Iaac

Some Student Work Samples

Institute for Advanced Architecture of Catalonia (IAAC)

Digital Tools for Environmental Analysis

ACADIA

Mohammad Mahdi Mohammadi

7 JUL - 2025

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Group **7** Async.

Digital Tools for Environmental Analysis

Cesar Diego Herbosa, Esteban Alvarez Ruiz, Giorgia Wolman*

Session 1: Climate Analysis

Session 2: Sun Hours, Solar Radiation

Session 3: Thermal Comfort

Session 4: Daylight Studies

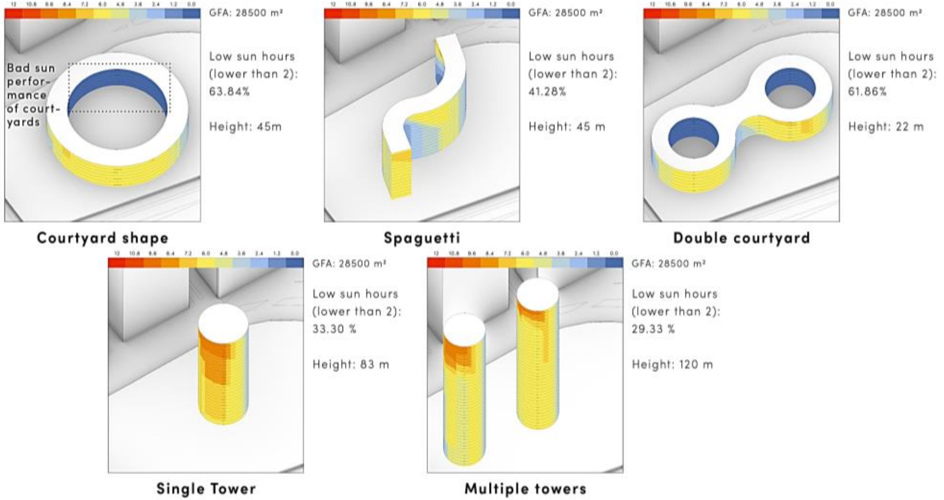
Session 5: Wind Comfort, CFD

Session 6: Infrared.city: AI-Driven simulation

*All analysis, design, and layout are done by the team.

FORMFINDING (SUN HOURS)
Options analysis

Sun hours analyzed during the cloudiest day in average in New York (January **3** **[1]**). Each option has a horizontal shading device with **1** meter offset from the facade.
We can see in the analysis that in winter due to the position of the sun, the courtyards remain in shadow, even in the parts exposed to the south. In this sense, the open shapes, have better performance in New York for sun hours, and even more the circular towers, which also increase the amount of sun light.



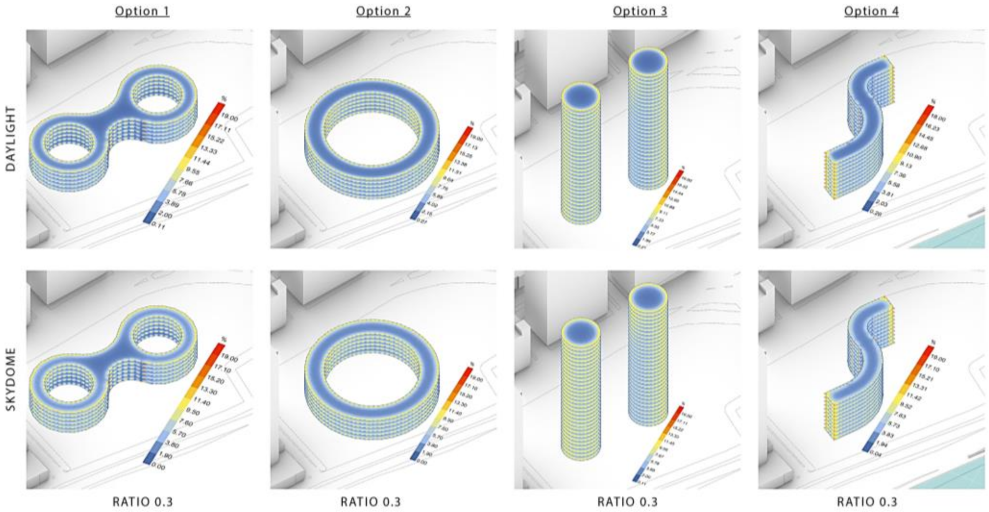
FORMFINDING (DAYLIGHT)
Options analysis

OPTION 1
Average Daylight Factor: **2.92**
Average Sky View: **3.21**

OPTION 2
Average Daylight Factor: **2.92**
Average Sky View: **3.21**

OPTION 3
Average Daylight Factor: **2.92**
Average Sky View: **3.21**

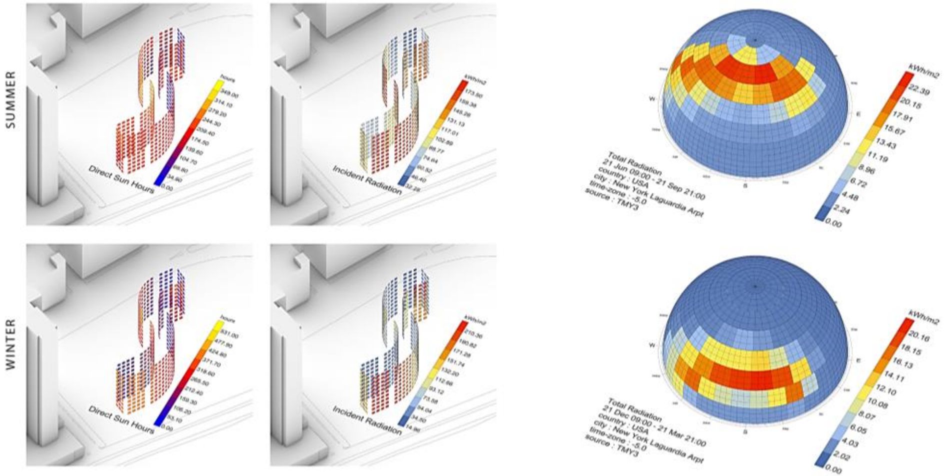
OPTION 4
Average Daylight Factor: **2.92**
Average Sky View: **3.21**



[1] [https://weatherspark.com/y/23912/Average-Weather-in-New-York-City-New-York-United-States-Year Round#:~:text=The%20cloudier%20part%20of%20the,cloudy%2052%25%20of%20the%20time](https://weatherspark.com/y/23912/Average-Weather-in-New-York-City-New-York-United-States-Year-Round#:~:text=The%20cloudier%20part%20of%20the,cloudy%2052%25%20of%20the%20time).

INCIDENT RADIATION AND DIRECT SUN HOURS

Direct sun hours analysis and incident radiation analysis on the opening and widows in summer and winter conditions.

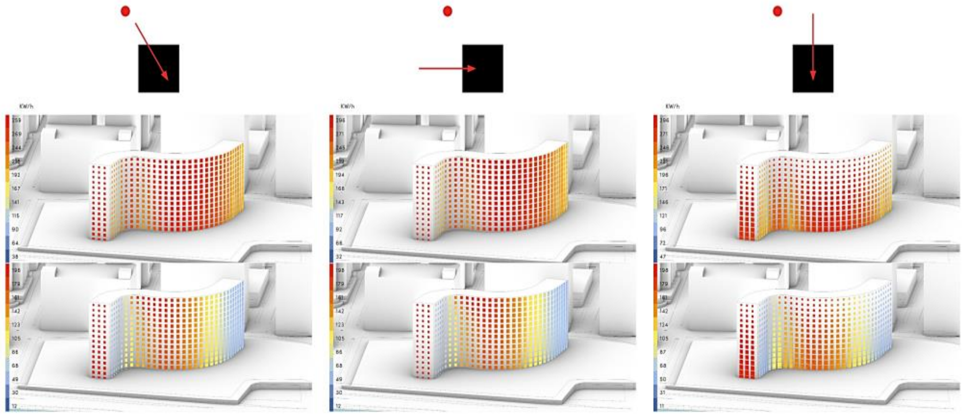


Direct Sun Hours Analysis

Incident Radiation Analysis

OPENINGS DESIGN
Options analysis

The option with the windows from top to button presents a better performance during summer and winter.



FROM SUN DIRECTION

Total radiation summer: 937578.52 kw/h
Total radiation winter: 344711.85 kw/h

VERTICAL FROM SUN DIRECTION

Total radiation summer: 942710.84 kw/h
Total radiation winter: 340522.78 kw/h

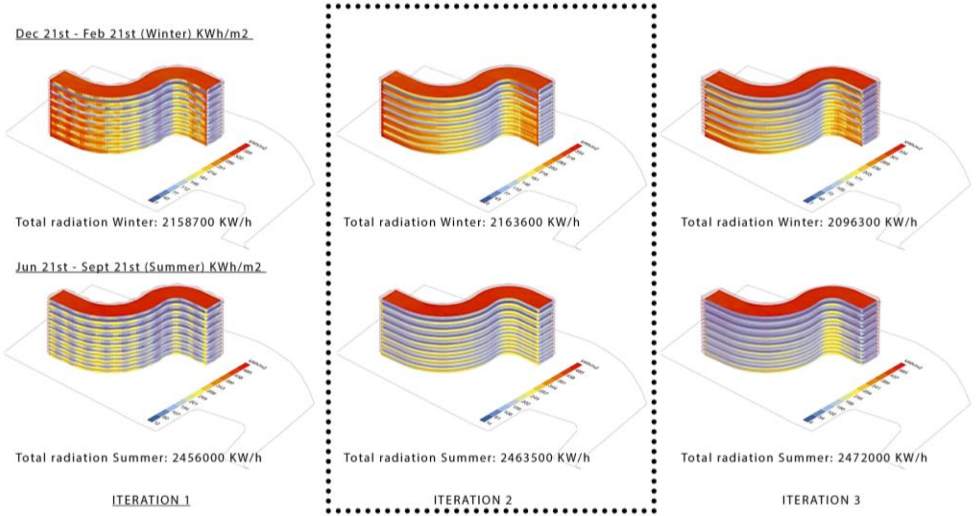
HORIZONTAL FROM SUN DIRECTION

Total radiation summer: 920625.39 kw/h
Total radiation winter: 358810.72 kw/h

SHADING DEVICES
Options analysis

IMPROVEMENTS DURING HOT SUMMER DAYS
All three options offer improvements during the summer, with the most effective option increasing flight in areas of more unfavorable orientation.

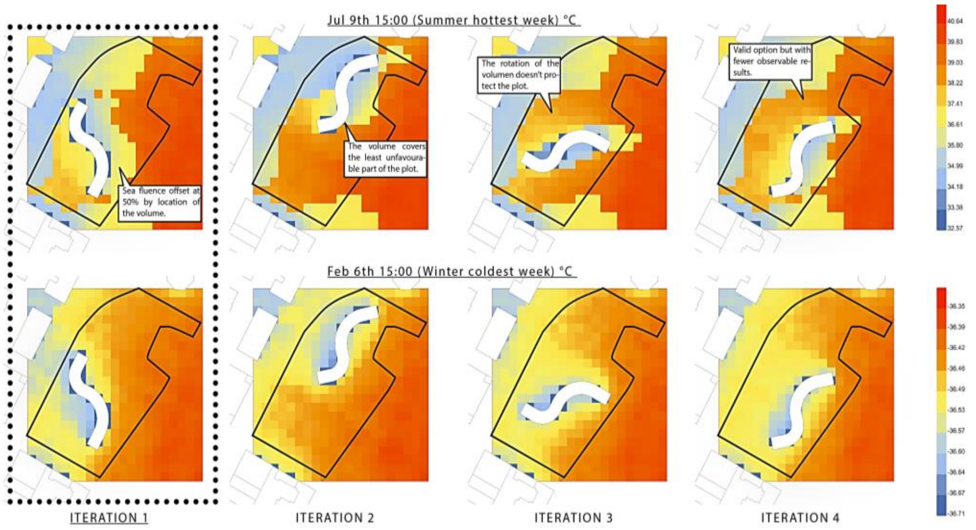
IMPROVEMENTS DURING COLD WINTER DAYS
During the winter months the sun shines from a lower angle allowing the radiation generated to be used to combat the low temperatures.



MRT AND UTCIS COMFORT
Only daily hours considered (8:00am - 20:00pm)

IMPROVEMENTS DURING HOT SUMMER DAYS
Considering our volumetry's position in the plot, we can achieve a drop of up to **5°**C in the UTCI values in areas of the plot during the worst summer days.

IMPROVEMENTS DURING COLD WINTER DAYS
Considering our volumetry's position in the plot, we can achieve a drop of up to **5°**C in the UTCI values in areas of the plot during the worst summer days.



MATERIALS AND TREES FOR UCTI

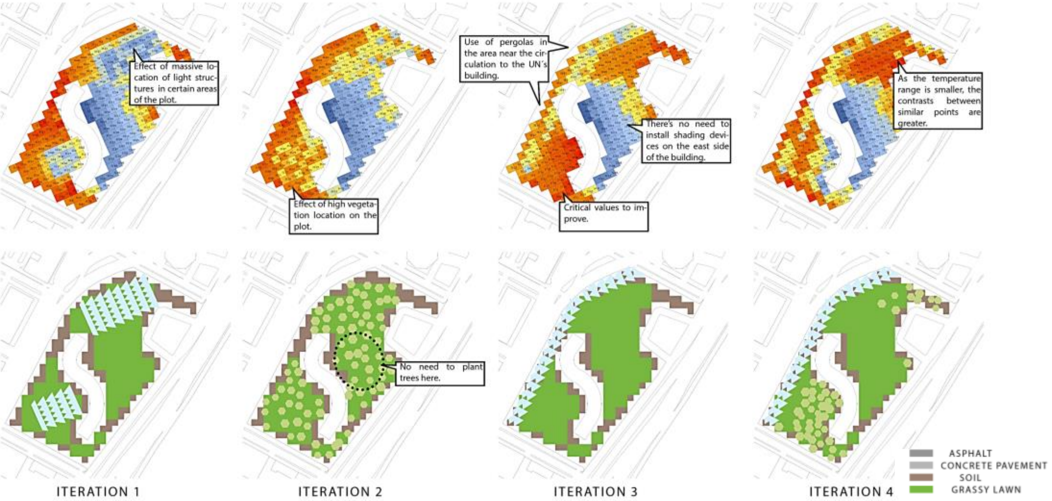
Jul 9th 15:00 (Summer hottest week) °C

ITERATION 1
We start by looking at the behavior of different shadow solutions for urban space separately.

ITERATION 2
High vegetation planting implements the UCI values uniformly.

ITERATION 3
A walk under pergolas is proposed on the street that connects the building of the United Nations with St Vartan Park.

ITERATION 4
The rest of the critical areas are extracted and implemented with vegetation.

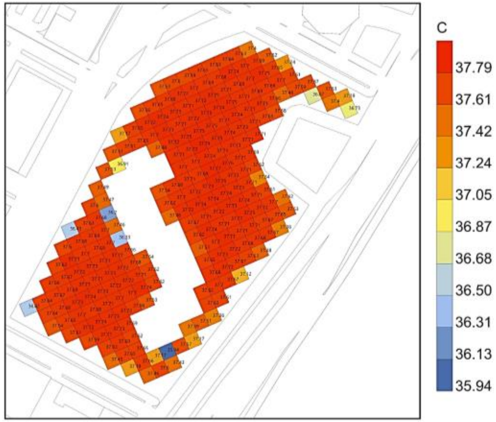


CONCLUSIONS

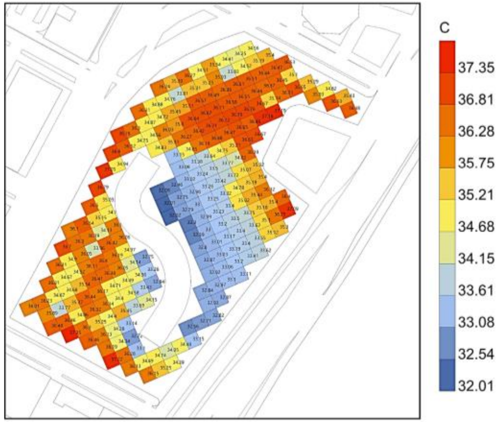
Jul 9th 15:00 (Summer hottest week) °C

The values within the grid analyzed range between almost **36** °C and **38** °C. This makes it difficult to imagine the solution of installing a paved site on the grid from an urban comfort point of view.
For the quality of urban space, this shows the poor quality of certain solutions (such as ex tensive parking) which are so common in our cities.

The location of certain volumes within urban space achieves improvements of more than **5** °C in more favorable areas.
The use of architectural elements and green areas in our projects makes a difference to make our cities much more comfortable.



INITIAL HYPOTHESIS: no building and asphalt ground



FINAL HYPOTHESIS: correct building location and green spaces

Group **1** Sync.

Digital Tools for Environmental Analysis

Angeliki Maragakis, Anzhelika Ignateva, Khalifah Alnisof*

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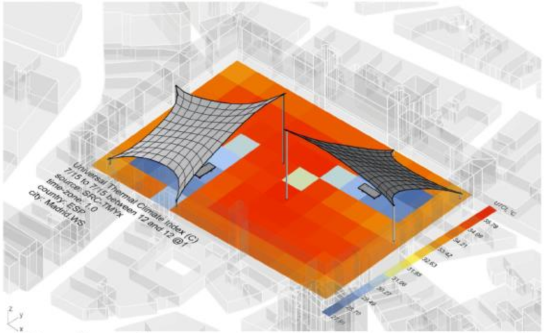
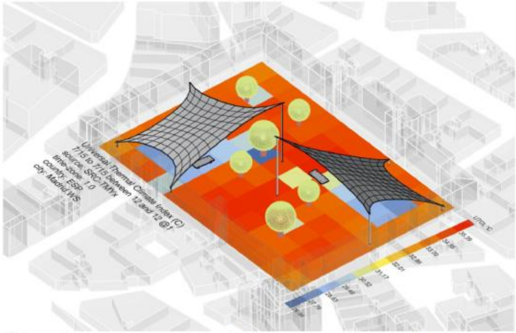
Plaza Mayor in Madrid. Shading strategies

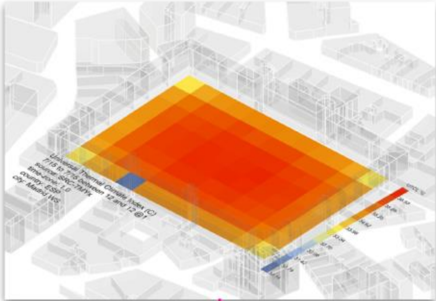


Shades A

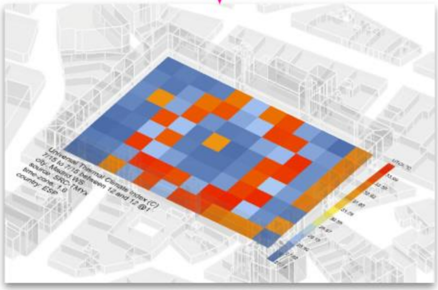


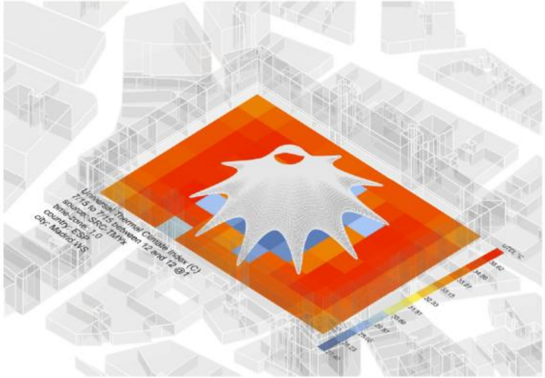
Shades A + small amount of trees

Before

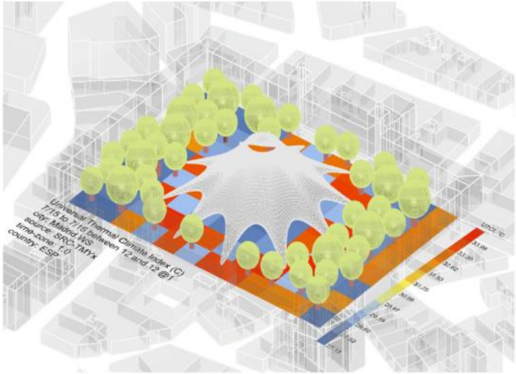


After





Shades B



Shades B + lots of trees

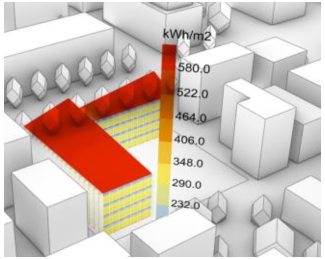
Photovoltaic optimisation - iterative steps

(+) = increase in performance over original massing (iteration 1)
(-) = decrease in performance

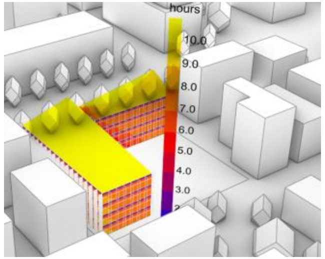
Iteration 5: L-configuration

Building forms: cuboid/cuboid
GFA ratio: 0.3:0.7

Shading offset: 1.5m(max)
Roof slant: 4.0m(max)



Summer kWh(wall): 468719 (++)
Summer kWh(roof): 507314 (-)

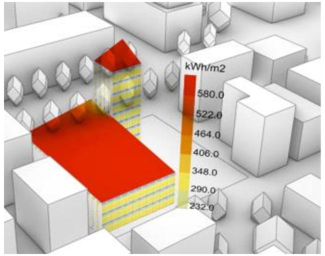


Low sun hours: 43% (+)

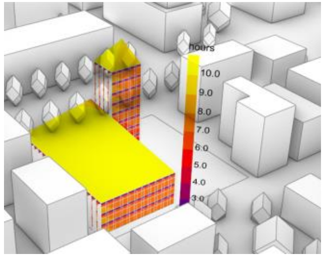
Iteration 6: Scaling/tower

Building forms: cuboid/cuboid
GFA ratio: 0.2:0.8

Shading offset: 1.5m(max)
Roof slant: 4.0m(max)



Summer kWh(wall): 459442 (++)
Summer kWh(roof): 583771 (++)

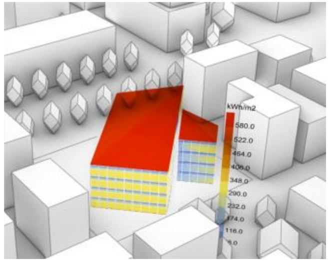


Low sun hours: 48% (+)

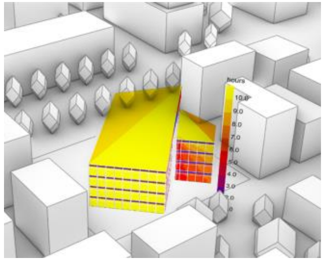
Iteration 7: Rotation

Building forms: cuboid/cuboid
GFA ratio: 0.1:0.9

Shading offset: 1.5m(max)
Roof slant: 4.0m(max)



Summer kWh(wall): 392171 (++)
Summer kWh(roof): 504831 (-)

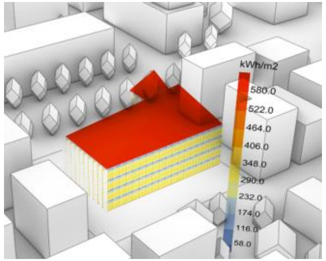


Low sun hours: 55% (++)

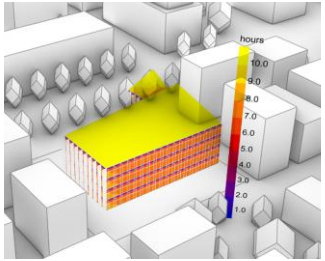
Iteration 8: Long dimension

Building forms: cuboid/cuboid
GFA ratio: 0.1:0.9

Shading offset: 1.5m(max)
Roof slant: 4.0m(max)



Summer kWh(wall): 402765 (++)
Summer kWh(roof): 514966 (-)



Low sun hours: 48% (+)

Building in Madrid: daylight factor

We checked the heatmap of **HB Daylight Factor** for different types of shades and their angle.

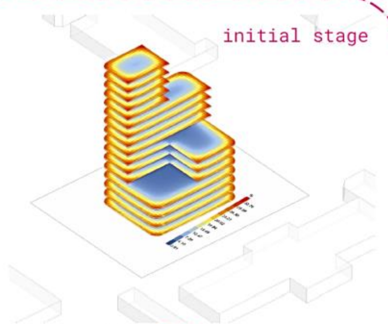
The idea was to find the shades for the panoramic windows that are less obstructive for daylight.

In our iterations, **vertical shades seems to be more obstructive than the horizontal ones**.

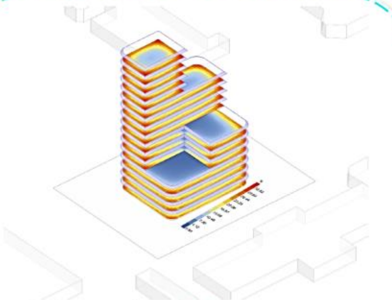
Whereas, the angle haven’t seem to play much role in it for vertical shades.

As the daylight factor analysis **has many disadvantages**, we checked our suggestion in the alternative one - HB SkyView analysis.

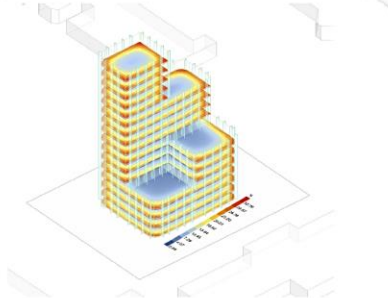
initial stage



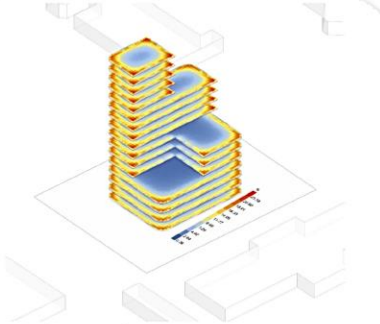
window ratio: 0.95
no shades



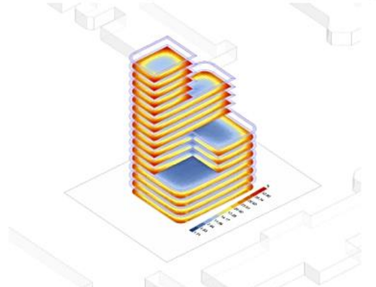
window ratio: 0.95
horizontal shading distance: 1.0
horizontal shading angle: 45°



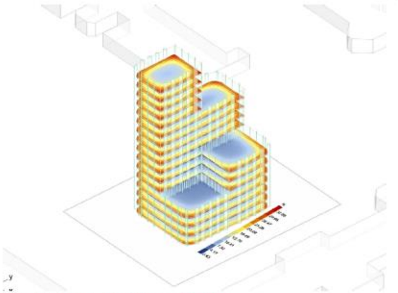
window ratio: 0.95
vertical shading distance: 1.0
shading angle: 90°
distance between shades: 3.0



window ratio: 0.5
no shades



window ratio: 0.95
horizontal shading distance: 1.0
horizontal shading angle: 0°



window ratio: 0.95
vertical shading distance: 1.0
shading angle: 45°
distance between shades: 3.0

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Group 2 Sync.

Digital Tools for Environmental Analysis

Andrea Ardizzi, Ernesto Preciado, Krisztián Hajdu*

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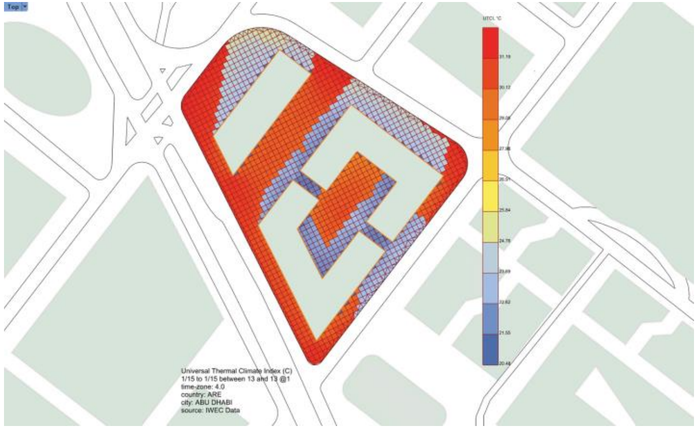
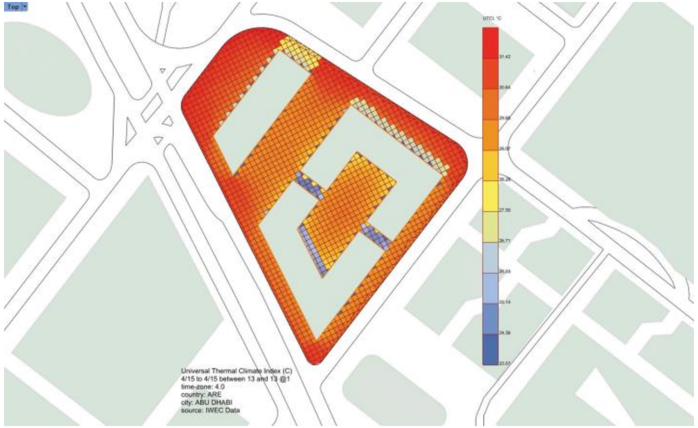
Thermal comfort // **UTCI OUTDOOR AREAS**

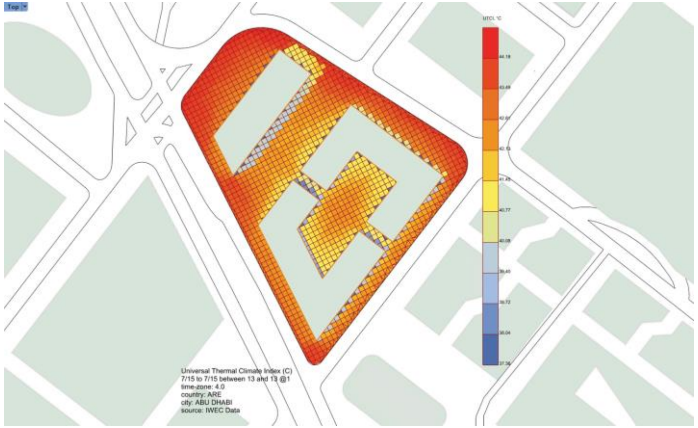
January 15 LOWEST TEMPERATURE



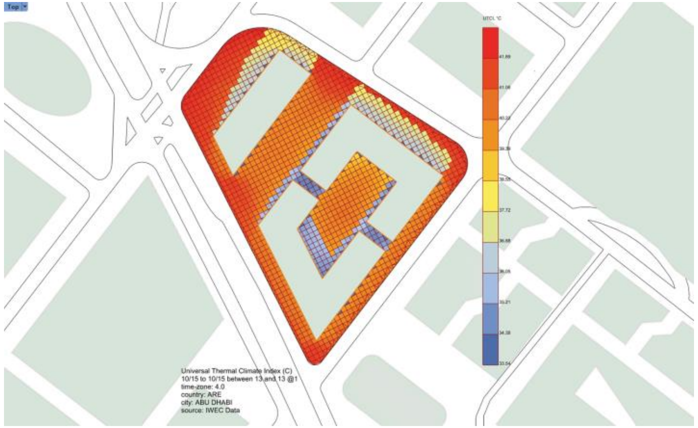
April 15 HIGHEST TEMPERATURE



July 15

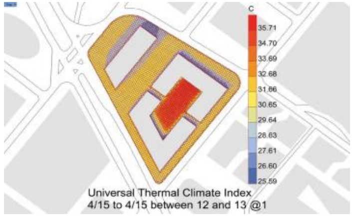


October 15

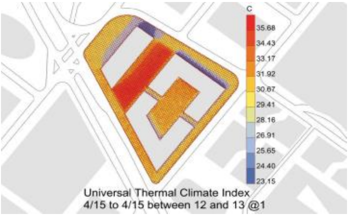


Thermal comfort // **UTCI STRATEGY GROUNDCOVER**

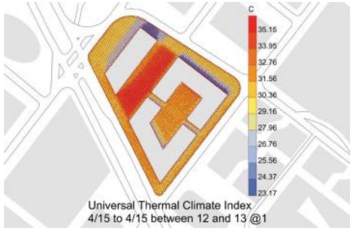
BRICK PAVERS



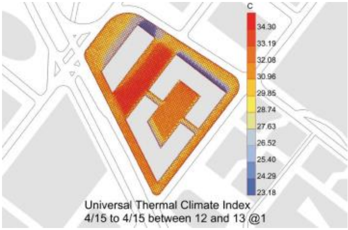
CLAY TILE



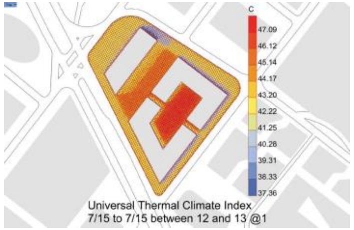
SANDSTONE



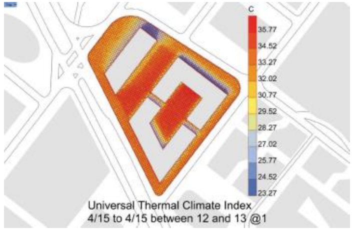
GRANITE



CONCRETE PAVEMENT



SOLID ROCK



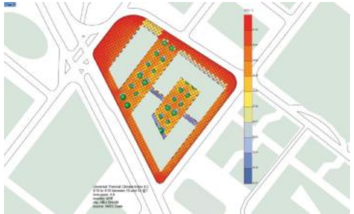
Thermal comfort // **UTCI SHADOW STRATEGY TREES**

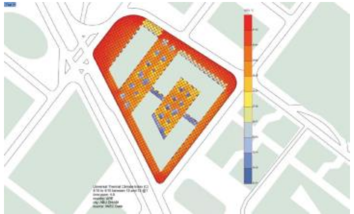
April 15, day with worse UTCI

View with trees

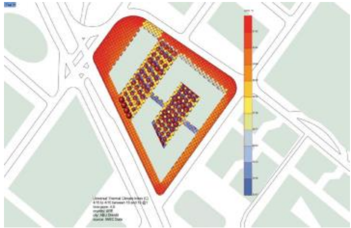
View without trees

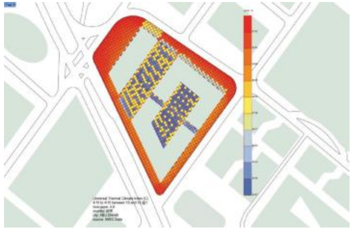
5 trees per row, spaced 10m



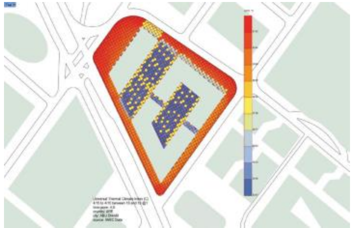


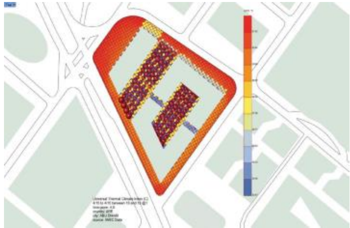
10 trees per row, spaced 6m



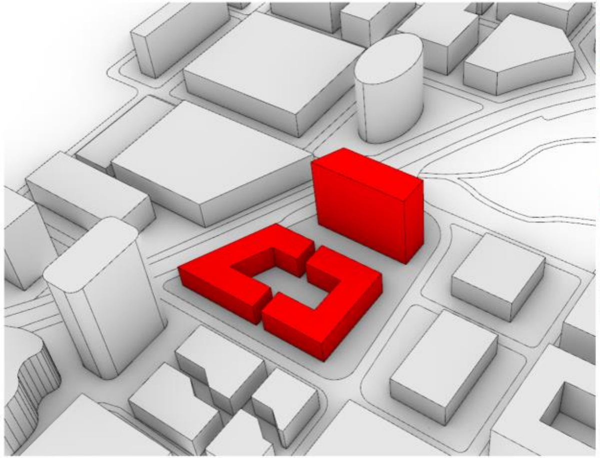


15 trees per row, spaced 6m

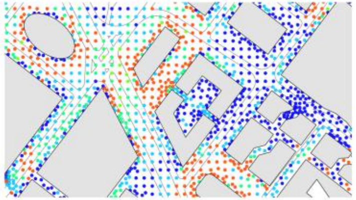




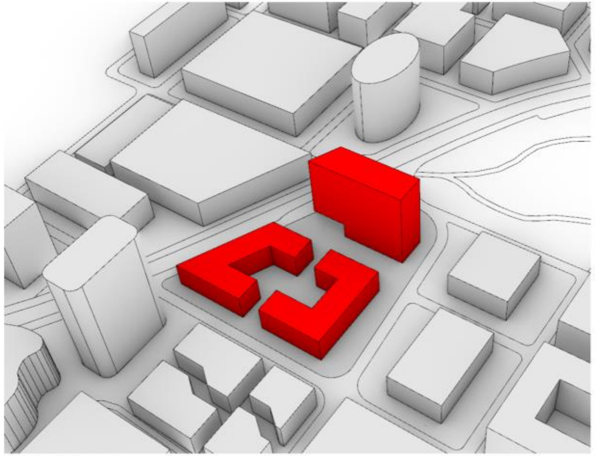
Wind Analysis // **Scenario 1-3**
Wind Annual Hour Comfort



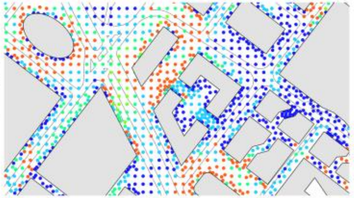
Average wind comfort // 2,72



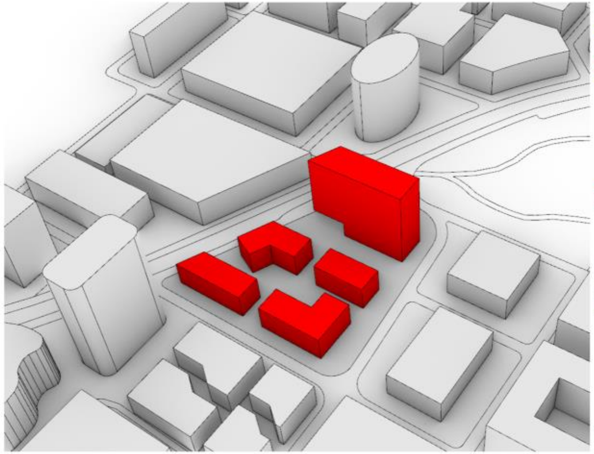
Wind velocity // Direction 320°



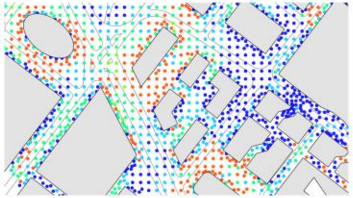
Average wind comfort // 2,70



Wind velocity // Direction 320°

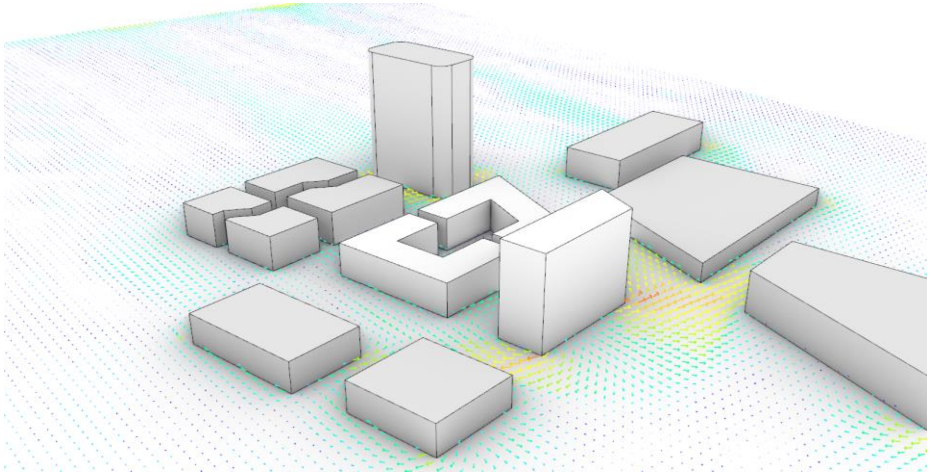


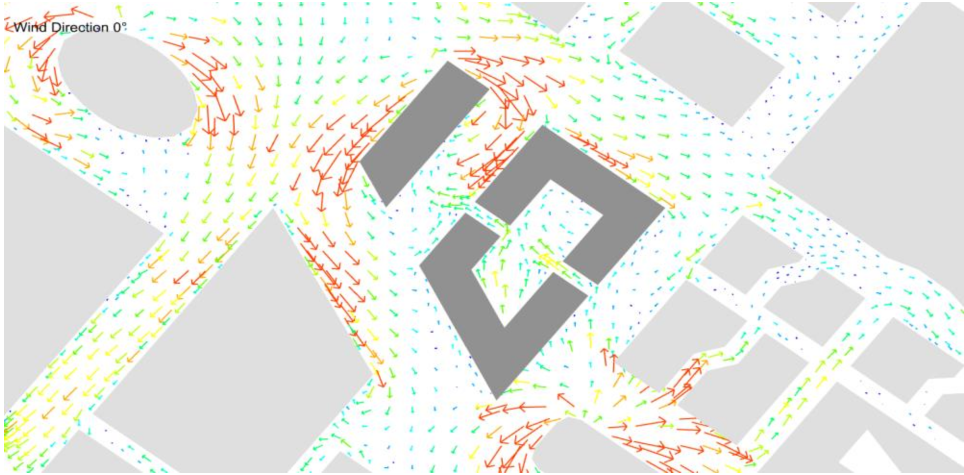
Average wind comfort // 2,68

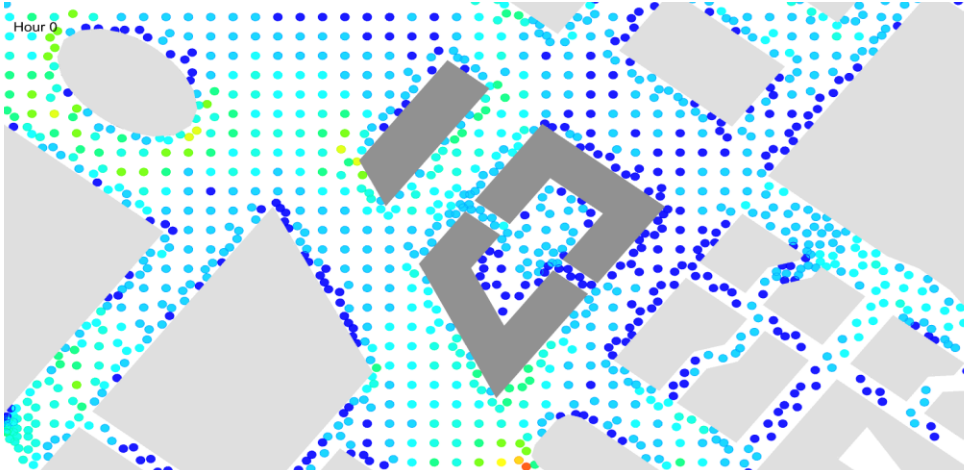


Wind velocity // Direction 320°

Wind Analysis // **Scenario 1**
Wind Annual Hour Comfort







Group **1** Async.

Digital Tools for Environmental Analysis

Aymeric Brouez, Daniel Escobar, Carlos Andrés Espinosa Romero*

Session 1: Climate Analysis
Session 2: Sun Hours, Solar Radiation
Session 3: Thermal Comfort
Session 4: Daylight Studies
Session 5: Wind Comfort, CFD
Session 6: Infrared.city: AI-Driven simulation

*All analysis, design, and layout are done by the team.

GROUP 1
Aymeric Brouez
Daniel Escobar
Andrés Espinosa

Windows shading

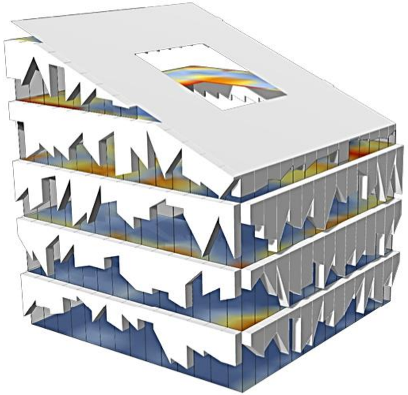
1 Adaptive Shading

A panel that can adjust to add a solid shading device on the window. The device has three parameters. Two points on the right and left mullion and a thickness.Thus provide multiple types of shades depending on orientation.

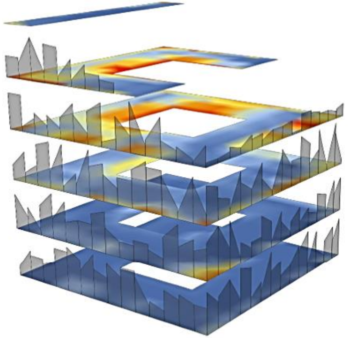
2 Optimization

The optimization is a multi objective function that attempts to maximize the area of the window while minimizing the radiation in the summer. A weight parameter can be adjusted to prioritize either objective.

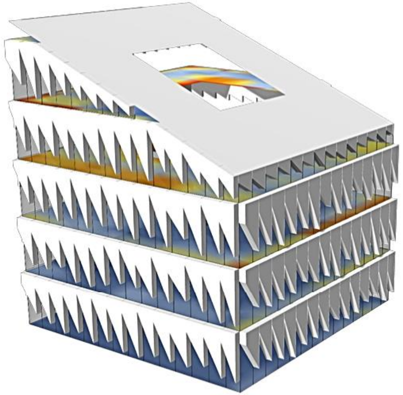
Fitness(maximize) = w1 * Window_Area - w2 * Radiation



Randomized parameters

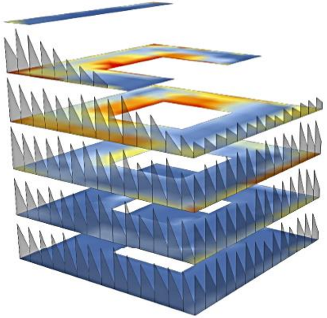


Randomized Interior Analysis



Summer optimized parameters

Parameter count: 238
2 * 64 (west_windows) + 2 * 54(south_windows) + 2 (depth)



Summer optimized Interior Analysis

Iterations: 12
Fitness value: -9.0029

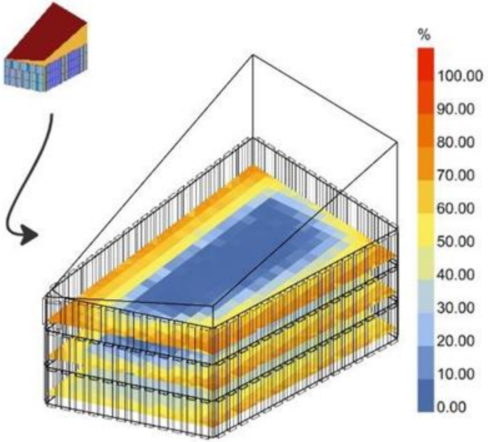
ADVANCED ARCHITECTURE GROUP

GROUP 1
Aymeric Brouez
Daniel Escobar
Andrés Espinosa

V2
Optimize Solar Roof

Spatial Daylight Autonomy

Average sDA300/50% Building = 28%
Average sDA300/50% Ground Floor = 10%
Average sDA300/50% 2nd Floor = 24%
Average sDA300/50% 3rd Floor = 51%

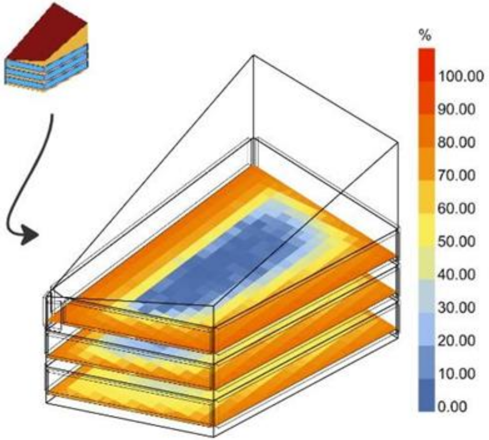


Next Steps:

- Optimize WWRs to enhance daylight according to the orientation of the facades.
- Optimize Window Geometry. Sill-height below 80cm has low efficiency for daylight.

Spatial Daylight Autonomy

Average sDA300/50% Building = 47%
Average sDA300/50% Ground Floor = 42%
Average sDA300/50% 2nd Floor = 43%
Average sDA300/50% 3rd Floor = 56%

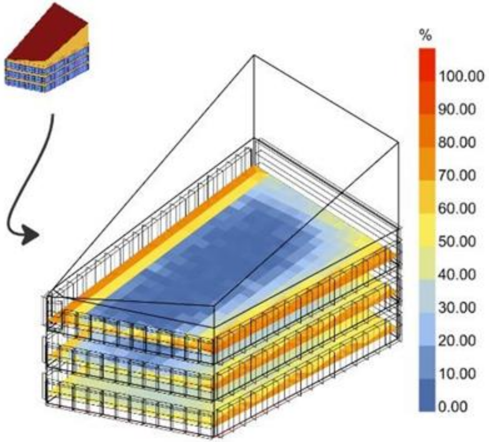


Next Steps:

- Introduce light shelves and vertical fins, and reduce sill height to bring diffuse light deeper into the building.

Spatial Daylight Autonomy

Average sDA300/50% Building = 19%
Average sDA300/50% Ground Floor = 12%
Average sDA300/50% 2nd Floor = 15%
Average sDA300/50% 3rd Floor = 28%



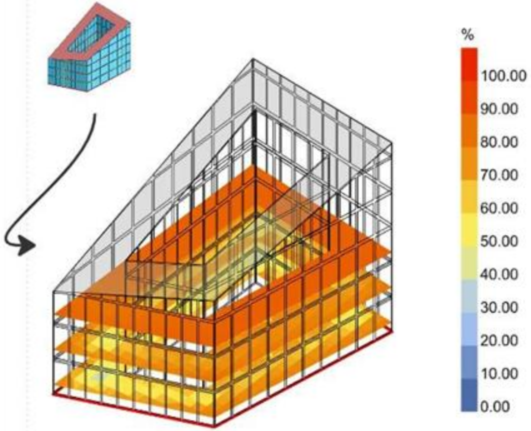
Next Steps:

- Assign material properties to ceilings and slabs to analyze the reflection of light

GROUP 1 | **V2**
Aymeric Brouez | Optimize
Daniel Escobar | Solar
Andrés Espinosa | Roof

Spatial Daylight Autonomy

Average sDA300/50% Building = 95%
Average sDA300/50% Ground Floor = 87%
Average sDA300/50% 2nd Floor = 90%
Average sDA300/50% 3rd Floor = 97%

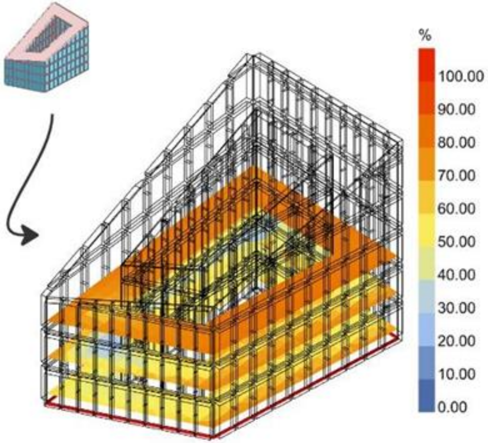


Next Steps:

- Optimize Window geometry by extruding shades

Spatial Daylight Autonomy

Average sDA300/50% Building = 69%
Average sDA300/50% Ground Floor = 50%
Average sDA300/50% 2nd Floor = 57%
Average sDA300/50% 3rd Floor = 90%

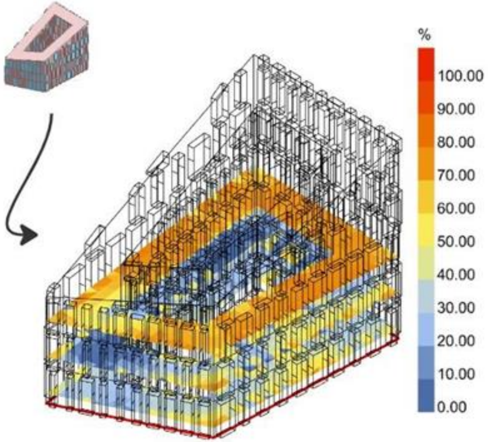


Next Steps:

- Decrease window size

Spatial Daylight Autonomy

Average sDA300/50% Building = 36%
Average sDA300/50% Ground Floor = 08%
Average sDA300/50% 2nd Floor = 11%
Average sDA300/50% 3rd Floor = 85%



Next Steps:

- Assign material properties to ceilings and slabs to analyze the reflection of light

ACADIA

Mohammad Mahdi Mohammadi

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