

Building zero energy districts in tropical climates. Development of design tools for morphology/comfort/energy coupled optimization.

Du bâtiment au quartier à énergie zéro en climat tropical. Développement d'outils de conception pour une optimisation morphologie/confort/énergie.

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Research Laboratory
Physics and Mathematical
Engineering for Energy and the
Environment

www.piment.univ-reunion.fr

Research Areas and Structuring

Energy, the Environment and Construction: 20 years of international experience in research and development in the fields of.

PERSONNEL

47 staff members
30 teachers-researchers
2 technicians/engineers
15 PhD candidates

Internationally recognized expertise in:

- Mass transfer, Energy and Concentration
 - Thermodynamic systems
 - Building Physics
 - Thermal Engineering
 - Design
 - Civil Engineering
- Mathematical Engineering
 - Model analysis
 - Numerical methods
 - Optimisation
- Human interactions
 - Urban Engineering / Comfort / Behaviour

Structured into two research themes:

- Energy Efficiency of Buildings and Neighbourhoods
- Sustainable Energy

CONTACTS

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CONTEXT

La Réunion 21°S/55.5°E





CONTEXT

830 000 inhabitants
1 million by 2020

Rugged topography
Limited available land for construction

Target: Electric autonomy 2030
Innovative low energy buildings /neighborhoods

Renewable energy
38% of electricity is renewable (2013)

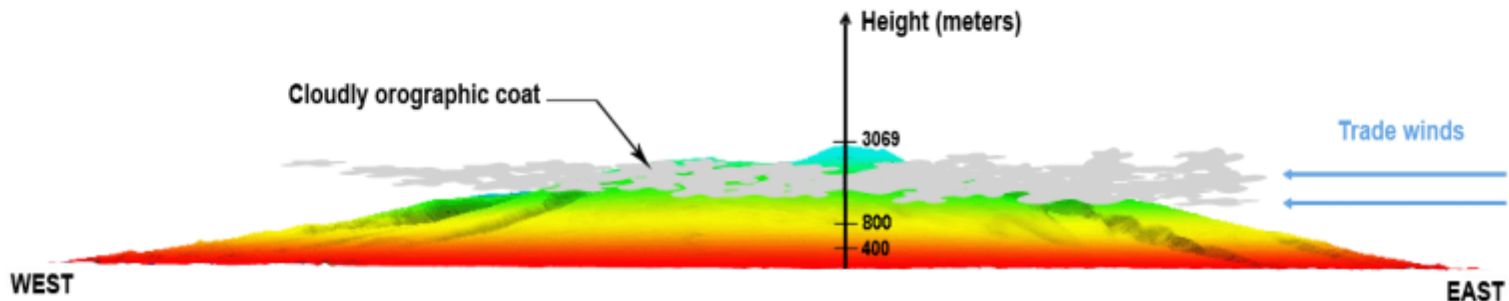
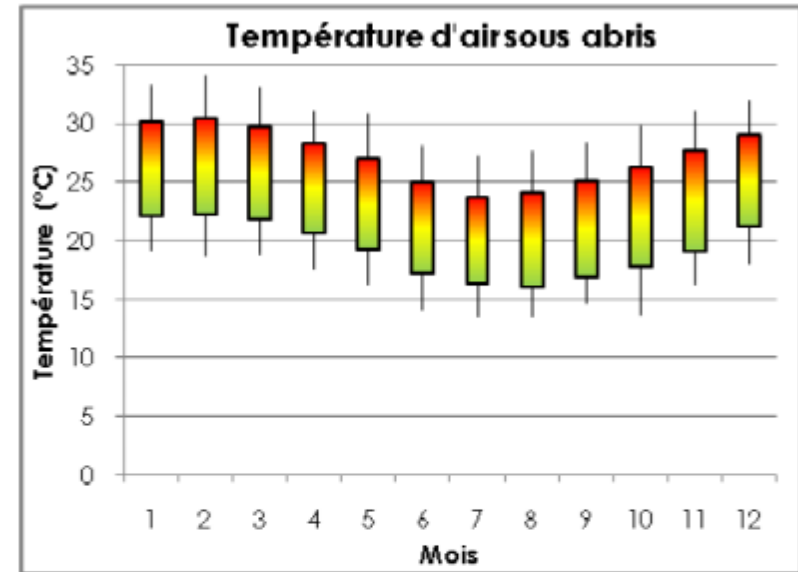


Jerome Balleydier

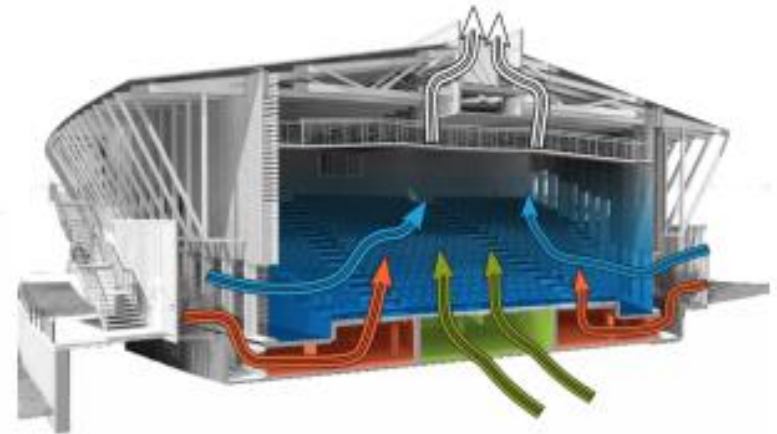
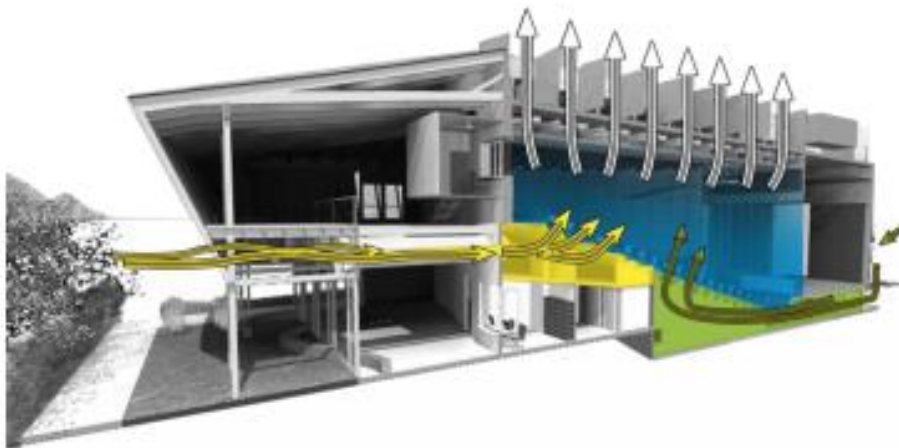


CLIMATE

- Summer season and winter season
- Humid tropical climate along the coast
- (32°/24°) (25°/17°)
- Rather temperate in mid-highlands
- Cold winters in highlands (0°C)
- Lots of micro-climates



CHALLENGE



CHALLENGE



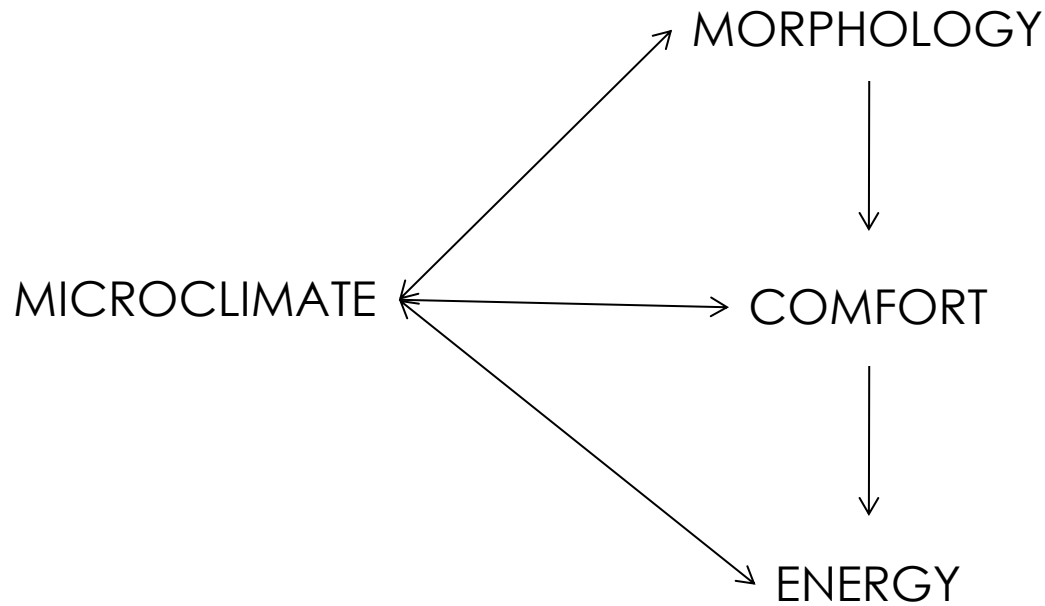
CHALLENGE

How to design bioclimatically optimized buildings in dense tropical urban areas?



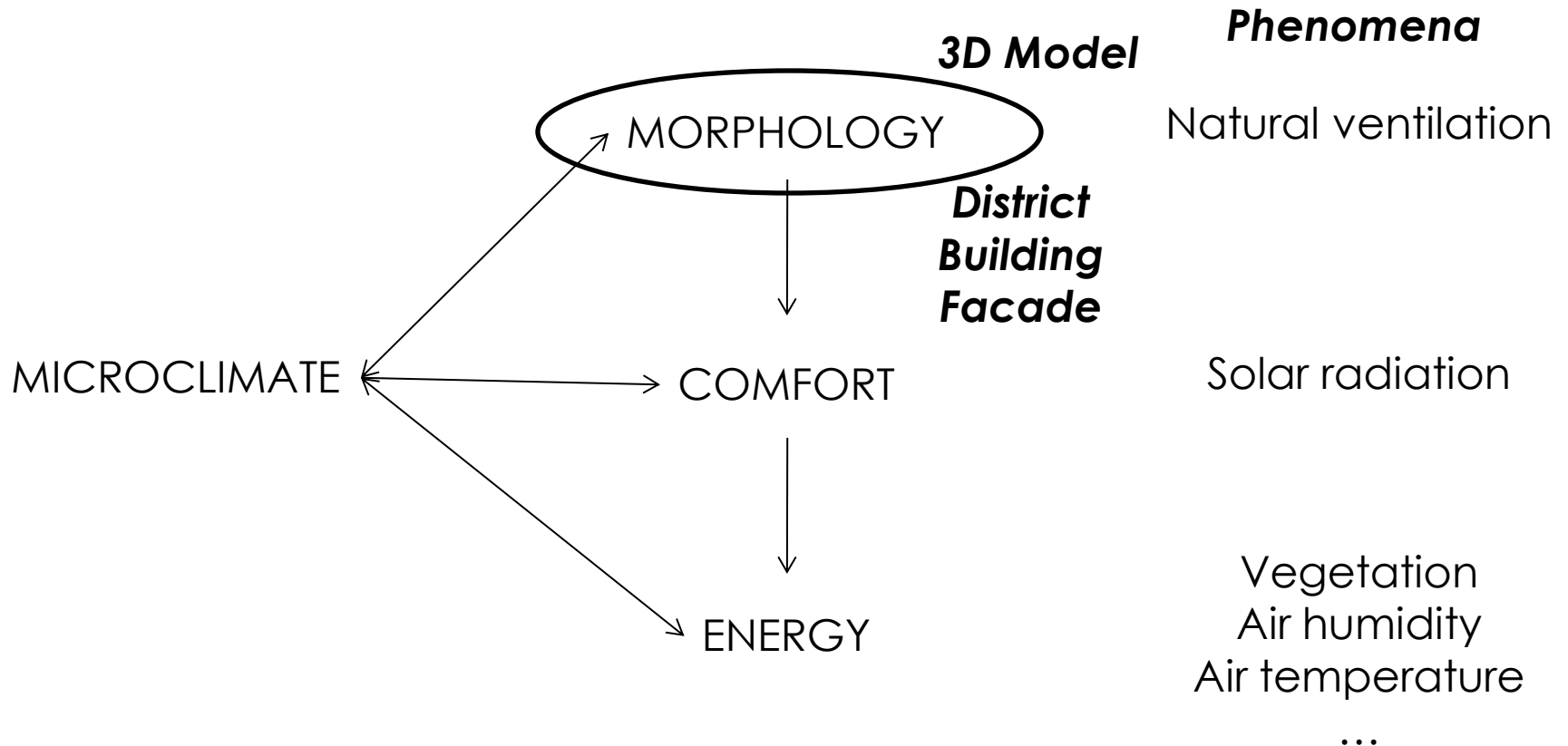
CHALLENGE

How to design bioclimatically optimized buildings in dense tropical urban areas?



OBJECTIVES

Optimise the urban morphology for bioclimatic principles.

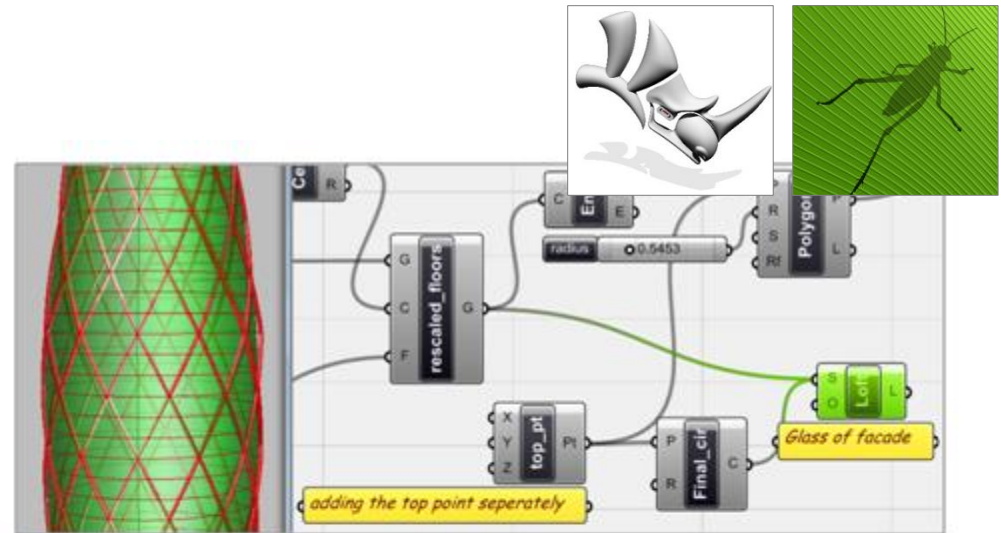


Optimisation multi-scale, multi-objectives taking the microclimate into account.

APPROACH

The pair Rhino-Grasshopper is a **parametric modelling** tool that is able to algorithmically control **3D models** and geometrically optimize them to any defined criteria.

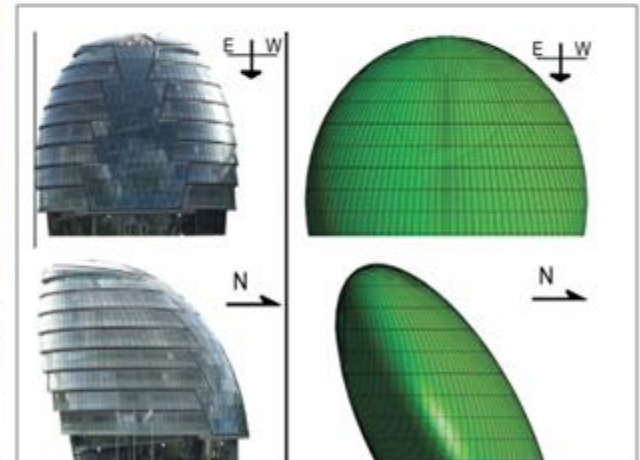
Grasshopper as a script-based Rhino plugin makes generating **complex geometries** easy.



Algorithmically generated and controlled building form in Rhino-Grasshopper.
Khabazi_Algorithmic modeling with Grasshopper



Swiss Re HQ Building,
London
Foster and Partners



Greater London
Authority Building

Solar irradiation
optimized building form

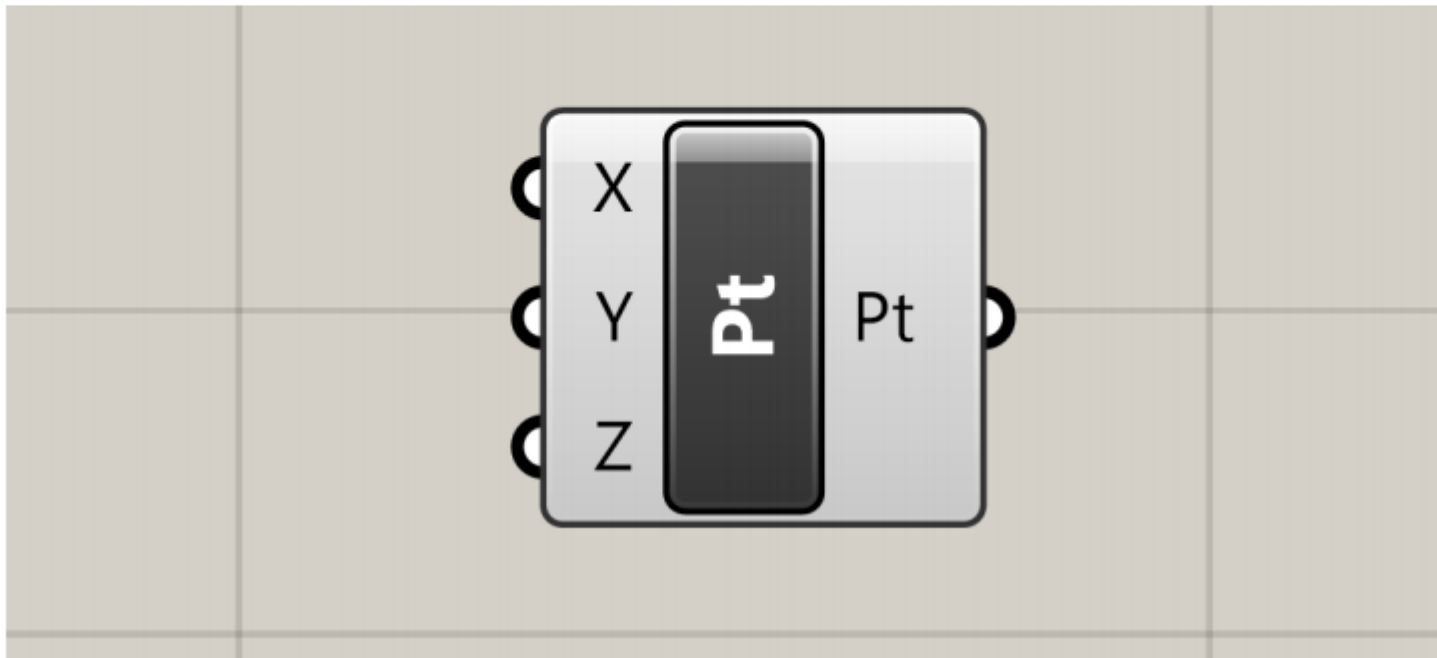
2013-Caruso_Optimal theoretical building form to minimize direct solar irradiation.

GRASSHOPPER

Visual Scripting



Pt = Rhino.Geometry.Point3D(X, Y, Z)

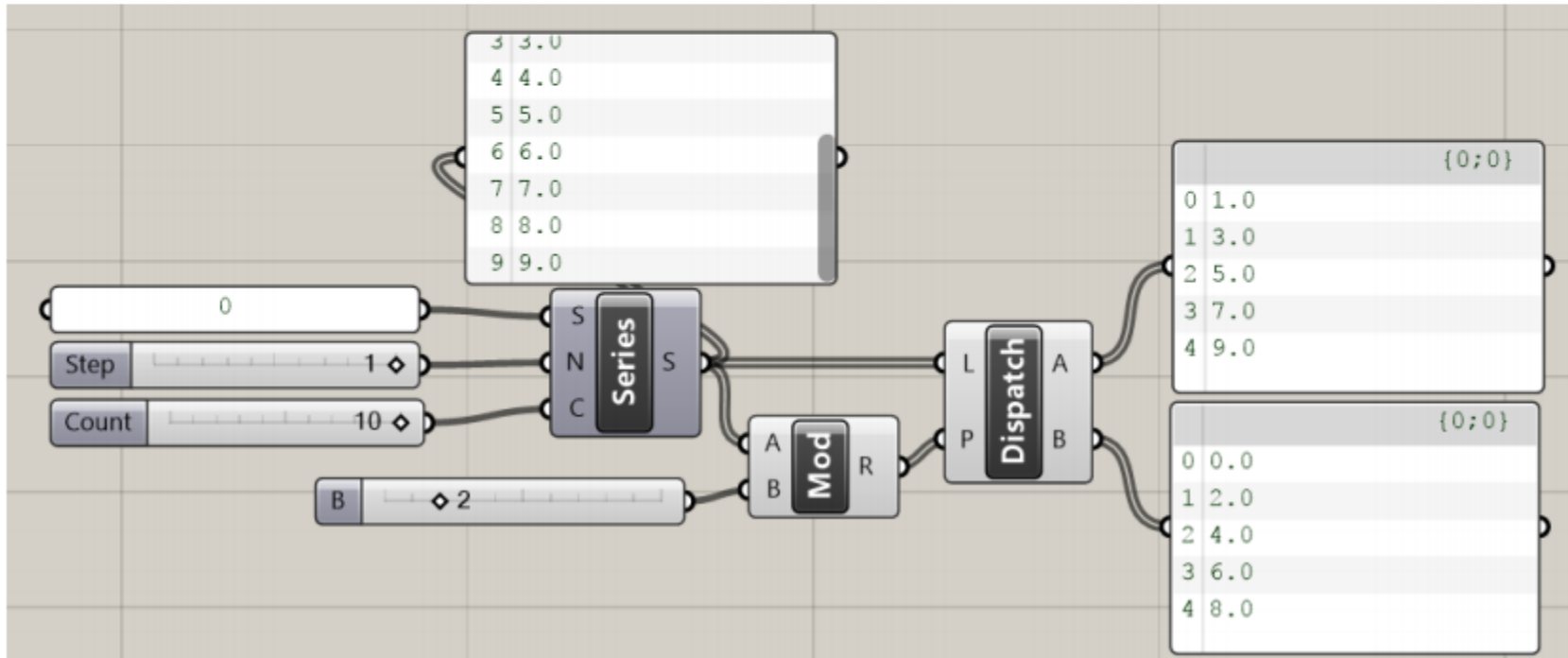


Parametric Analysis is the new black! Mostapha Roudsari | Thornton Tomasetti 12th International Radiance Workshop - 14 AUG 2013

GRASSHOPPER



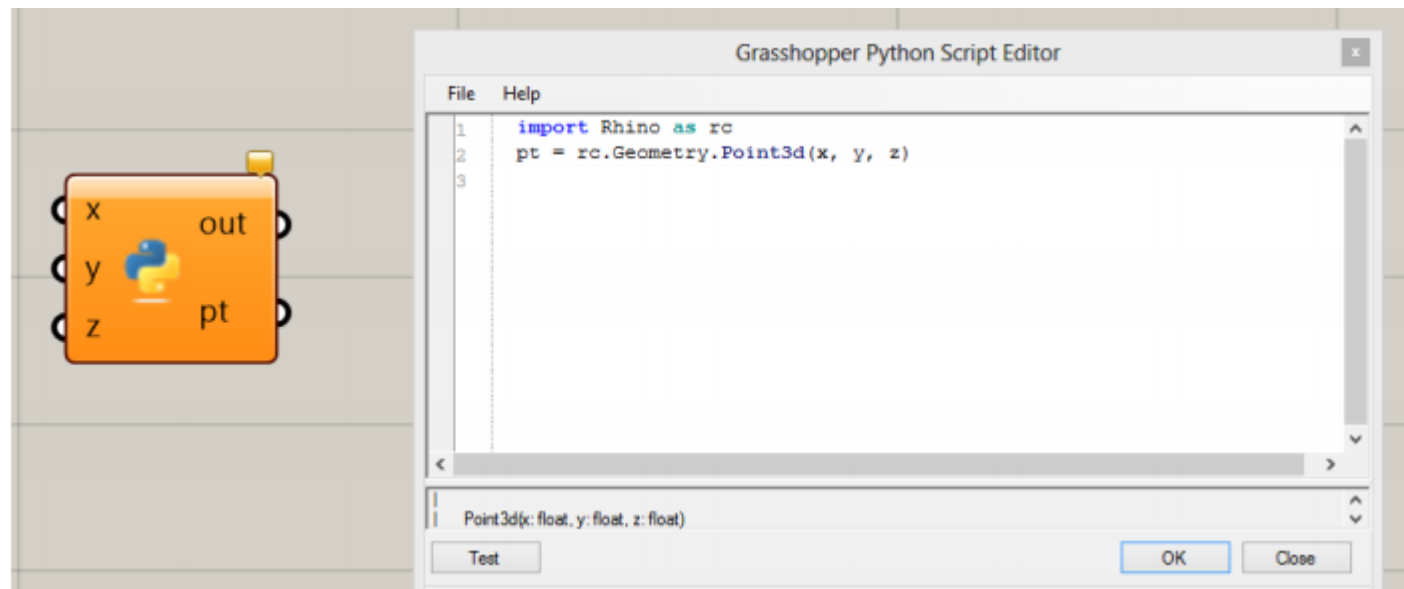
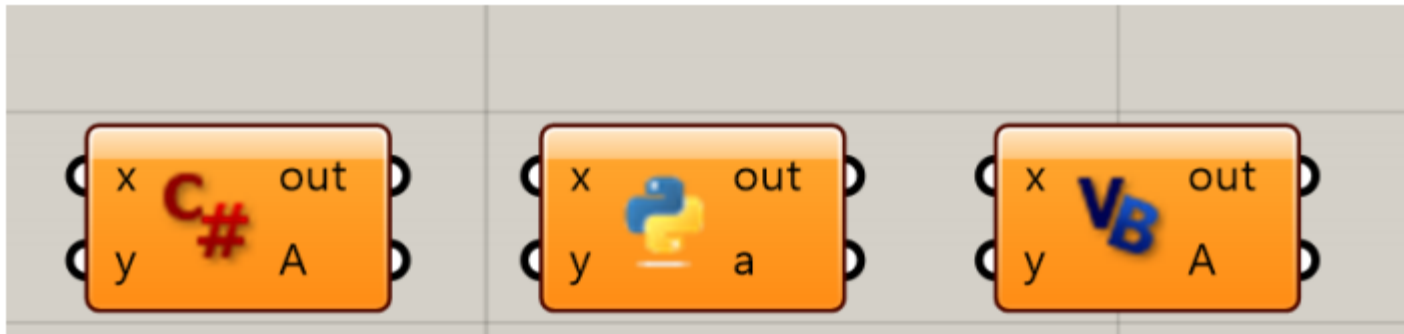
```
evenNum = []  
oddNum = []  
for i in range(10):  
    if i%2 == 0: even.append(i)  
    else: odd.append(i)
```



Parametric Analysis is the new black! Mostapha Roudsari | Thornton Tomasetti 12th International Radiance Workshop - 14 AUG 2013

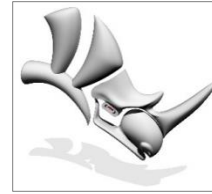
GRASSHOPPER

Make your own components!

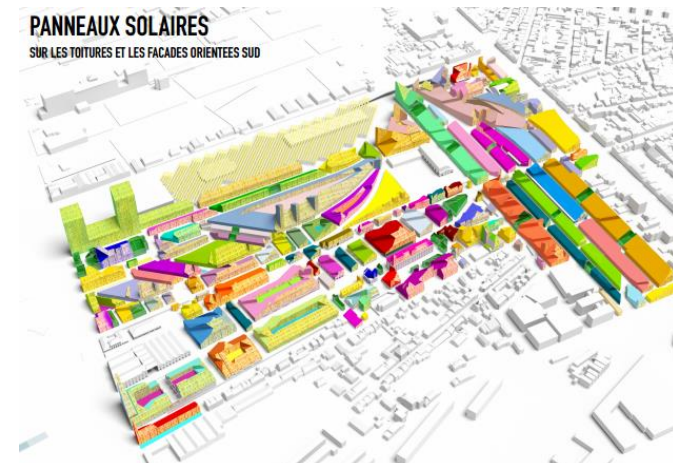
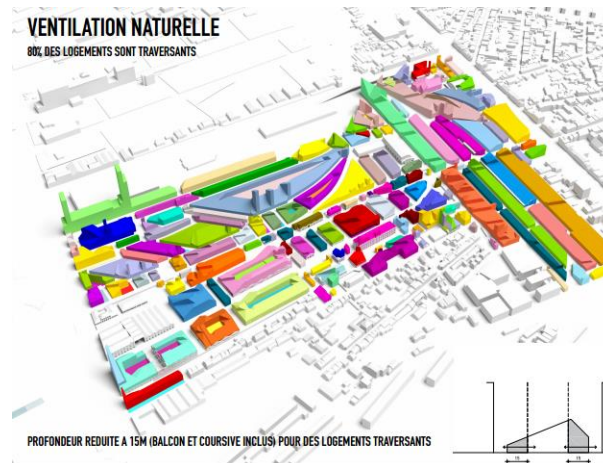
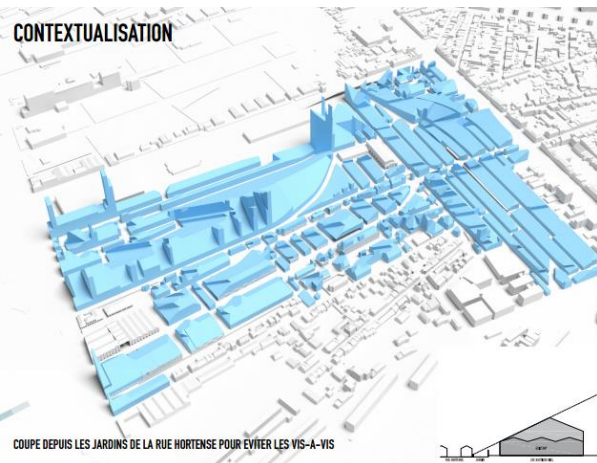
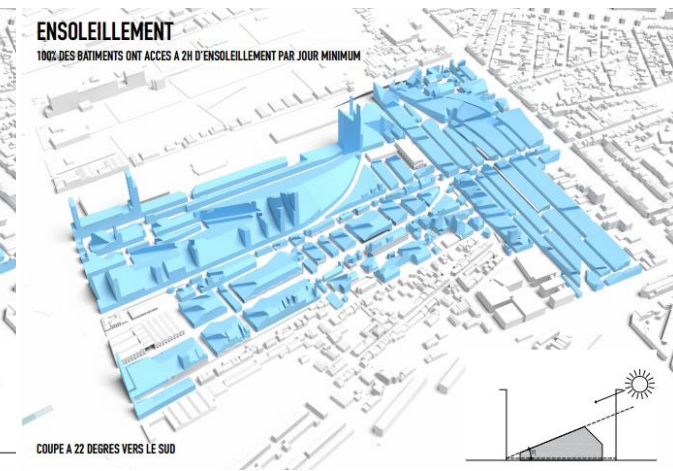
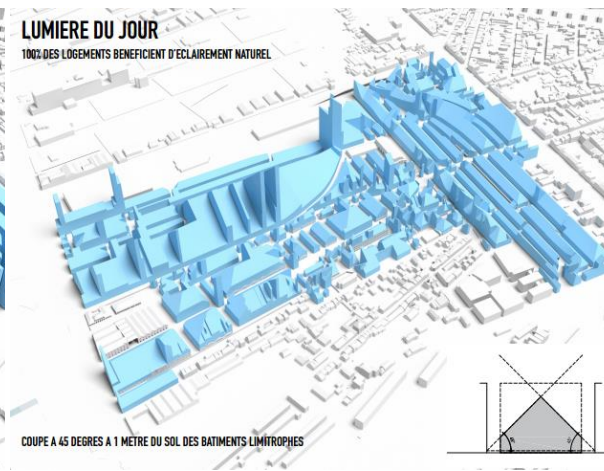
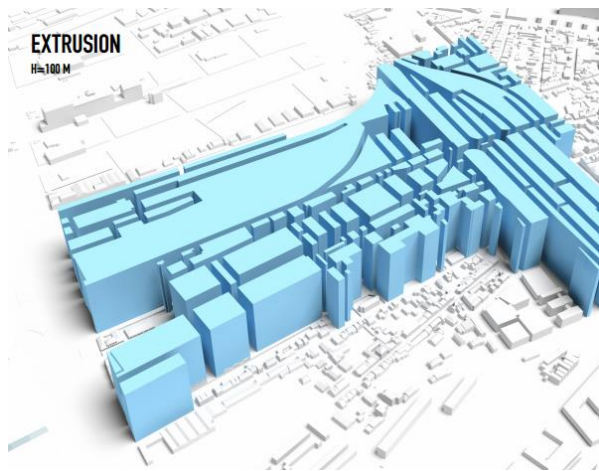


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DEMONSTRATION

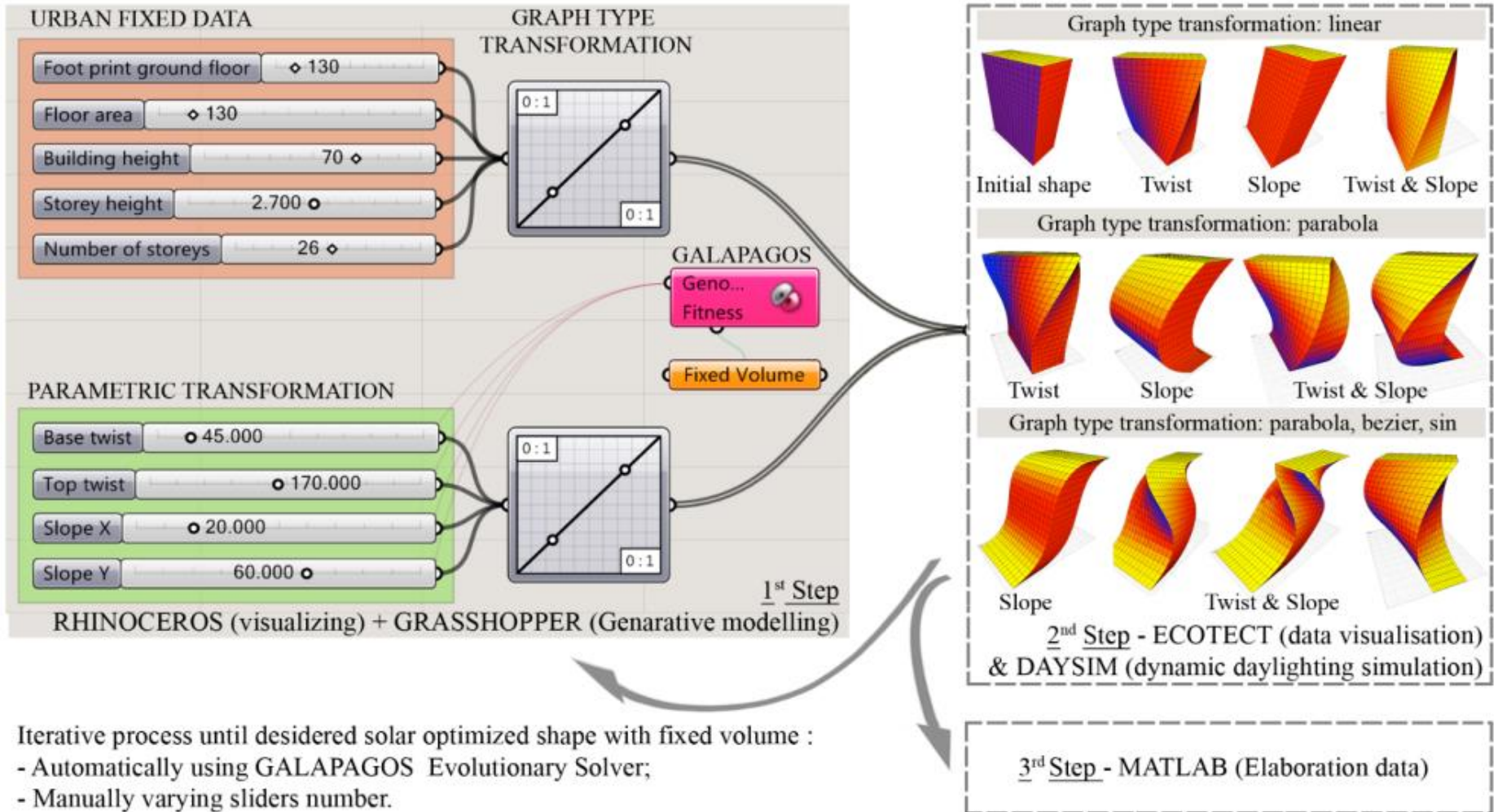


DISTRICT



BASTIDE-NIEL BORDEAUX_MVRDV

BULDING



Iterative process until desired solar optimized shape with fixed volume :

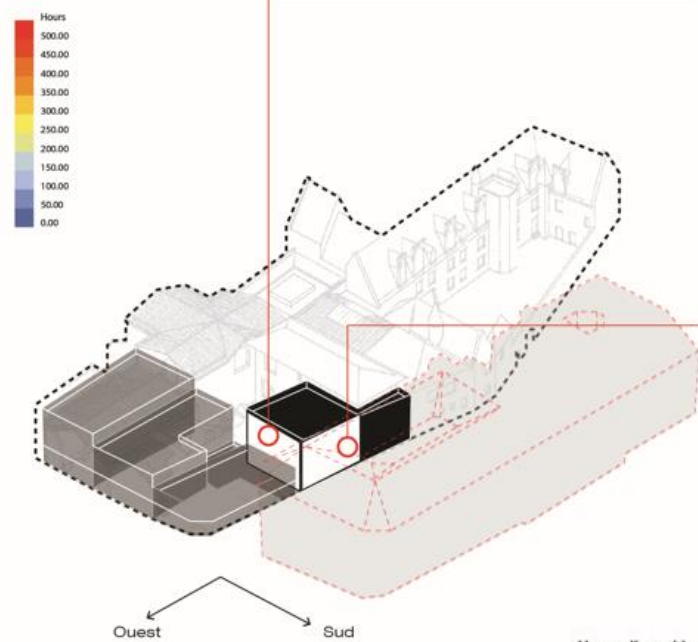
- Automatically using GALAPAGOS Evolutionary Solver;
- Manually varying sliders number.

Lobaccaro, G., Fiorito, F., Masera, G., Prasad, D., 2012. Urban solar district: a case study of geometric optimization of solar façades for a residential building in Milan, in: Proceeding of the 50th Annual Conference, Australian Solar Energy Society, Melbourne, Australia.

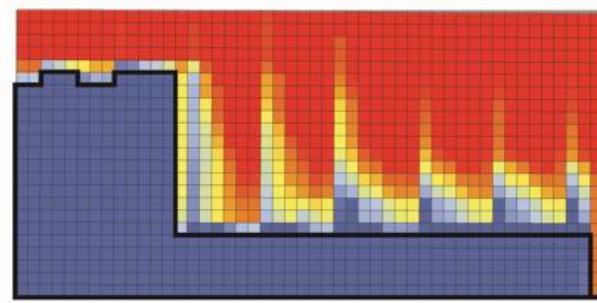
FACADE

Optimised sun-shadings from simulated data

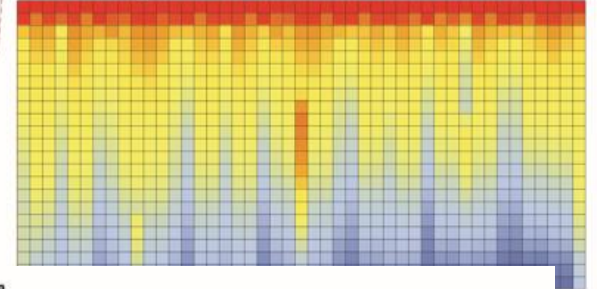
Analyse de l'ensoleillement sur les façades de Mai à Octobre



Façade Ouest Option 2 1 +Poutre perpendiculaires aux façades



Façade sud Option 2 1 +Poutre perpendiculaires aux façades



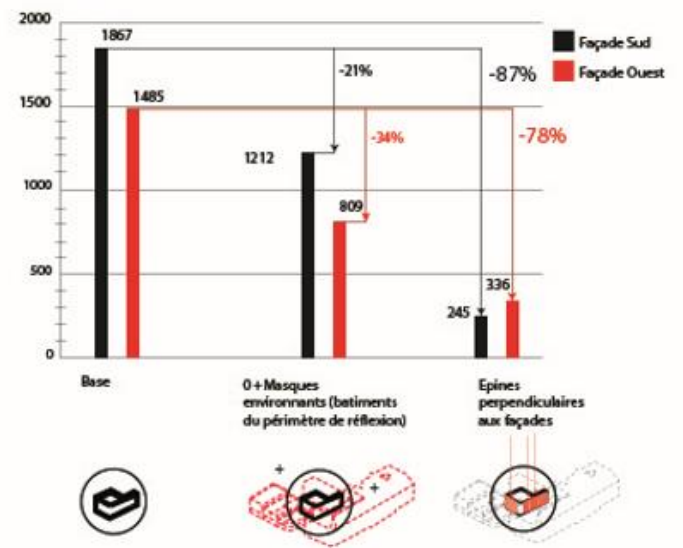
Paramètres d'optimisation

ORIENTATION

LARGEUR

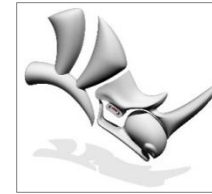
ECART

Heures d'exposition à l'ensoleillement direct en milliers

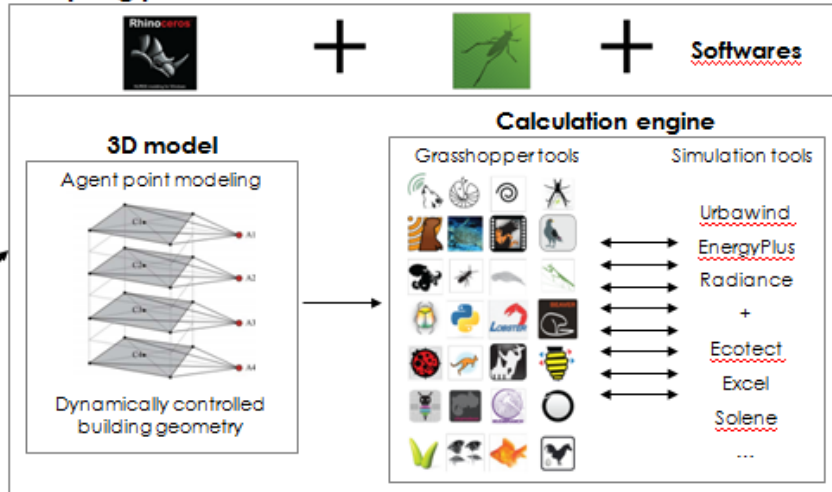


PLATFORM

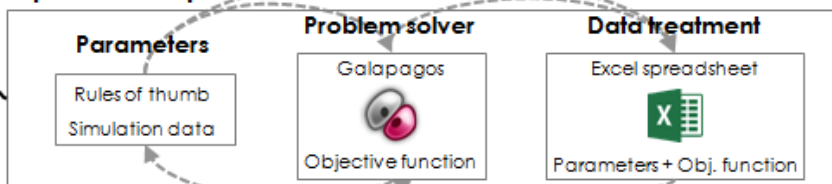
For coupling multiple tools/models



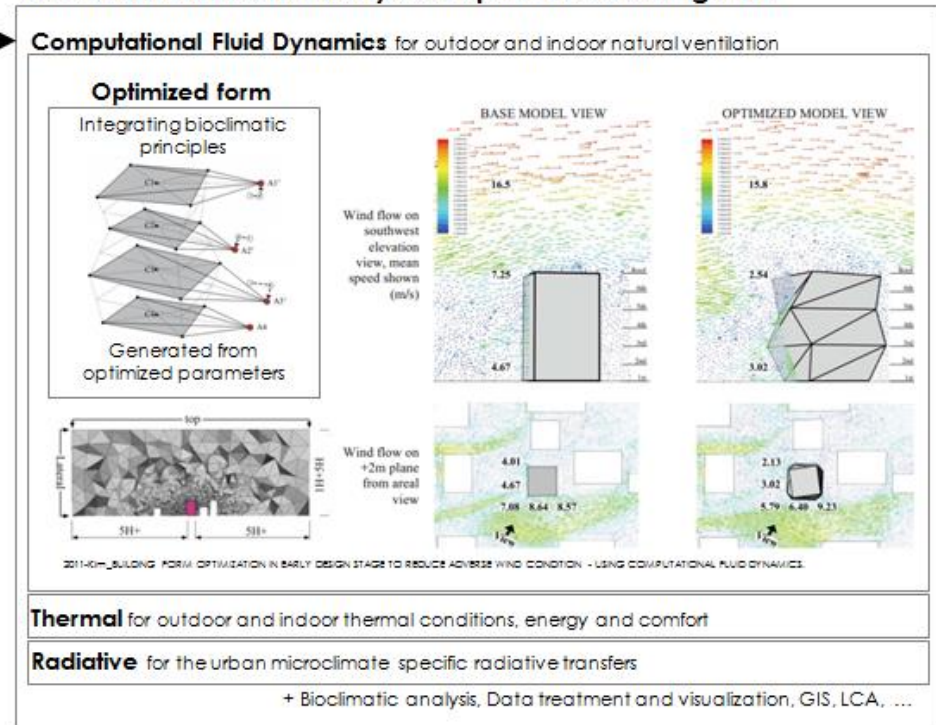
Coupling platform



Optimization platform



Global environmental study and optimized building form



Using SOLENE-MICROCLIMAT and its different models with Rhino-Grasshopper