Computational Materiality in the Early Stage Design for Sustainable Architectures
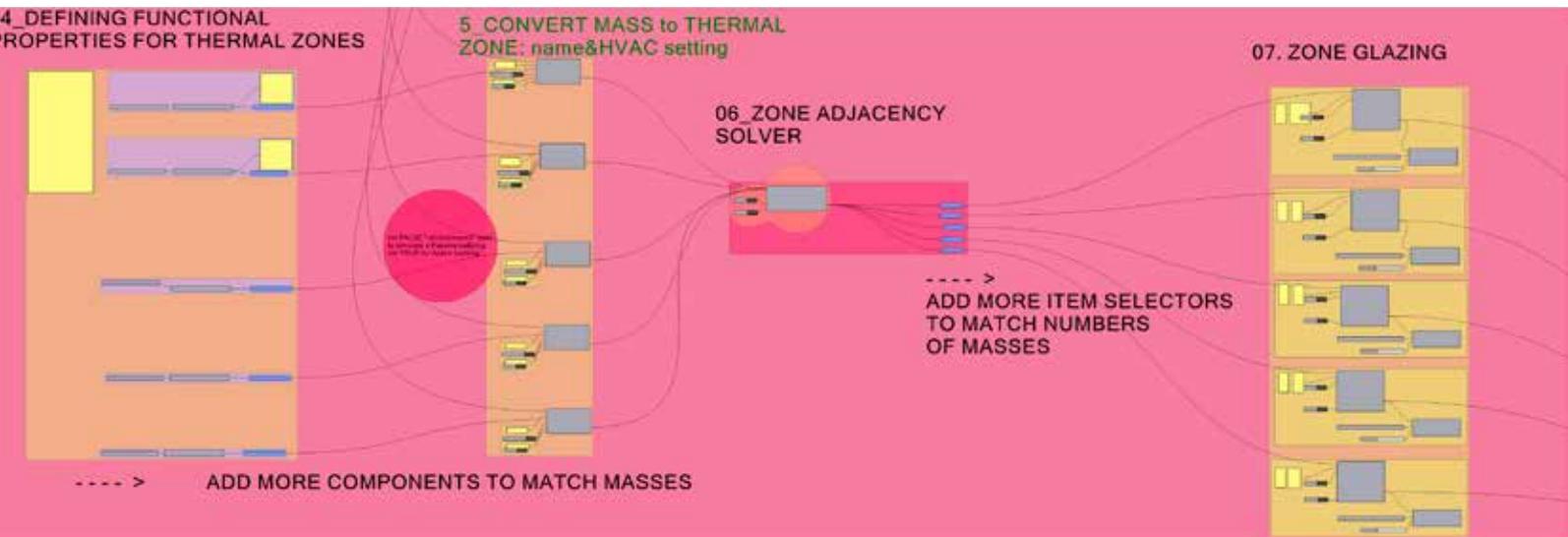
ENVIRONMENTAL MASS OPTIONEERING USING GRASSHOPPER-HONEYBEE

Prof. Giuseppe Ridolfi, PhD
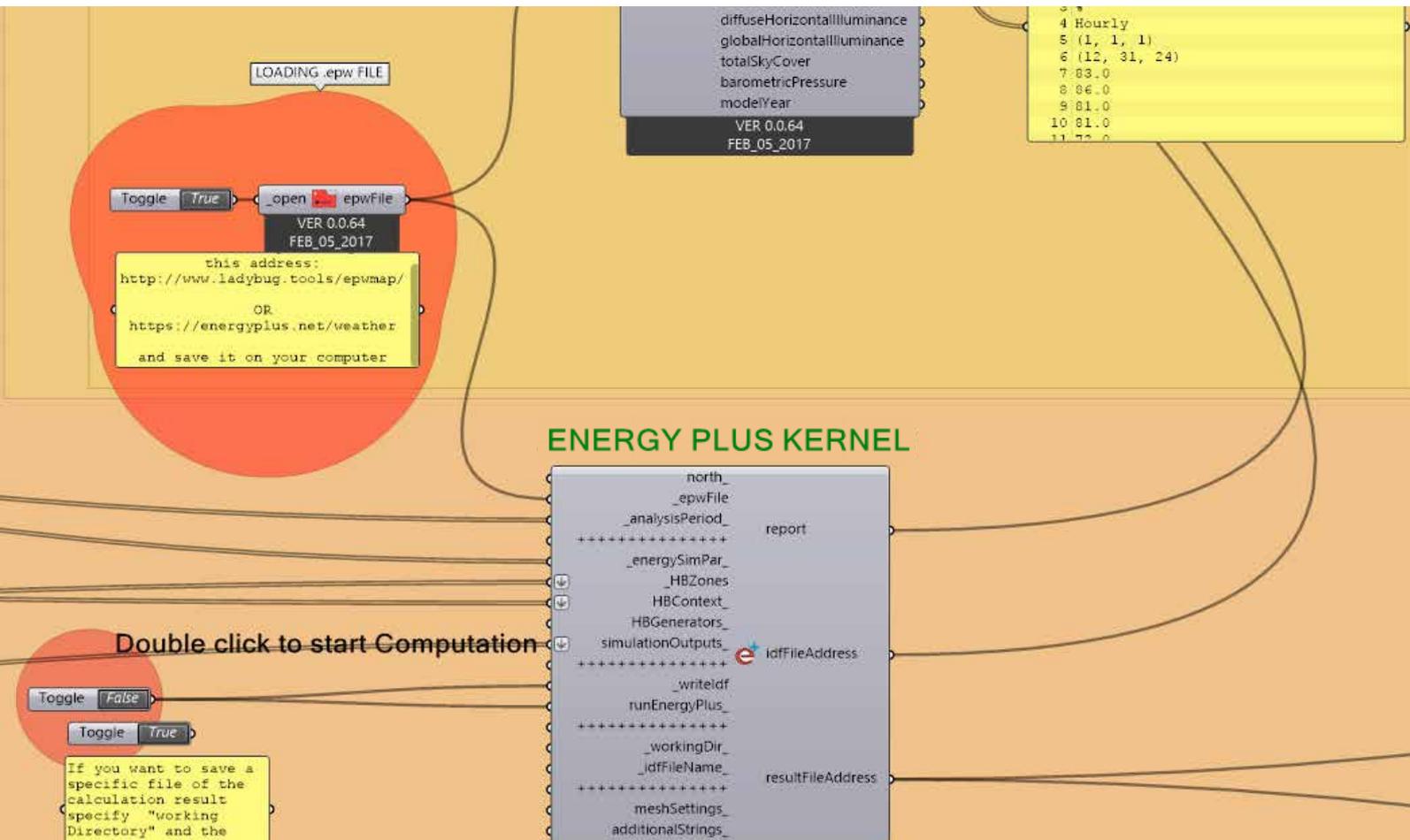
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CLIMATE ZONE IDENTIFICATION

To design a building able to preserve the environment and exploit the available natural resources the first thing to do is the knowledge of the climate zone in which the building will be located. Internationally, the Koppen-Geiger Climate Classification is the most diffuse system which offers us specific indications covering the whole world.
https://en.wikipedia.org/wiki/Köppen_climate_classification
According to the detected climate zone it will then be possible to select, from the scientific literature, the most appropriate design strategies. (see M. DeKay, G.Z. Brown, Sun, Wind & Light, Wiley III ed. 2013)

Another system is the ASRHAE classification system, developed in the USA, that can be extended by analogy to other parts of the world.
https://www.wbdg.org/resources/building-enclosure-design-principles-and-strategies

In this case, for each climatic zone, the ASHRAE Agency has defined corresponding technological solutions for the building envelopes that are also present, by default, in the majority of energy software. As the design strategies have been identified, this second method can therefore be useful for detailing the technological solutions of the project.

The climate zone can easily be determined using the following Grasshopper-Honeybee patch
http://www.mailab.biz/wp-content/uploads/4.GRASSHOPPER_PATCH-ES/01.HBCLIMATE_ZONE_DEFINITION_.gh

ENERGY SIMULATION

For a more detailed analysis able to evaluate different design options it is possible to carry out specific simulations in a computational way.

To conduct this type of analysis run the two Grasshopper-Honeybee patches using Energy Plus* kernel

*) EnergyPlus Documentation-Basic Concepts Manual - Essential Information You Need about Running EnergyPlus is available on:
https://energyplus.net/sites/default/files/pdfs_v8.3.0/GettingStarted.pdf

01. THERMAL ZONES ENERGY CONSUMPTIONS & PASSIVE BEHAVIOURS VISUALIZATION

http://www.mailab.biz/wp-content/uploads/4.GRASSHOPPER_PATCHES/02.HBTHERMAL_ZONES_ANALYSIS_.gh

This patch makes it possible to transform any architectural mass, suitably created, into different thermal zones and to visualize consumption and comfort conditions.

In order to conduct the analysis correctly it is necessary to observe the following recommendations:

1. Design your building with simple masses in metric unit (!). Since Energy Plus does not work well with non-convex casting surfaces it will report errors. Although this problem will not affect the thermal analysis (only the lighting analysis) it is advisable to break down all the volumes into convex by breaking it up into a set of smaller component surfaces that are each convex. For example, an L shape should be decomposed into two simple volumes.

Once the mass is completed, import it on Rhinoceros software (or design it directly into this software); select all volumes and assign them to the Brep component of Honeybee .

During this action taking care to set "multiple breps" and "internalize data" so you can then delete or hide the volume in Rhinoceros preserving the mass in Grasshopper. When you reopen the Grasshopper file the volume will be still available.

For more accurate analysis is also possible to import and to consider contextual volumes.

2. In the beginning, carry out a passive analysis in order to verify the building behavior without any contribution of the HVAC system. To operate in this way set "false" the "ISconditioning" node and assign some basic functional use such as deposit to each thermal zone in order to avoid any internal load or other energy sources. Try different building orientation using True North, test specific analysis periods and compare the "Operative comfort temperature" output for each solutions. To set the analysis periods in the most effective way, use the hot/cold weeks of the year indicated in the "Getting climate zone reference" section.

More detailed specifications are described inside the patch.

3. Subsequently, and if necessary, modifies the architectural volume in order to host the activities in the most suitable thermal zones.

Assigns the HVAC system, setting "true" the "ISconditioned" component, and the real functional destinations to each thermal zone.

Run the simulation and compare the total consumption of each architectural solution. More detailed information can be obtained from gain/lose values of each thermal zones and from comparing the different type of consumptions (heating, cooling, lighting, equipment,..).

02. ENVELOPE SURFACES ENERGY ANALYSIS

http://www.mailab.biz/wp-content/uploads/4.GRASSHOPPER_PA-TCHES/03.HBENVELOPE_SURFACES_ANALYSIS_.gh

In this module temperatures and energy flows of the building envelope can be extracted either in a unitary way per square meter and in total. These results offer the possibility of evaluating types and amount of insulation or louver system for each part of the building envelope such as walls, roofs, and windows. For this reason it is good practice to use this patch in a more advanced phase of design when it is required to evaluate the technological solutions. In fact, although in this patch it is not possible to assign any specific technological solutions, the visualization of the parts more or less energetically solicited can be a valid help in decision making.

03. ENVERGY SIMULATION FULL PATCH

http://www.mailab.biz/wp-content/uploads/4.GRASSHOPPER_PA-TCHES/00.HBENERGY_ANALYSIS_GLOBAL.gh

This patch collects the previous three in order to conduct all the anailis in the same operating environment. Please note that the larger size may result in higher processing times.

In any case, it is good practice to activate the results visualization one at a time and to deactivate the energy plus calculation engine whenever you want to make changes to the model or to the analysis parameters. This will avoid unnecessary recalculations with long waiting times.

link
• Energy modeling with Grasshopper. Plugin installation & Tutorials playlist
http://www.mailab.biz/smart_green/

• Quick start with HoneyBee and how to set True North

httpp://www.youtube.com/watch?v=ubkHdERn8a8

• Grasshopper basics. Tutorials from the program developer
http://www.mailab.biz/grasshopper-basics-with-david-rutten/

• How to set the appropriate analysis period and users'requirements
http://www.mailab.biz/lab_-ambientale-07-08/

• BREP - Boundaries representation Fundamentals for geometry modeling
https://www.youtube.com/watch?v=sXbRT439vRI

• How to solve surfaces adjacency and intersection.
https://www.youtube.com/watch?v=cDvBWDA0aF0

• Simple Conceptual Mass. Automatic floors and mass thermal zones generation
https://www.youtube.com/watch?v=DClON71RuuA

• Curvilinear mass planarization in EnergyPlus geometry.
https://www.youtube.com/watch?v=nMQ2Pau4q6c