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

Aymeric Delmas

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

Coupling multiple weather-based simulation models and tools via a Rhino-Grasshopper platform.

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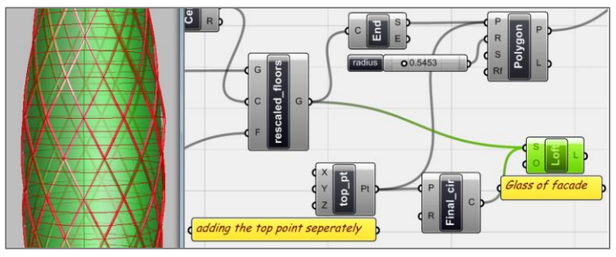
## Approach

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

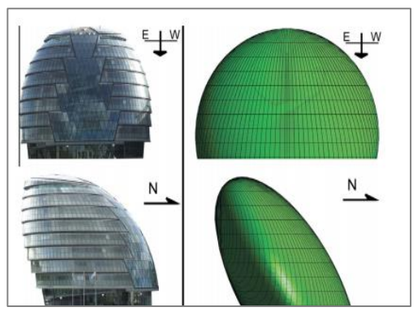
Grasshopper as a script-based Rhino plugin makes generating **complex geometries** easy. Architectural building designs belong to these complex geometries and are nowadays a reality.

Environmental sustainable building design requires the use of **multiple weather-based simulation tools** to assess the effect of the built environment on the local weather conditions.




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.

## Objectives

*How to design bioclimatic neighborhoods in dense tropical urban areas?*

Current design practice for buildings located in dense urban tropical areas imply multiple, independent and multi-scale models, tools and interfaces making continuity of the overall building environmental study (from mesoscale to microscale) impossible. This **modeling issue** makes the efficiency of passive design strategies adapted to tropical climates **uncertain**.

The **objectives** of the presented thesis are:

- To take into account both thermal and airflow transfers at the urban scale
- To improve currently available models ;
- To couple them ;
- To make them suitable for urban tropical microclimate simulation .
- To develop a unique, reactive and flexible environmental models coupling platform via Rhino-Grasshopper.

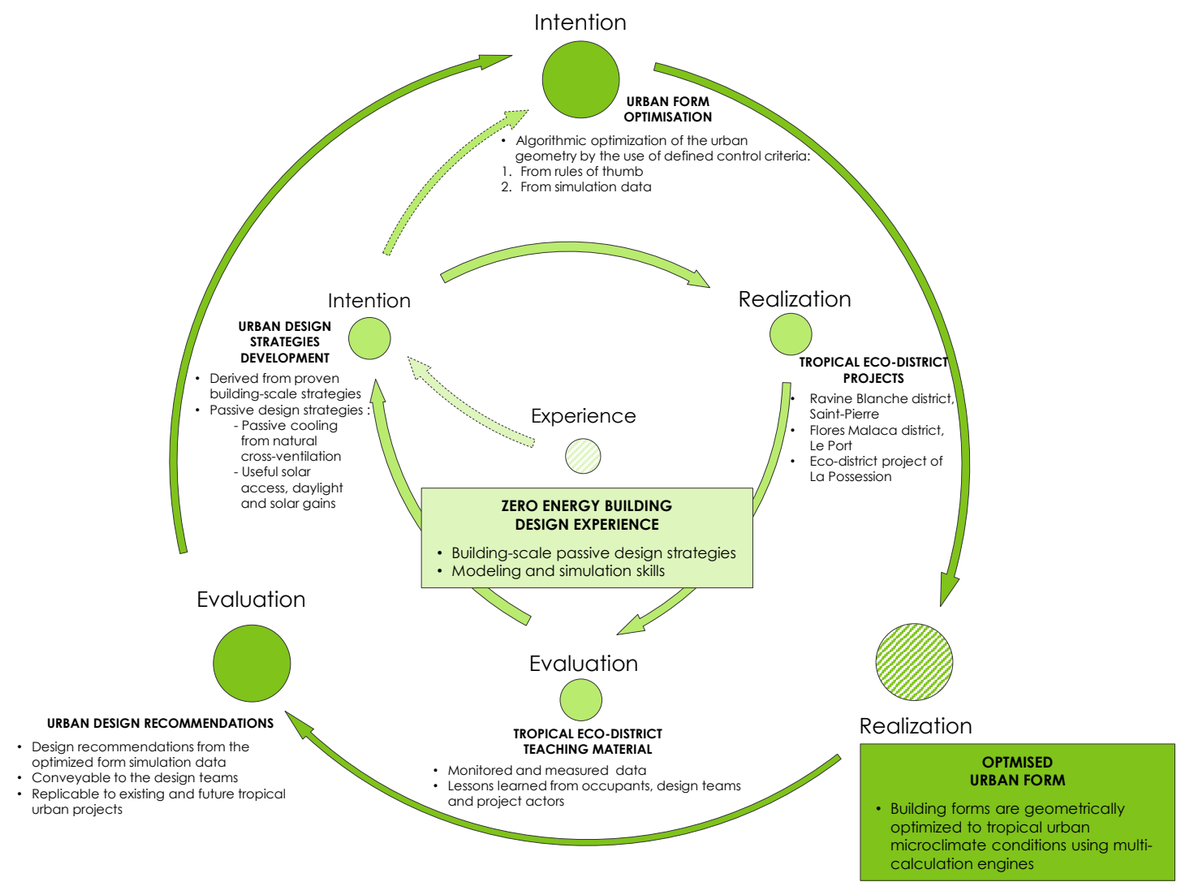
## Methodology – Design Process

*"Design is the process of realizing intentions."*

Developing design tools for morphology/comfort/energy coupled optimization involves a development methodology following a **global design process**.

This thesis' methodology is built around selected design principles and **experiences** drawn from zero energy built and monitored projects in the **tropical climate of La Reunion**. The methodology can be illustrated by the following spiral.

**From zero energy building design experience to passively optimized urban form.**

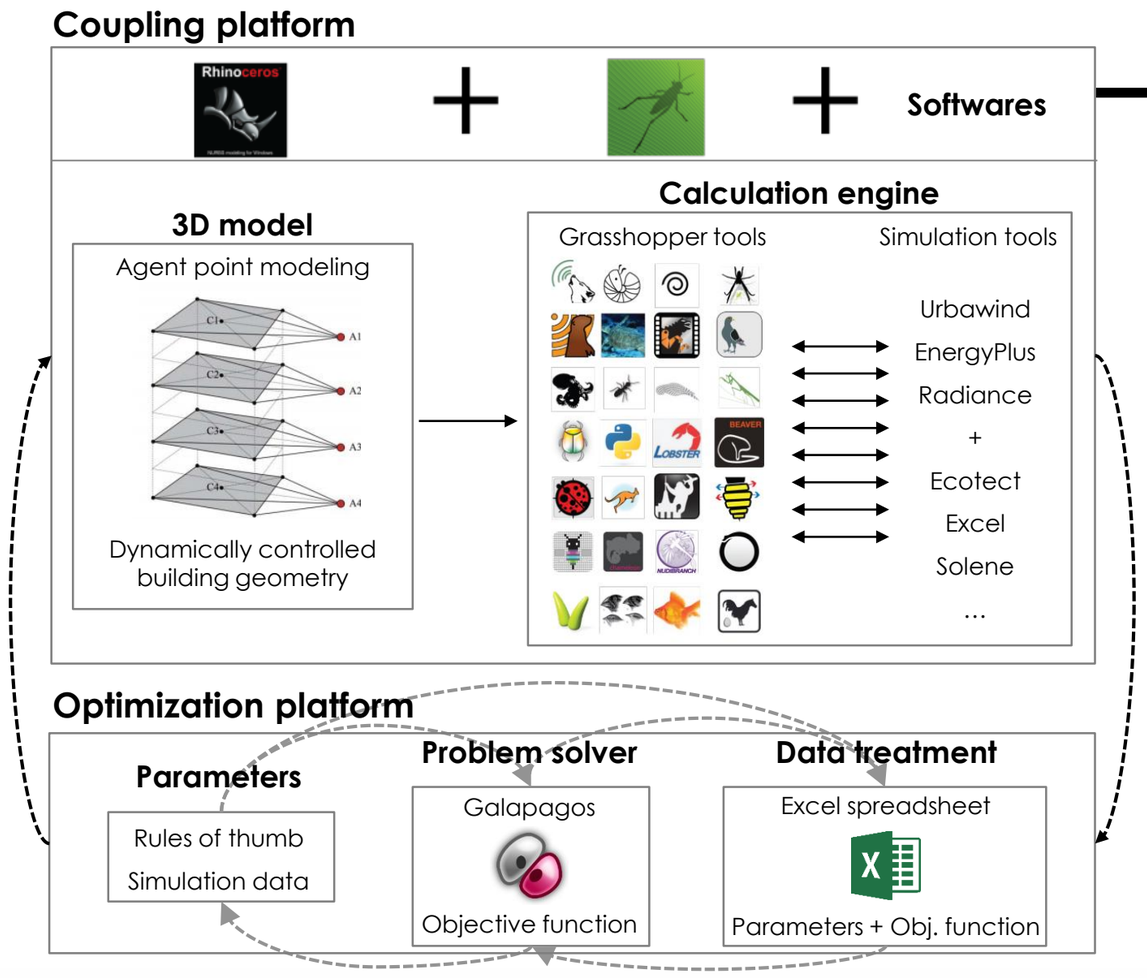



## Expected Results

The expected achievement of this thesis is a **coupling platform**, solving continuity (temporal and spatial) issues of current **global environmental study** of buildings in tropical urban areas.

It will use the great range of weather-based simulation tools to assess the impact of the urban microclimate on buildings, occupants and pedestrians' comfort and ultimately **optimize the urban form to passive design strategies**.

### Coupling platform

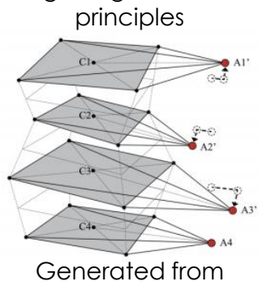



### Global environmental study and optimized building form

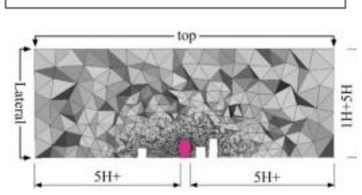
**Computational Fluid Dynamics** for outdoor and indoor natural ventilation

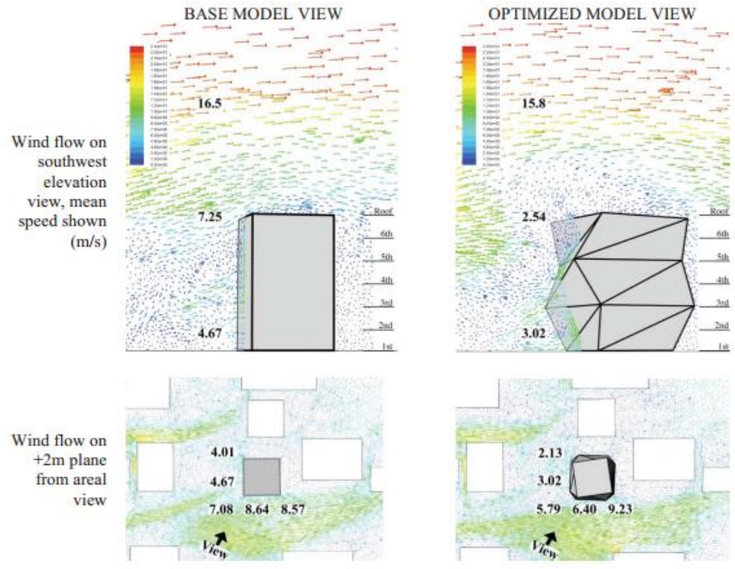
**Optimized form**

Integrating bioclimatic principles



Generated from optimized parameters






2011-Kim_BUILDING FORM OPTIMIZATION IN EARLY DESIGN STAGE TO REDUCE ADVERSE WIND CONDITION - USING COMPUTATIONAL FLUID DYNAMICS.

**Thermal** for outdoor and indoor thermal conditions, energy and comfort

**Radiative** for the urban microclimate specific radiative transfers

+ Bioclimatic analysis, Data treatment and visualization, GIS, LCA, …

Thesis director: Pr. François Garde, PIMENT, University of La Réunion
Thesis co-director: Marjorie Musy, CRENAU, University of Nantes

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