

A multi-interface software designed to share geometries within different simulation tools

João Mariz Graça¹, João Bento², Helder Gonçalves¹

1. Laboratório Nacional de Energia e Geologia – Unidade de Eficiência Energética; Estrada do Paço do Lumiar, 22, 1649-038 Lisboa, Portugal
2. EFACEC – Rua da Garagem, 1, 2790-078 Carnaxide Portugal

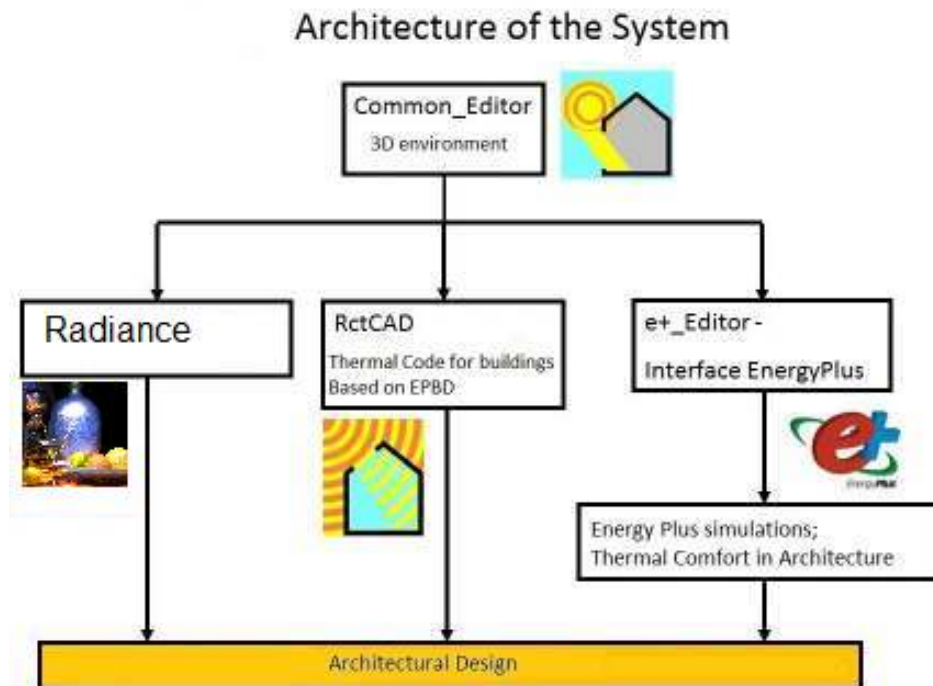
Introduction

- The performance requirements of buildings, imposed by the new regulations, have increased in number and complexity;
- There is now available an increasing number of powerful simulation tools that allow performance evaluations;
- However, these tools for simulation are often independent from one to another and each one requires independently an accurate and laborious work for defining the input ;
- Often to be used, these tools also need that the buildings under design are in a advanced state of definition.

Objectives

- The performance of buildings in terms of thermal and daylight comfort is an important issue for improving its sustainability, since:
 - Thermal and daylight comfort are often considered as Social Parameters that influence the sustainability of the building;
 - If thermal and daylight comfort are achieved with low energy use the impact of the building to the environment will be also lower;
- Architects are often criticized for not considering these parameters related to comfort during the design process;
- So:
- **How to give information to the architect to be used during the design process so that he can take the better decisions while sketching the shape of the building?**

Contribution to solve this issue

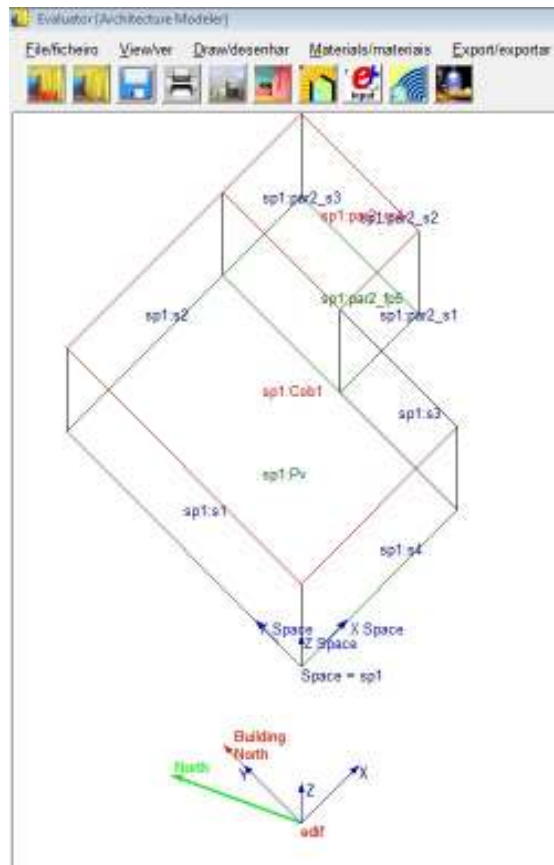


- A computer system that consists of a set of several programs that share both the same geometric definition and a consistent set of definitions for construction elements, **is under development**;
- The system consists of a common program allowing different types of exportation to other simulation programs or to other modules:
 - Interface with **Energy Plus** simulation program;
 - Interface with **Radiance** program, and;
 - Interface with **EPBD transposed regulations** to the Portuguese national codes for buildings

System developed using PROLOG

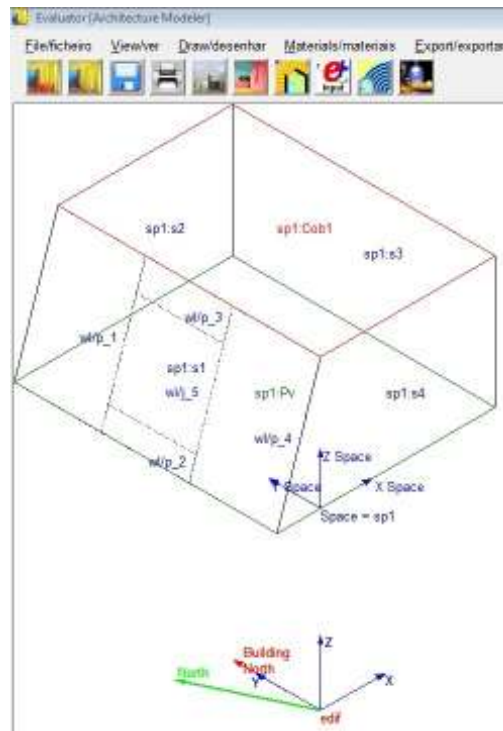
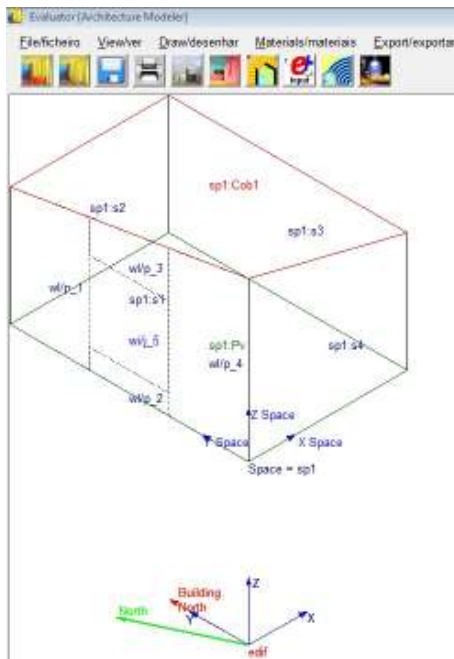
- System under development is implemented using the Swi-PROLOG/XPCE, a programming language with a hybrid paradigm that allows both knowledge representation and object oriented programming
 - Knowledge representation is used to implement some expert system like procedures and also to prevent errors;
 - Object oriented programming is mainly used in the Graphical User Interface which consists of a bar of menus, an icon bar and a 3D graphical editor where shapes are represented.

Common Editor Module



- This module pretends to be as close as possible to the traditional process of sketching the buildings shapes, by architects;
- Instead of a sketch drawn in a paper sheet the idea of a electronic sketch is implemented here, however with the 3D facility included, and also the evaluation of some performance parameters.

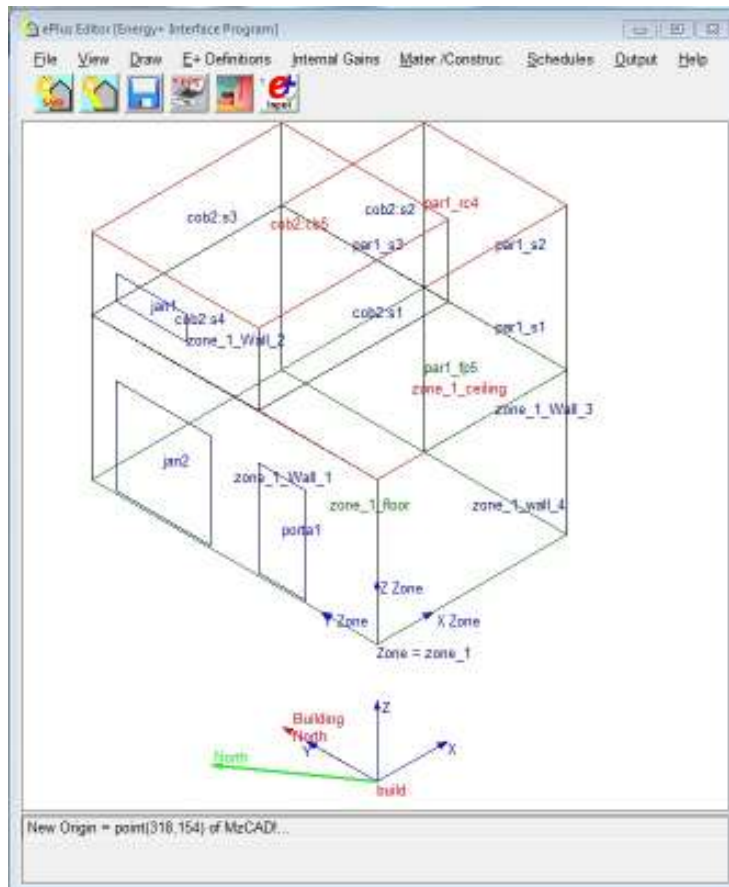
Common Editor Module



Main entity is the space – a “space” is built of several “common surface” objects (walls, roofs and floors) and “sub surface” objects (windows or doors);

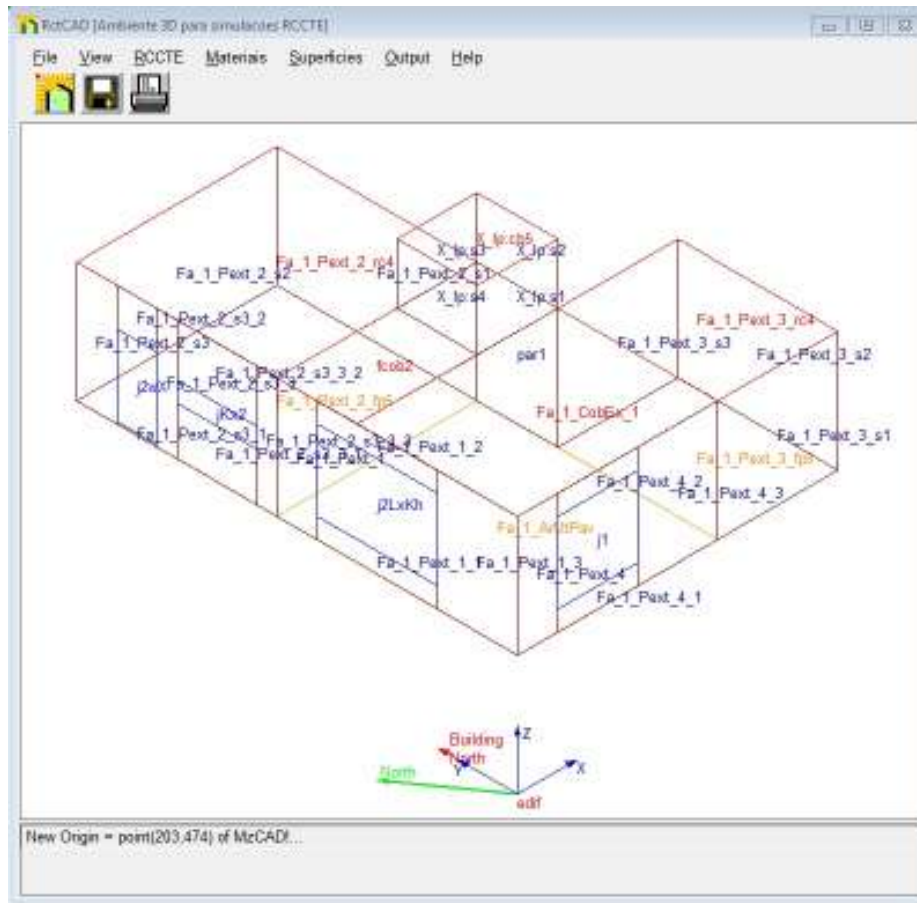
Windows are represented inside walls with dynamic points – a relation between the wall and the window is defined, and windows remain linked to that wall even when the wall is modified (tilted or stretched);

Energy Plus Interface Module



- The main entity conceptualized here is the “zone” – also the corresponding OOP object defined is the “zone”;
- When the user imports the geometrical definition from the common 3D Editor, if no groups are defined “spaces” are automatically converted into “zones”, otherwise groups of “spaces” will correspond to new “zone” objects inside this environment;
- Also exports the text files for radiance further evaluation.

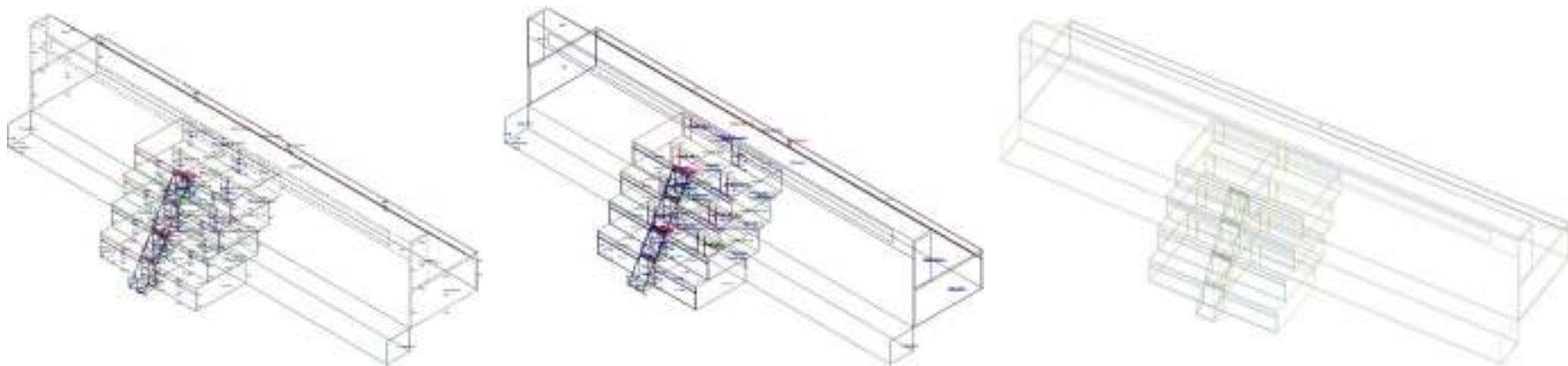
EPBD interface Module



- The main entity conceptualized here is the “dwelling unit” (Fracção Autónoma). Similarly to the “zone” entity of “energy plus” interface 3D editor; if “spaces” are grouped, each group will be exported from common 3D Editor as a “dwelling unit”; otherwise every “space” will be included inside a unique “dwelling unit”;
- This module will allow to check the compliance with the Portuguese Thermal Regulation for Buildings which is based upon European Directive EPBD Energy Performance of Buildings Directive

Example of exporting

- From “common Editor” to “Energy Plus interface” and;
- From “E+ interface” to Energy Plus



Common_Editor
representation
of the building

Energy Plus
Interface
representation

Autocad 3D file
generated by Energy
Plus

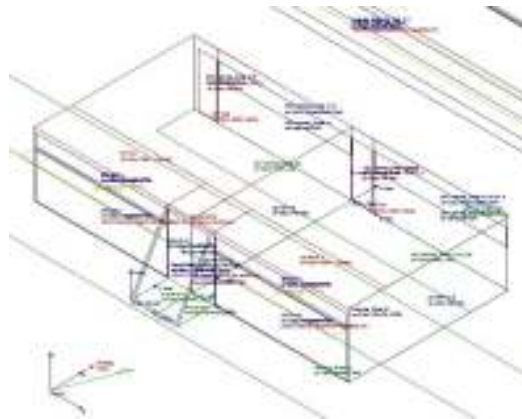
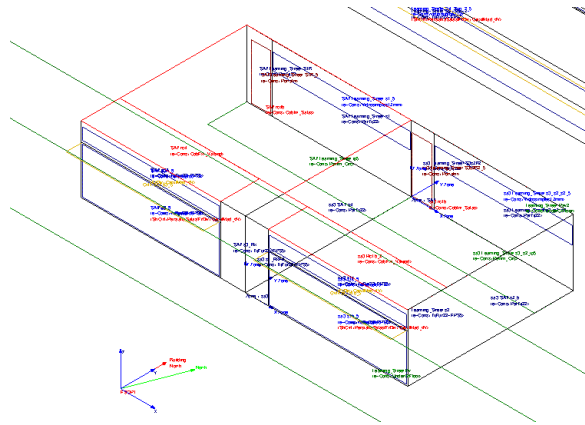
Example of simulation for sustainability

- This work also pretends to be a method for designing with sustainability;
- Designing the shape, construction and passive systems of a building by reasoning about thermal comfort.

Definitions used in simulations – according to EN 15251:

- Occupation schedules: from 9:00 to 14:00 and from 15:00 to 18:00,
- Metabolic rate: 1,2 met = 70W/m²
- Clothing level of insulation:
 - Winter: 1,0 Clo = 0,155 m²°C/W,
 - Summer: 0,5 Clo = 0,078 m²°C/W;
- Air velocity: 0,2m/s;
- Minimal air change rate: 4,2 l/s,m² => Rph = 5,6^{-h}

Results

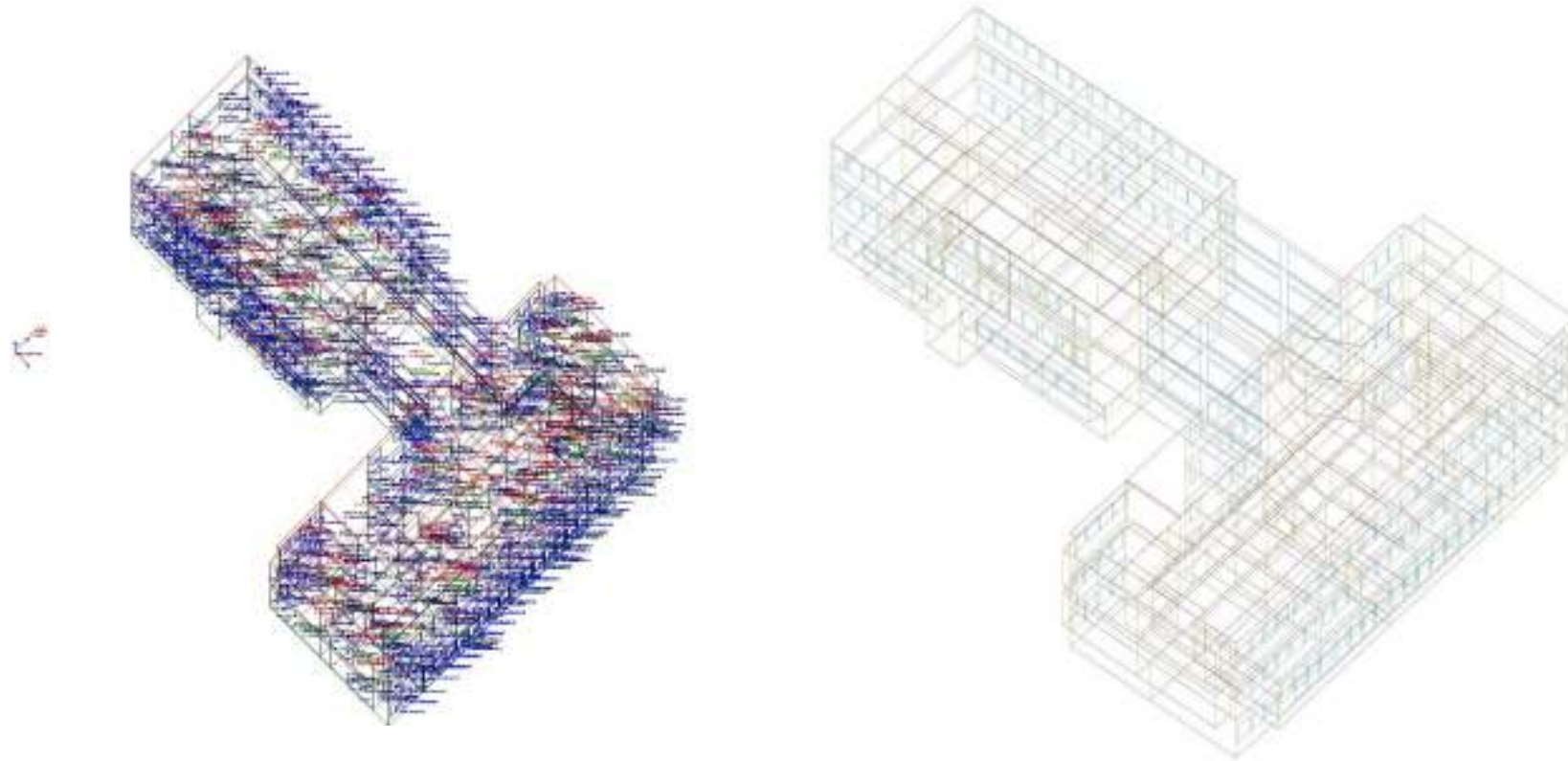


Winter	Operative Temp. during 95% of time	Comfort Category
Initial Solution	13,77°C	IV
Sunspace	21,48°C	I

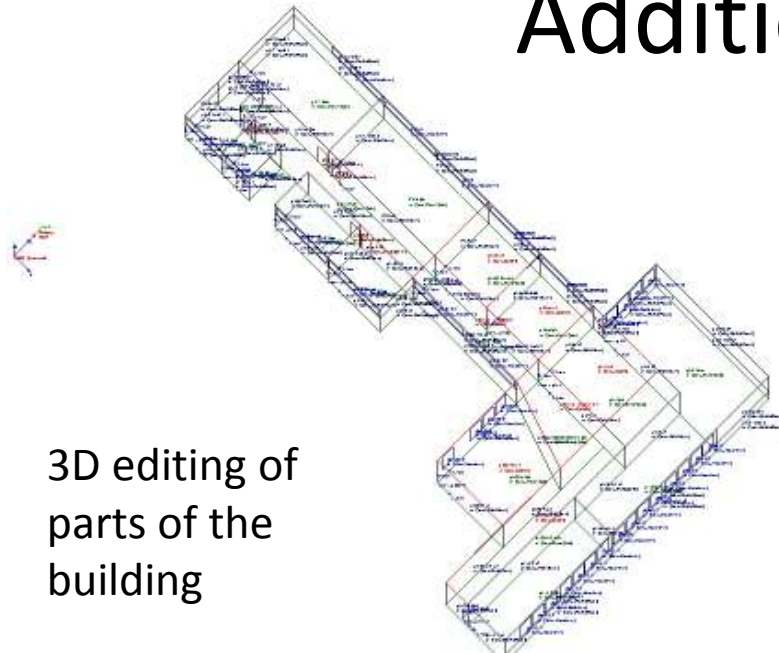
Summer	ΔT Operative during 95% of time period	Comfort Category
Initial Solution	4,31°C	Doesn't fulfil the standard
Earth tubes	2,93°C	II

Example – LNEG, S. Mamede de Infesta

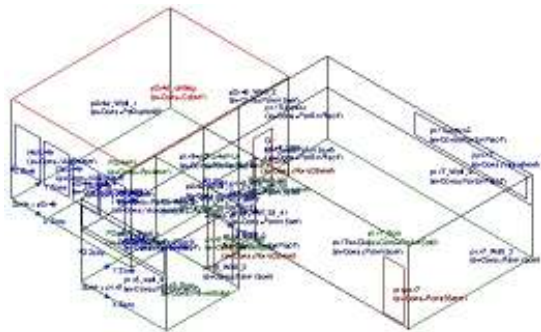
- From E+Plus Interface to E+ simulation



Additional facilities



3D editing of parts of the building



- **The module has:**
 - Tools for 3D editing;
 - Tools that allow further e+ plus object definitions:
- **As mainly designed for architectural conception this interface program is restricted to the some energy plus objects, considered more important, such as:**
 - 3D definitions of building geometries;
 - Construction;
 - Passive systems;
 - Daylight;
 - Thermal comfort
 - Ideal system

Discussion

- Nowadays there is several software programs that allow interfaces with simulation programs like energy plus and Radiance, like for instance: ecotech, google sketchup and openstudio, simergy, etc.
- however the program under development, since it is developed with PROLOG, it can allow the development of expert systems procedures – An algorithm, using the Portuguese thermal code for buildings of 1996, that searches the best construction solutions for a given shape of a building was developed in 1999 using PROLOG,
- This program also will allow the performing of calculations for Portuguese thermal code for buildings

Conclusions

- The use of this system proved that:
 - it could contribute to reduce the time spent in simulation tasks, particularly those of graphical representation;
 - it can be used as a design tool for architecture conception and so can contribute to improve sustainability of buildings while being designed.
- Some tests have revealed that different distribution of spaces in the plan of the building lead to different results in terms of thermal comfort, so it can be concluded that it is very important to test different architectural shapes while designing in order to achieve better solutions in terms of buildings sustainability.