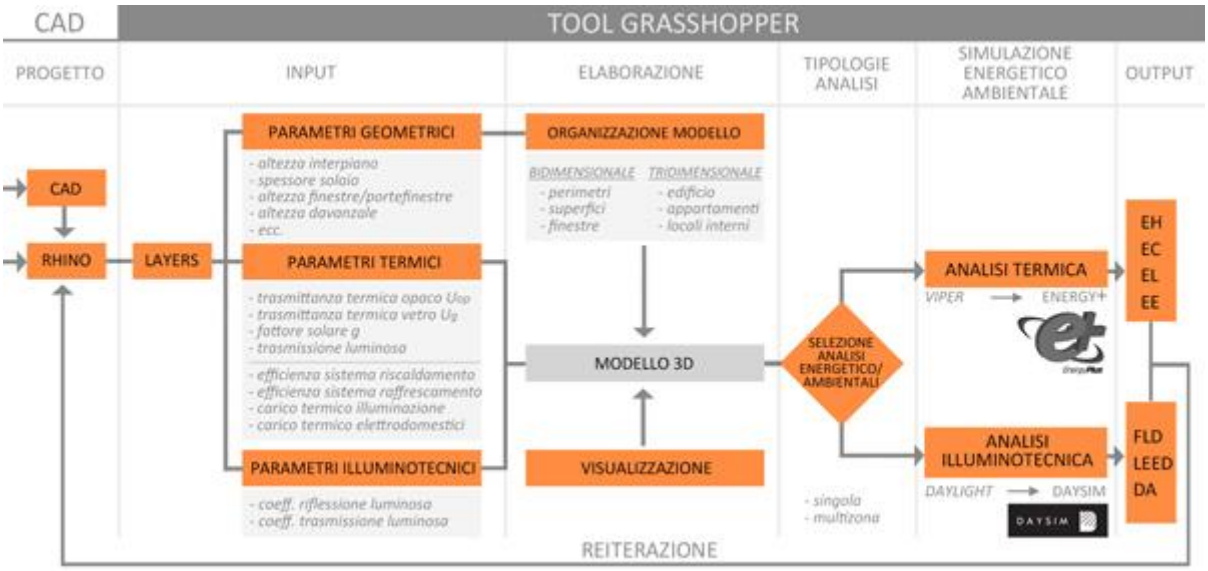
POLITECNICO DI TORINO
SECOND SCHOOL OF ARCHITECTURE
Master of Science in Architecture
Honors theses

A parametric approach to environmental-energetic analyses: development of supporting Tool for computerized architectural design

by Diego Giuseppe Sosello
Tutor: Valerio Roberto Maria Lo Verso
Co-tutor: Chiara Aghemo

Nowadays, buildings have become complex objects to plan and manage, considering the amount of requirements that must be satisfied for the purpose of energy saving and environmental sustainability. Therefore, tools capable of enhancing the interoperability between several applications are needed, in order to improve the efficiency and speed of the design process.

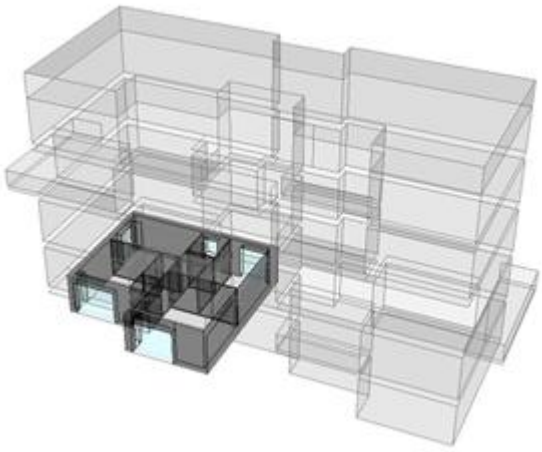
The goals of this work of thesis are the optimization of the architectural design using parametric modeling and interoperability between software related to several disciplines, combining the use of the plug-in Grasshopper, developed for the CAD software Rhinoceros, and the complex environmental-energetic analyses: the final result is the development of a Tool able to allow environmental-energetic analyses and planning/design to be carried out simultaneously and interactively, making it easier for the design team to assess if their solutions meet the standard requirements, dealing with a high number of outputs which come from external software such as EnergyPlus and Daysim.



Flowchart visualizing the use of the Tool and its connection with Rhinoceros and with the energy simulation process (Energy Plus and Daysim)

Achieving the building model through Rhinoceros (or importing that from other CAD software) and filling some input parameters allows the design team getting nearly in real time the energetic and lighting performance of the building. Moreover, modifying the geometric properties and physical/geometric parameters of two-dimensional model (which are input data of the algorithm) causes a reiteration of three-dimensional model of the building, visible on Rhinoceros canvas, and a updating of environmental-energetic results. In this way, monitoring of the building's performance is improved, achieving a considerable high number of output data, which simplifies the simulation process which would be otherwise necessary, according to regulations.

In order to test the Tool skills, a set of simulations have been carried out on a five-storey building project consisting of ten apartments. The apartment plans were different for each floor, changing spaces such as corridors, storage rooms and bathroom, in order to expand the number of case studies and to evaluate the versatility of the Tool in heterogeneous conditions. The building's volume is articulated by terraces and protruding/falling volume in order to test tool skills to shape a three-dimensional building model.



ANALISI ENERGETICA

Piano terra
Appartamento **1**
Superficie netta **77,40 m²**

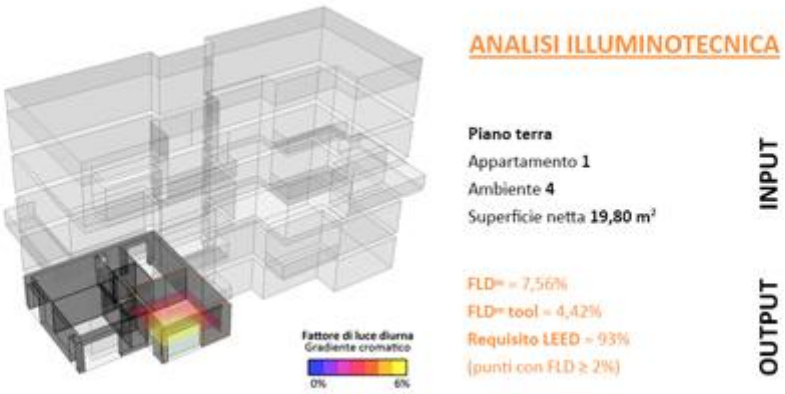
INPUT

Pareti esterne	U = 0,24 W/m²K
Solaio interrato	U = 0,31 W/m²K
Solaio esterno	U = 0,25 W/m²K
Trasmittanza vetro	U = 1,3 W/m²K
Fattore solare	g = 0,58

OUTPUT

Fabbisogno energetico per il riscaldamento **EHs**	54,46 kWh/m²anno
Fabbisogno energetico per il raffrescamento **ECs**	38,89 kWh/m²anno
Fabbisogno energetico per l'illuminazione **ELs**	25,07 kWh/m²anno
Fabbisogno energetico per gli elettrodomestici **EEs**	23,05 kWh/m²anno

Example of energetic analysis



Example of lighting analysis

For further information, e-mail to:
Diego Giuseppe Sosello: diego.sosello@live.it