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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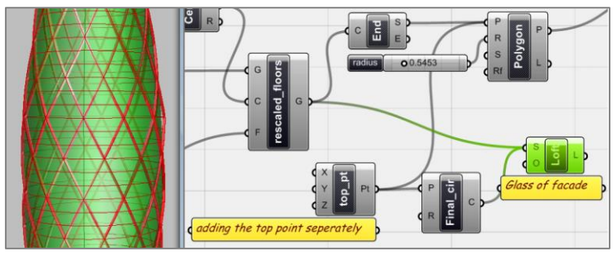
APPROACH

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.

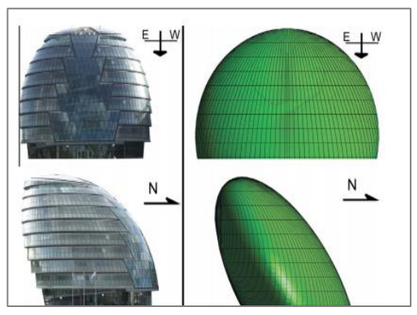
Grasshopper as a script-based Rhino plugin makes generating **complex geometries** easy. Architectural building designs belong to these complex geometries and are nowadays a reality.

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.

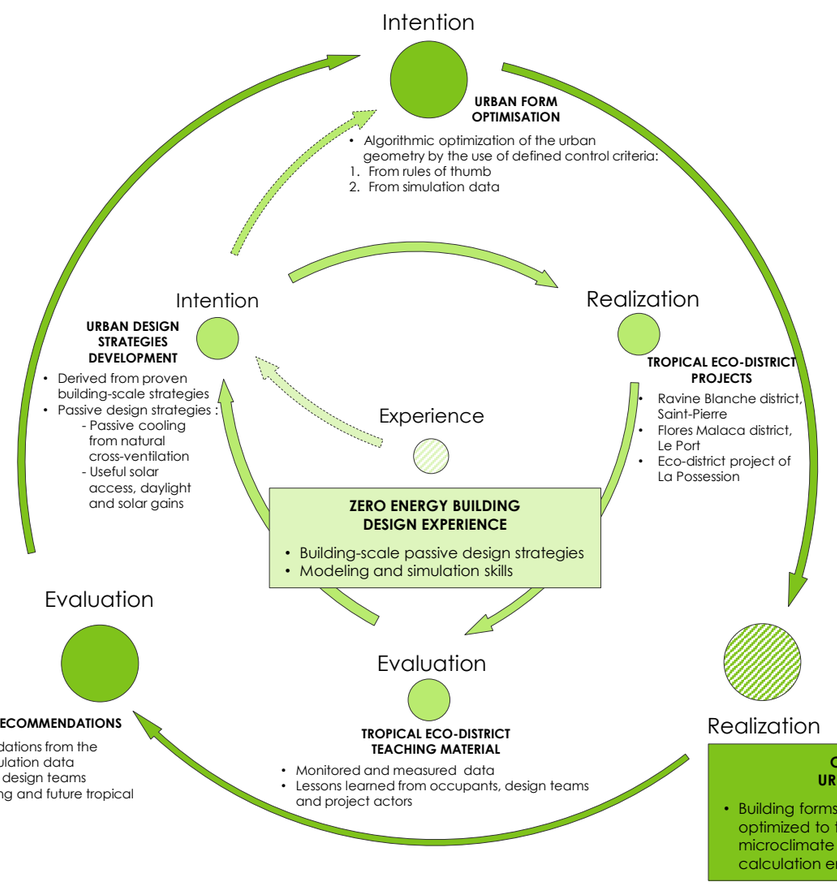
METHODOLOGY – DESIGN PROCESS

"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**.

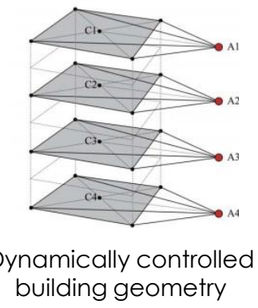
Coupling platform

Rhinoceros + Softwares

Calculation engine

3D model

Agent point modeling



Dynamically controlled building geometry

Grasshopper tools

Simulation tools

Urbawind
EnergyPlus
Radiance
+
Ecotect
Excel
Solene
…

Optimization platform

Parameters
Rules of thumb
Simulation data

Problem solver
Galapagos
Objective function

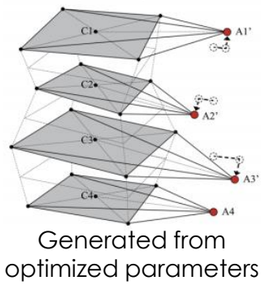
Data treatment
Excel spreadsheet
Parameters + Obj. function

Global environmental study and optimized building form

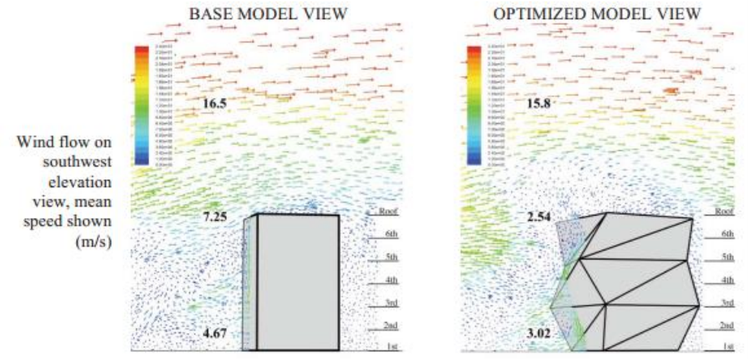
Computational Fluid Dynamics for outdoor and indoor natural ventilation

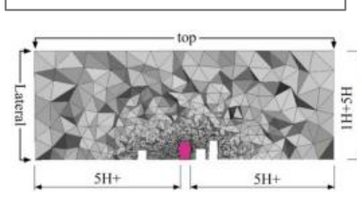
Optimized form

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, …

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Thesis co-director: Marjorie Musy, CRENAU, University of Nantes

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