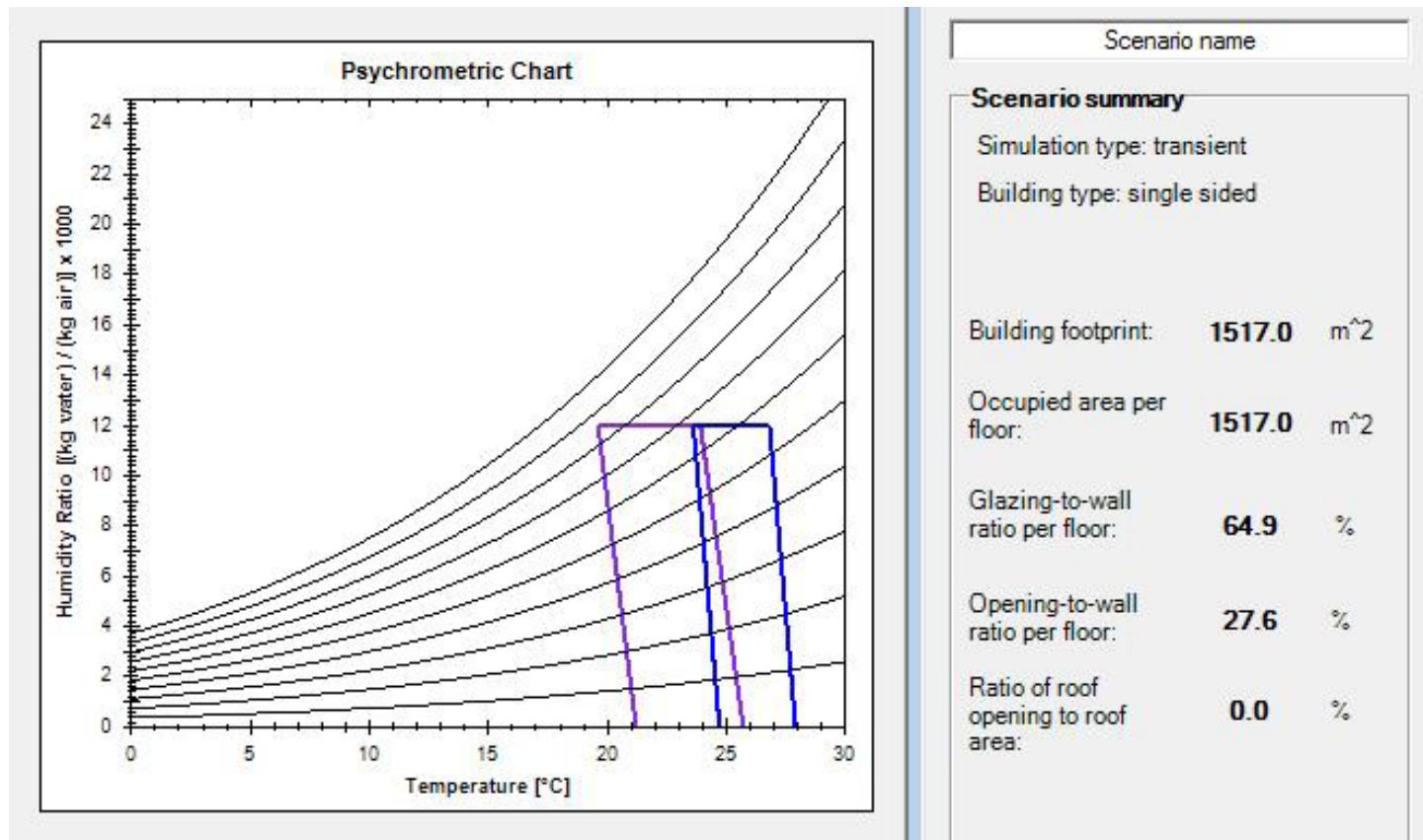


Time3 15:30



Time4 19:30

Psychometric Chart & Window Ratio



Thermal Comfort Chart

CoolVent Thermal Comfort Results USA_PA_Philadelphia.Intl.AP.724080_TMY3

2010 ASHRAE Standard 55 Thermal Comfort Model

Temperature Pie Charts



The pie charts represent temperature concerns for comfort in non-atrium zones of the building.

Red represents the percent of total occupied hours that a given zone is too hot.
Blue represents the percent of total occupied hours that a given zone is too cold.
Humidity concerns are not addressed in the pie charts.

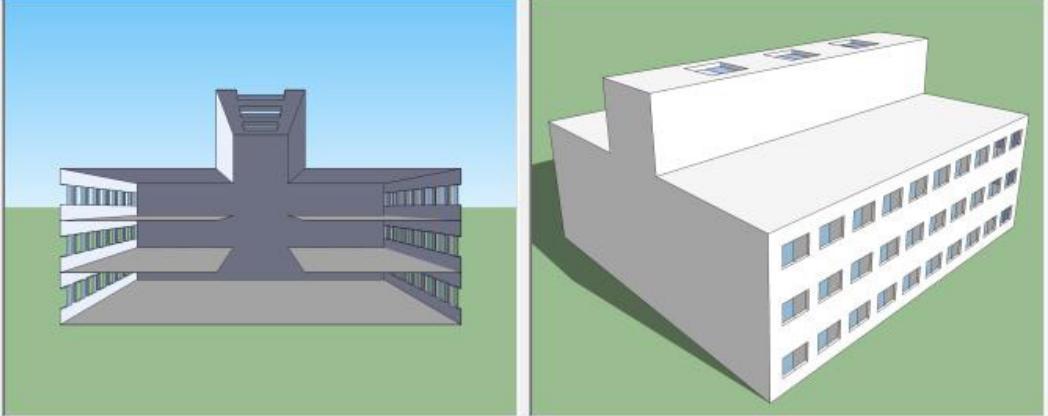
Summary:

The Meyerson Hall is centered with Lower Galley, Computer Lab and Fabrication Lab throughout the building, therefore the cross ventilation is almost completely blocked by these enclosed rooms in-between main east and west studio. In addition, There is not any North and South natural ventilation at all according to the rooms arrangements. The windows on main East and West sides are not operable. Therefore, the building is simulated as single sided building perhaps more accurately and people feel totally unconformable and very hot if only depending on natural ventilation in summer.

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Simulation type
 Transient (24 hour) Steady state (snapshot)

Building type
 Central atrium



Internal heat loads
 Heat source level: Educational 40 W/m² Occupancy schedule: From 0 hours to 24 hours
All zones but the atrium zones (if any) are assigned heat loads. Off peak equipment load fraction: 0.2

Terrain properties
 Terrain type: Urban, industrial or forest area

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Thermal mass
 Include slab thermal mass
 Floor / roof slab thickness: 5 cm Floor slab material: Concrete Floor type: Exposed
 Exposed area: 90 % of floor area Ceiling type: Exposed

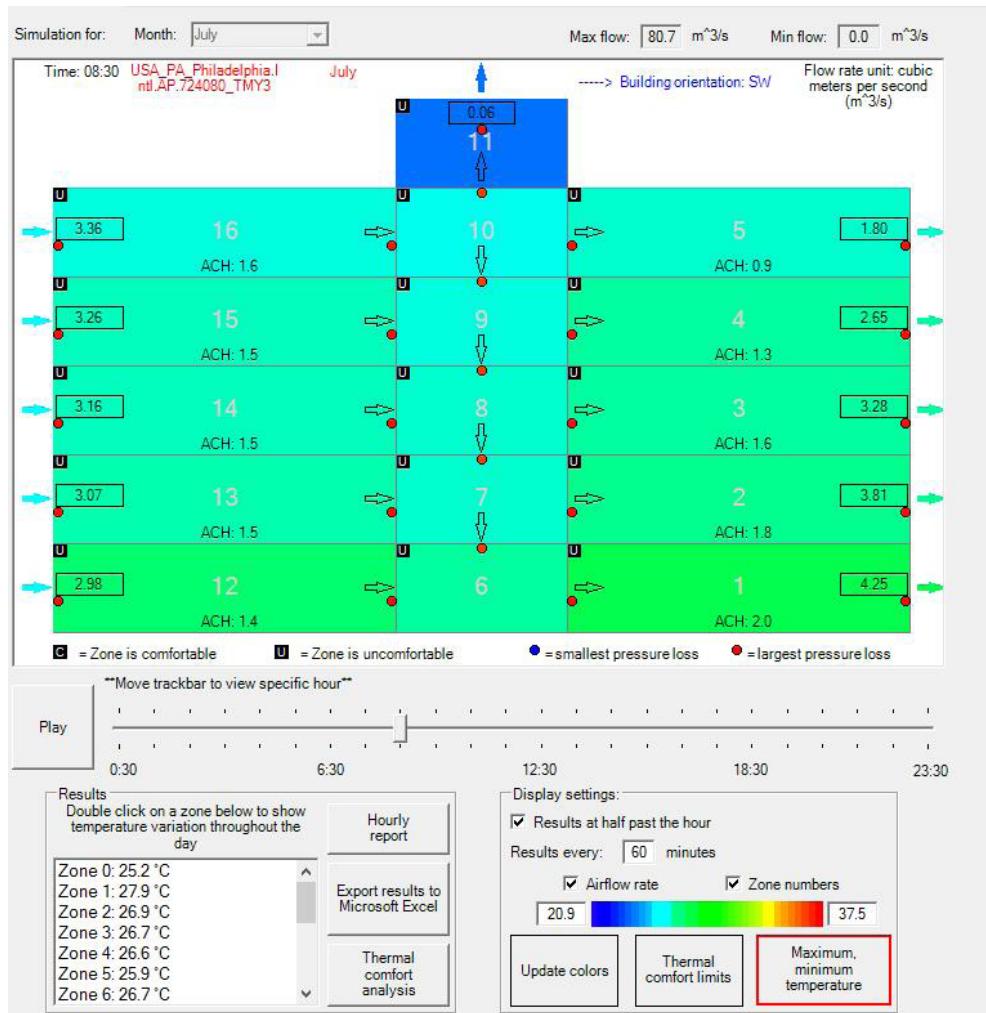
Night cooling
 Use night cooling. Windows open at nighttime, when the air is cold enough to cool down the thermal mass. Windows close (down to 10%) during daytime to prevent hot outdoor air from entering the building. If the building has a fan, it will be used to assist night cooling.
 Time controlled: close all windows at 7 hours, open windows at 19 hours
 Temperature controlled: close windows in zones where temperature is lower than outdoor temperature; close windows otherwise

Window operation
 Close windows when the outdoor air temperature drops below 16 °C
 Close Window and turn on heating when any internal zone temperature drops below 18 °C

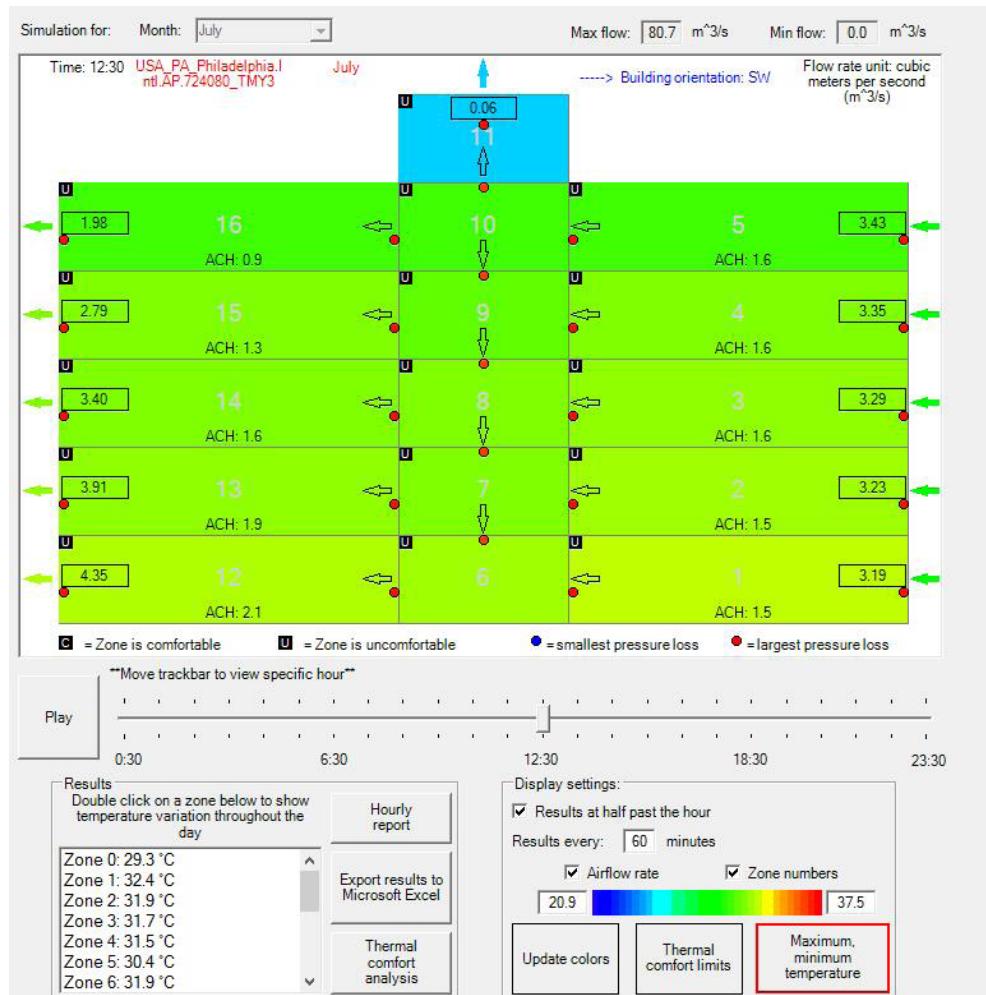
Hybrid ventilation mode
 Use hybrid mechanical-natural ventilation
 Turn on fan when any internal zone temperature is above 24 °C
 or humidity ratio is above 0.012 (kg water) / (kg air) Windows will open even if using night cooling.
 Close windows, turn off fan and turn on AC when any internal zone temperature is above 26 °C
 or humidity ratio is above 0.012 (kg water) / (kg air)
 Allow independent window and AC control in each zone
 Define fan / AC operating characteristics:

Strategy I: Add Atrium, Thermal Mass, Night Cooling & Mechanical Ventilation

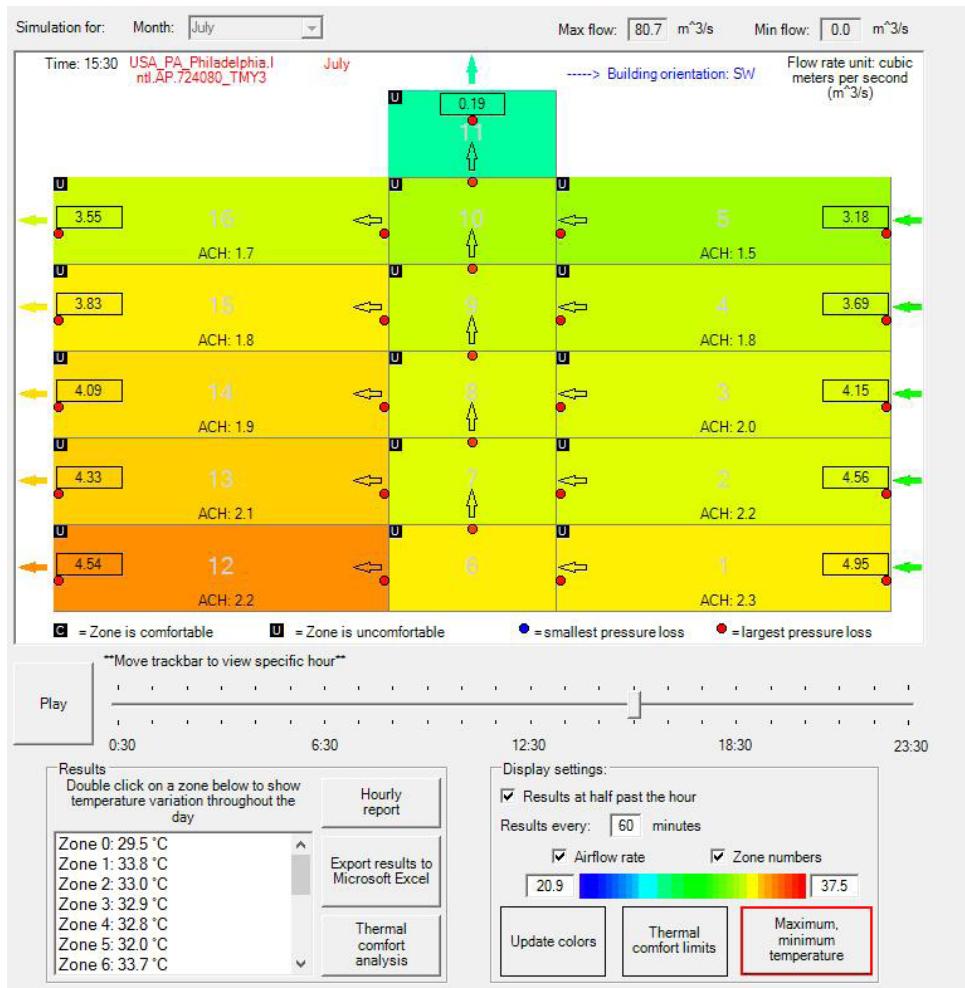
Simulation Strategy I



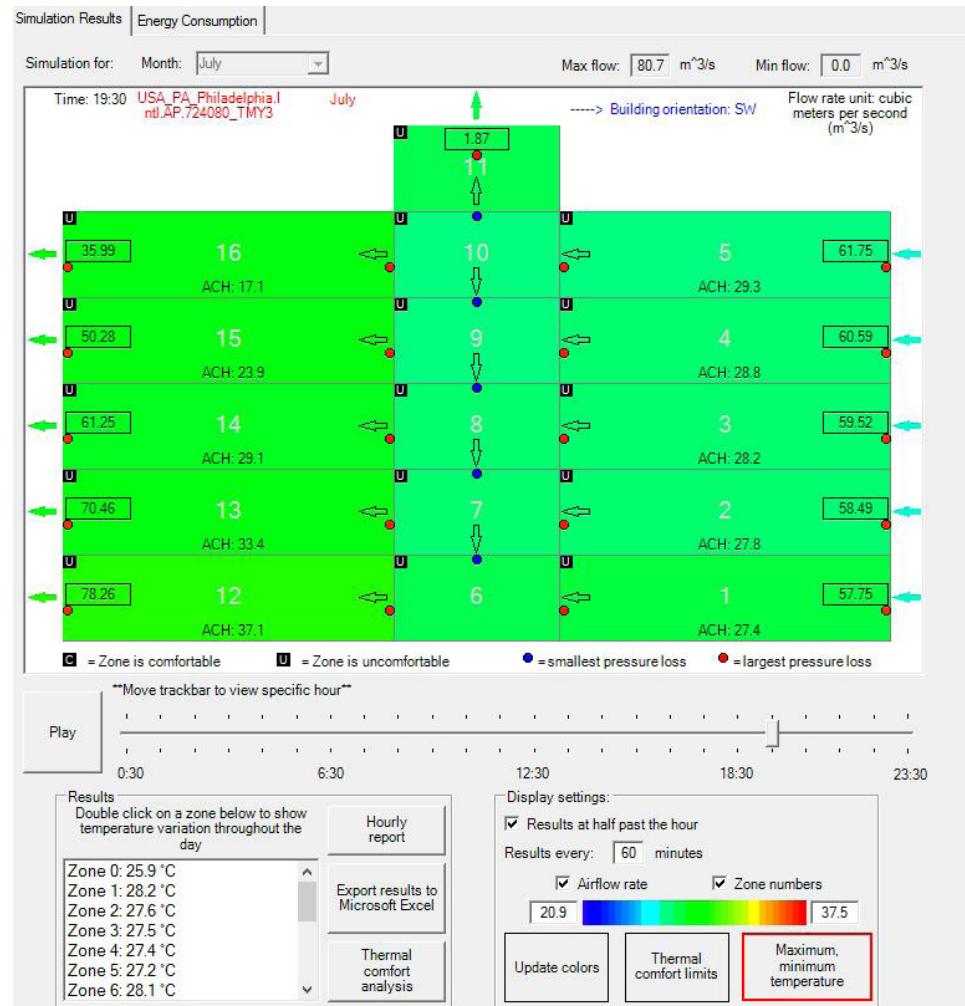
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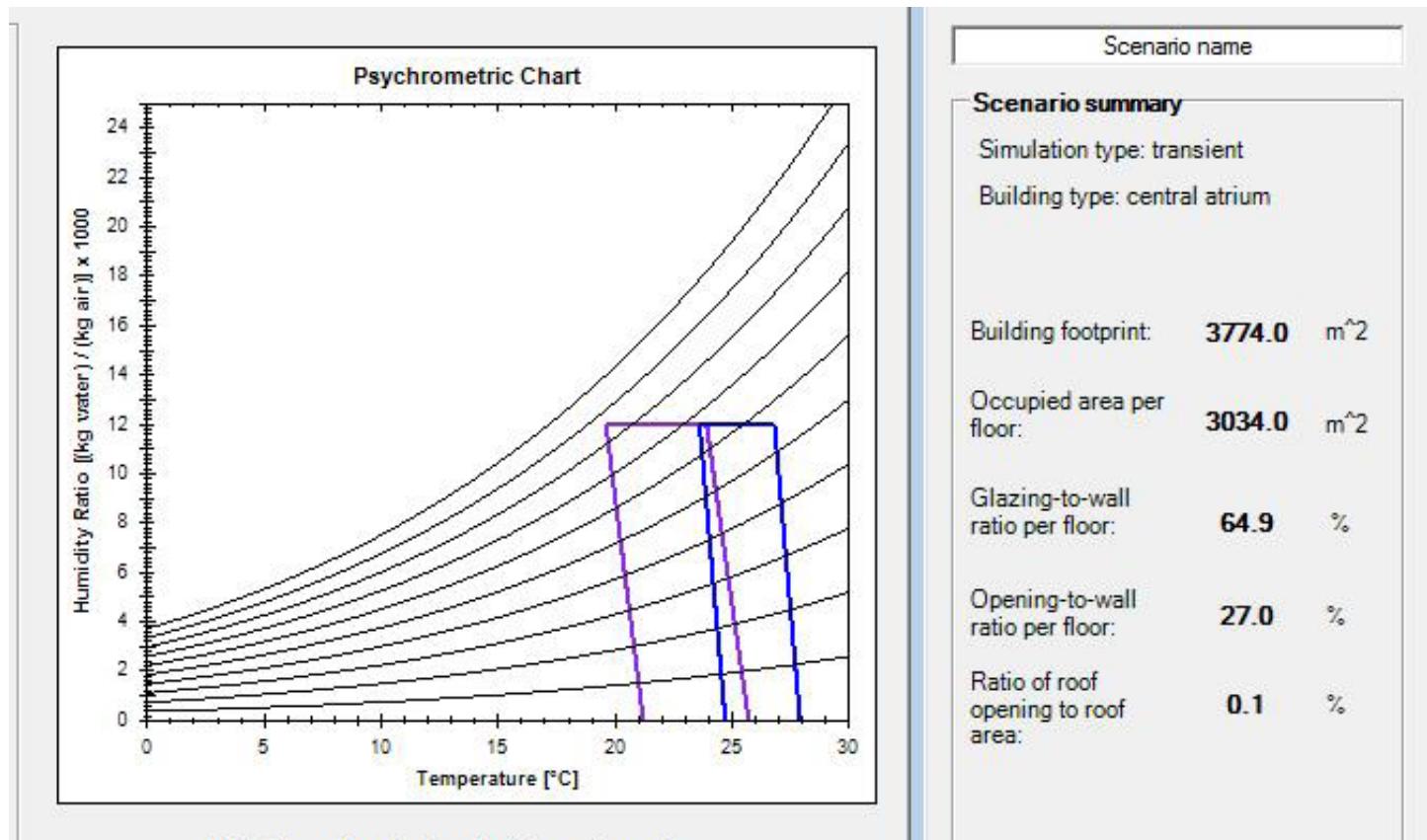


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Psychometric Chart & Window Ratio

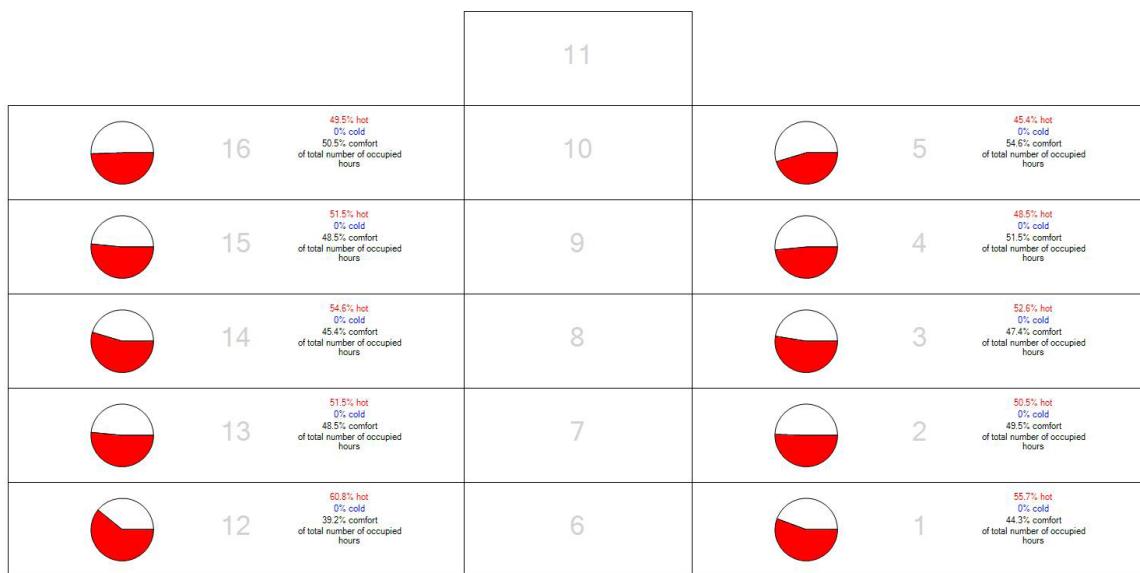


Thermal Comfort Chart

CoolVent Thermal Comfort Results USA_PA_Philadelphia.Intl.AP.724080_TMY3

2010 ASHRAE Standard 55 Thermal Comfort Model

Temperature Pie Charts



Summary:

The first strategy includes the thermal mass values into the simulation, open some windows at night and add hybrid Mechanical and Natural Ventilation system. In addition, adding a big atrium to change the central rooms from lower gallery to lab till roof is another important approach. Based on this strategy, the performance of building improves a lot, most area could keep around 50% comfort during the day, people will feel hot only in some lower parts of the building. Generally, it can keep in an neutral-comfort condition according to simulation analysis.

Start Here Main Inputs Transient Inputs Building Dimensions Windows and Openings Ventilation Strategies Thermal Comfort Models

Simulation type

Transient (24 hour) Steady state (snapshot)

Building type

Cross ventilation

Internal heat loads

Heat source level: Educational 40 W/m² Occupancy schedule: From 0 hours to 24 hours
All zones but the atrium zones (if any) are assigned heat loads. Off peak equipment load fraction: 0.2

Terrain properties

Terrain type: Urban, industrial or forest area

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Side windows dimensions

In each floor, there is only one opening per window (see schematic)
 In each floor, there are two openings separated vertically per window (see schematic). REQUIRED for single-sided ventilation

Single opening window

Window glazing area per floor per facade, fixed and operable (to calculate solar gains through windows): 180 m²
Operable window area per floor (used to calculate air flowrate): 120 m²
Height from floor to mid-opening (h): 1 m
Operable lower window area per floor per facade: 1 m²
Height difference between upper and lower opening (Delta H in figure): 1 m

Roof opening dimensions

Roof operable area: 1 m²

Note: CoolVent does not account for solar heat gains through the roof opening(s)

Internal opening dimensions

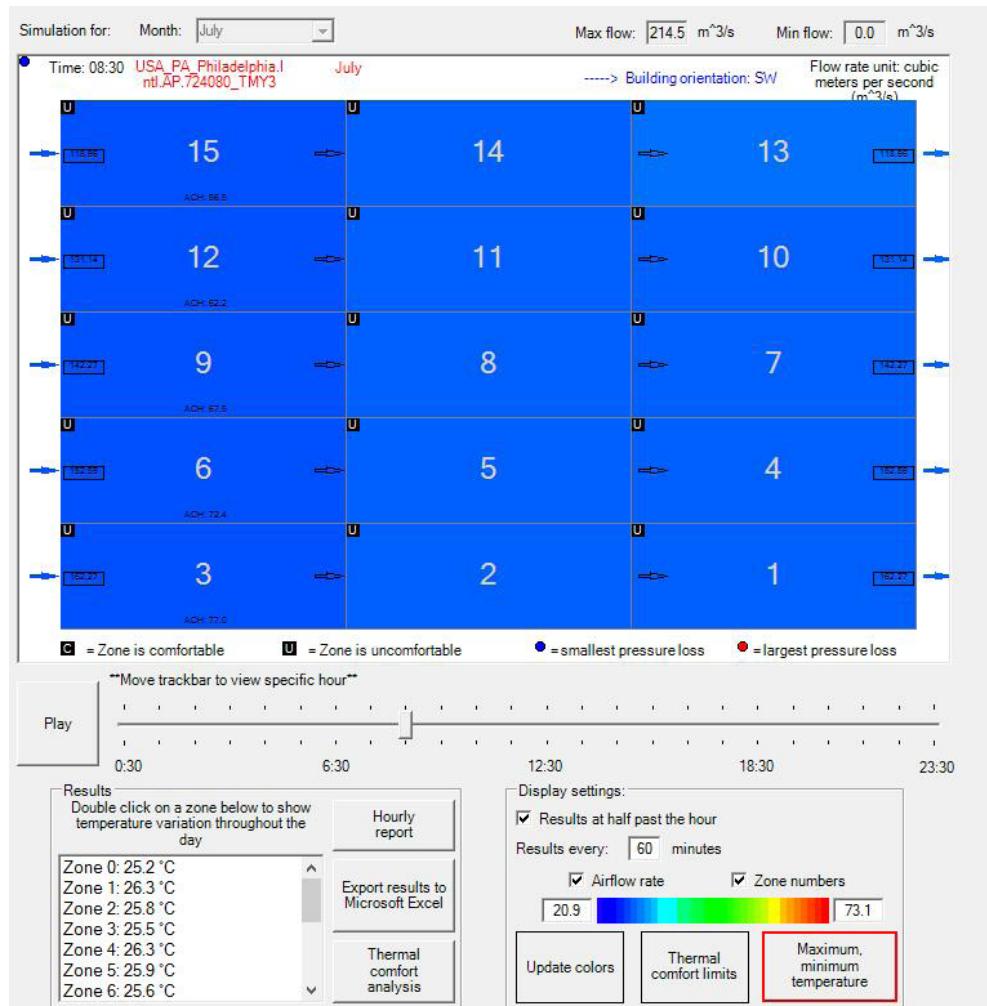
Internal opening area per floor: 50 m² Advanced internal opening options:

Additional opening options

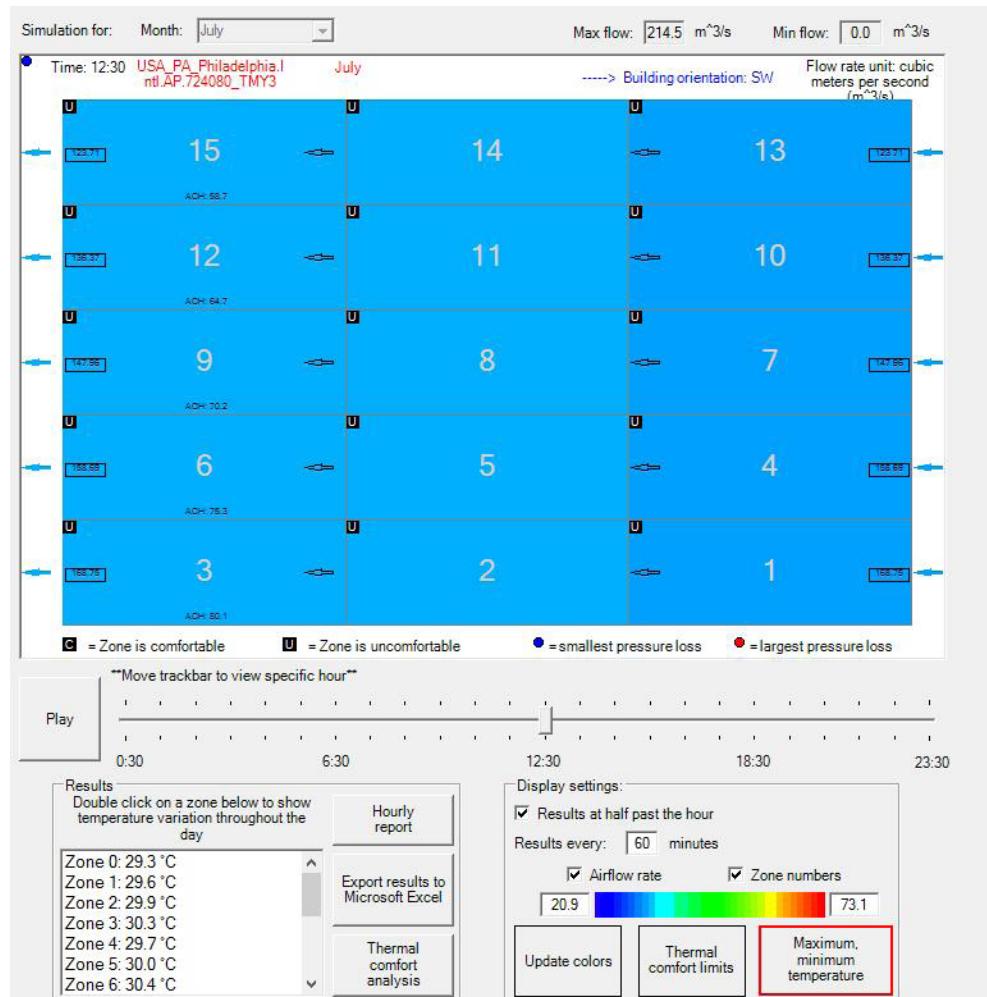
More window options and opening specifications:

Strategy II: Add Cross Ventilation & Increase the Area of Windows

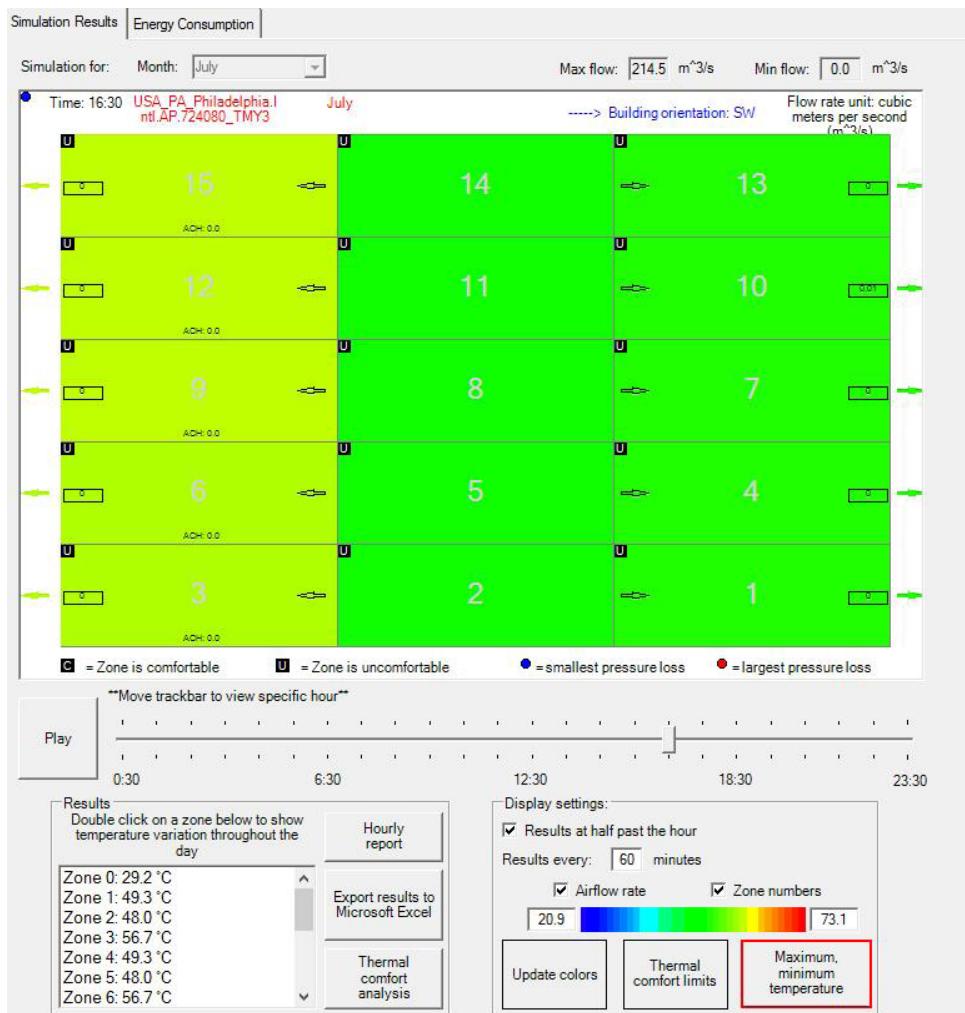
Simulation Strategy I



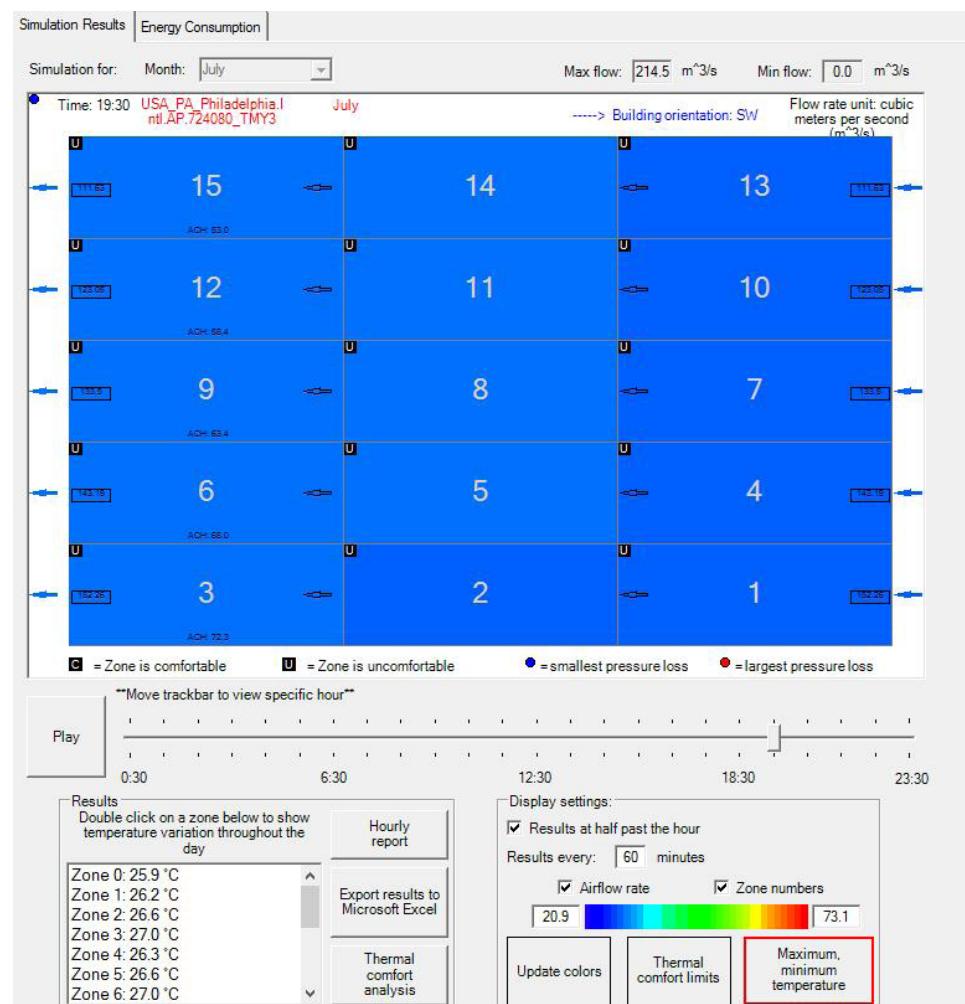
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Time2 12:30

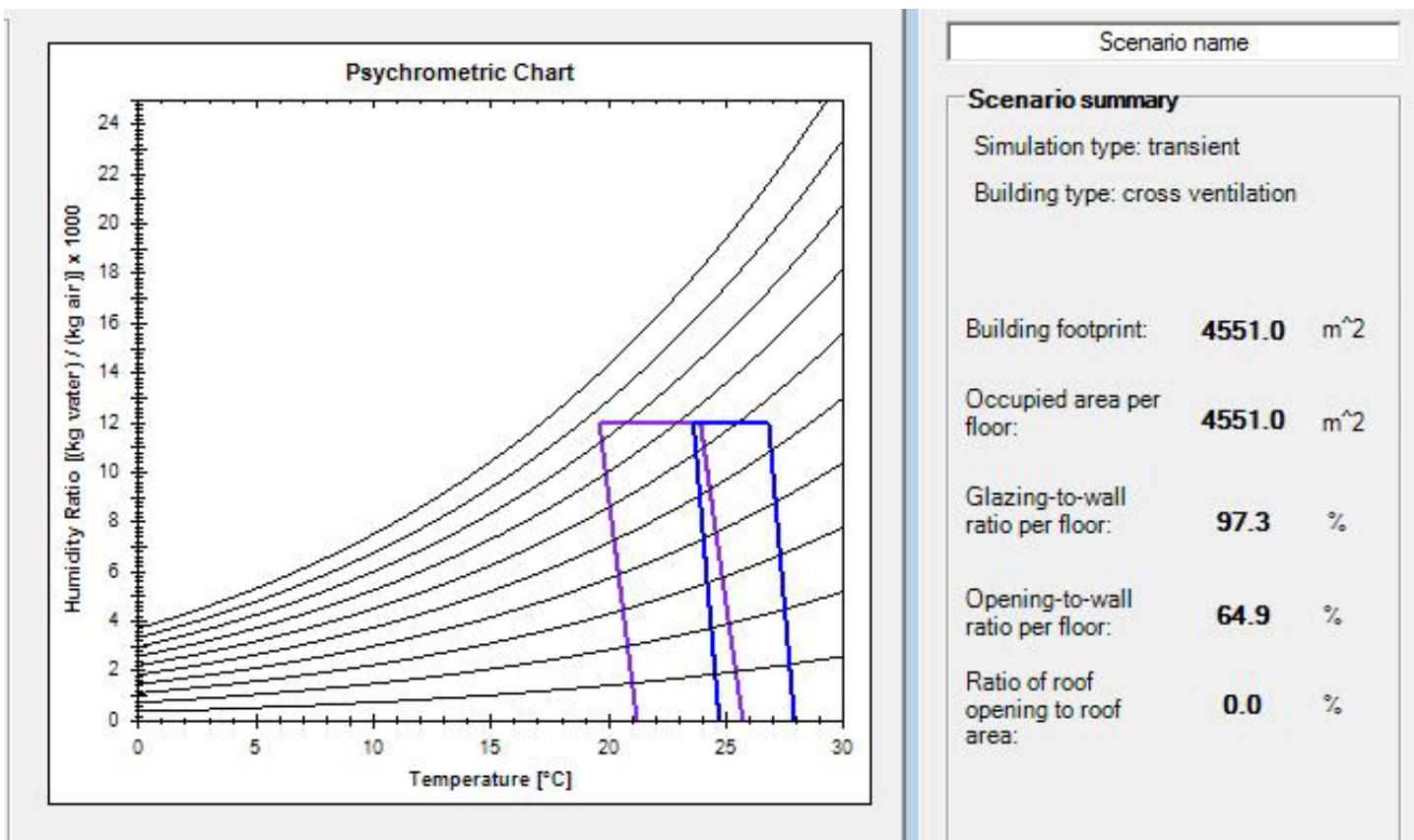


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Psychometric Chart & Window Ratio

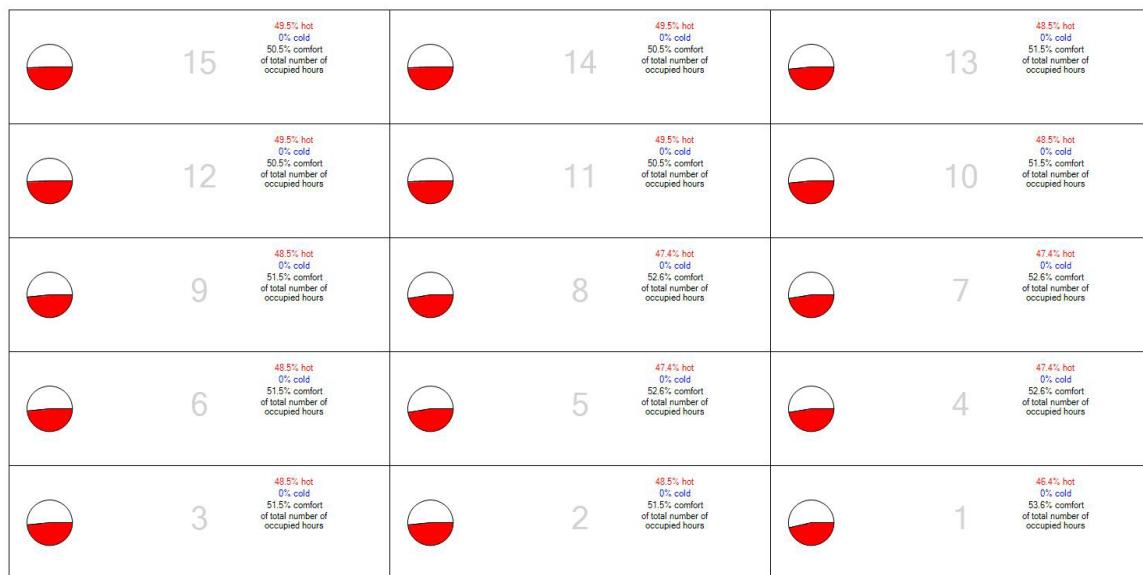


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Temperature Pie Charts



The pie charts represent temperature concerns for comfort in non-atrium zones of the building.

Red represents the percent of total occupied hours that a non-atrium zone is too hot.
Blue represents the percent of total occupied hours that a non-atrium zone is too cold.

Humidity concerns are not addressed in the pie charts.

Summary:

The strategy II is mainly focused on the cross ventilation on each floor, like connecting East and West wings studio, and try to increase the area of windows and operable parts as large as possible. The simulation result shows that it is better strategy than all area of the building could keep more than 50% comfort condition. In different time during the day, the building performance is still better than the Strategy I which combines with several different ventilation approaches. Therefore, probably, to introduce air go across the building if only want to improve natural ventilation effect.