Heva so clever!

David Chadwick explains how Bentley's Hevacomp Simulator V8i provides an enhanced tool for measuring building performance

I read an interesting press release this morning that gave details about two schools in the UK that had exceeded their carbon targets by significant margins. Apparently, 65-70% of the actual carbon footprint of these schools is derived from electricity consumption.

The approach taken by LowC - the scheme that the schools in question operate - uses combined heat and power (CHP), delivering a substantial portion of the heating and electrical requirements of the school from renewable resources. Under current planning regulations terms, these two schools need to reduce their carbon emissions by 90%, according to 2002 Part L building regulations, to comply with targets that require them to operate at a carbon intensity of no more than 27kg CO2/m2/year.

The source of their fuel is rape seed oil, a bio-fuel that is grown as an intermediate crop to standard food crops. The boilers will provide 60-70% of the electricity the schools use, and more than enough heat for their needs. All of this is part of a calorie-controlled diet as well, of course, as each school's structure also needed to be designed using technology that conserves energy usage.

Bully for them - and I don't wish to enter into the discussion regarding bio-fuel crops versus bio-feeding crops here. This will become of greater significance if the approach catches on and we decide to find more of our electricity from bio-fuels, as well as use them to power our cars and aeroplanes. However, the part that is of interest to us is the greater use of standards and techniques for evaluating the energy performance of a building before it is constructed. Irrespective of the tools we use for lighting and heating, our resourcefulness in discovering alternative methods of generating electricity will be wasted if the buildings, themselves, squander those resources.

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To find out whether energy is being squandered and we are shooting great loads of carbon dioxide into the atmosphere, we need to simulate the behaviour of a building throughout a typical year. That involves building a simple model that defines all of the floors, walls and roofs of a building and the materials used for their construction, including insulation properties, light admittance (windows), and other properties.

To that can be added where it is to be built, so typical weather conditions, supplied by meteorological centres worldwide, can be applied to provide sample weather, day or night, for the whole year. And, finally, we can add the artificial sources of heating, ventilation and air-conditioning that complement the natural environmental conditions. With data from each of these sources to hand, we should be able to perform a satisfactory building energy analysis.

Although we can take a 3D model from any other major CAD source, we can also create a sufficiently detailed model of both the core construction of a building and its plant within Bentley's Hevacomp Mechanical Designer, using that as the input for running simulations. Keeping the design and the simulation within Hevacomp also allows engineers to conduct analyses at an earlier stage in the design, and also to take advantage of all of the data being held in a coordinated database.

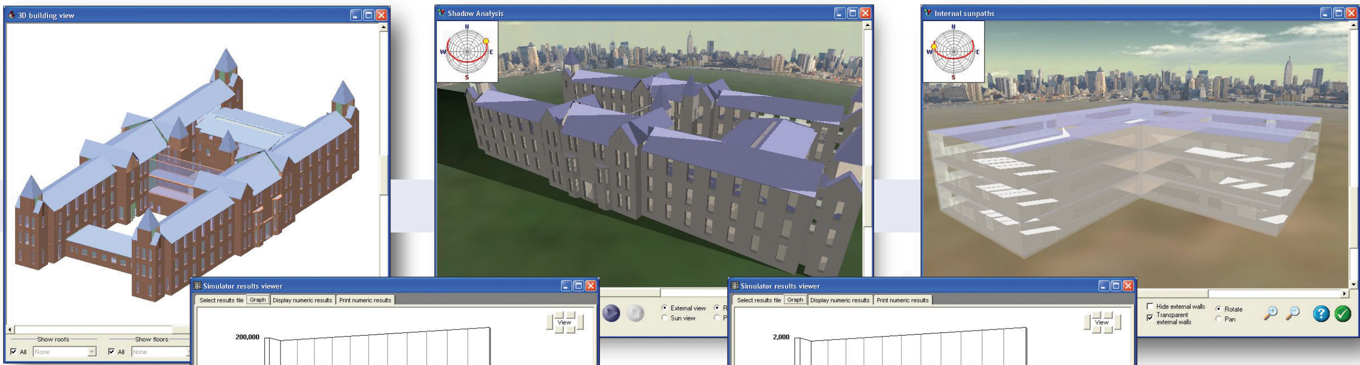
The structure is modelled by tracing the internal perimeters of rooms and adding partitions and walls from databases of construction elements. Roofs and floors are modelled similarly, enabling consultants, design contractors and MEP engineers to create complex structures, with a bit of help from the software that enables walls and other features to be trimmed automatically to fit floors and roofs. This creates a full 3D model comprised of a full complement of spaces, the only geometry that the simulation recognises - as simply as tracing in 2D.

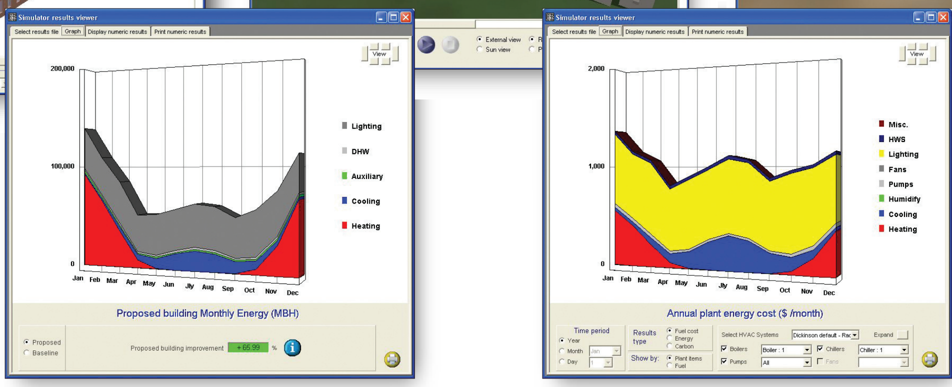
Once the building has been set up, a range of conditions can be simulated using Hevacomp Simulator V8i, a dynamic simulation module used with Hevacomp Mechanical Designer V8i that incorporates EnergyPlus, the most efficient, powerful and widely-used simulation engine. The software can predict heat losses and gains, whether the building or individual rooms will overheat during the summer months or freeze in winter, how often temperatures exceed specified maximum amounts and the general building energy.

The visual evidence of the results of its calculations can be quite compelling - such as the production of 3D external shading graphics and internal solar penetration - literally showing the paths of the suns rays entering the building, and the amount of energy they impart.

Hevacomp Simulator V8i can provide steady-state analyses or work on more

Creating a full 3D model comprised of a full complement of spaces, the only geometry that the simulation recognises, as simply as tracing in 2D





Annual energy consumption levels

passive designs. This can provide results where natural infiltration is complicated by the fact that occupants can open windows if it gets too warm! It's all meat and drink to the simulation software though, which can analyse quite complex natural and mixed mode ventilation systems, including the controlled opening of windows - using a range of FEA, CFD and other simulation tools.

To comply with the various standards for occupancy in each country (with Part 2002L, mentioned above, just happening to be one of ours in the UK) and quite apart from giving designers a tool that will enable them to produce a building that is comfortable to live and work in - engineers can enter the temperature schedules and profiles required for each type of building - a classroom would obviously require a profile that's different from that of a warehouse. The building simulation takes the profiles of each into account and provides an analysis of the energy requirements for each structure.

But hang on a minute! That is just one part of the picture. We need to include the heating and ventilating system as well. In addition to the large amount of weather data - provided by Hevacomp from 7000 locations worldwide - the simulation has to include the HVAC plant.

Using plant simulation, similar to building simulation, and also part of Hevacomp Simulator V8i, this can be simply defined to include such features as radiators, constant volume air conditioning, fans, boilers, chillers, cooling towers and so on - all from a similar database of common plant and equipment. All you need to set it up is a brief set of HVAC data and the software will set up the required components, including the pipes and ductwork for the water and air networks and the central plant. EnergyPlus close-couples the plant with the building spaces, comparing its performance against how the building responds.

Using the module, you can actually size the plant you will need in order to meet the performance criteria you have set up, calculated right throughout the year. You can then use it to compute an annual energy consumption, together with fuel costs and CO2 emissions.

HEVACOMP SIMULATOR V8I

Of course, Hevacomp Simulator is not new. It has been nicely updated though, taking advantage of the performance features available with Bentley's new core V8i platform - adding significantly to the basic engine and speeding up the workflow considerably. Hevacomp Simulator V8i can be used to create buildings much faster, allows floors to be copied across and windows inserted at will, provides extended viewing capabilities and improves the speed at which answers can be derived from the model.

Hevacomp Simulator V8i's interoperability with other systems has also been extended, with the ability to import considerably more data when you are loading in 3D models from other software by using gbXML 3.07. Early versions of gbXML only allowed you to import simple geometry for simulations. However, the newer version allows more robust geometry to be imported, including spaces and attributes - such as thermal properties and materials - and to be managed within the Hevacomp database. And, if necessary, the geometry can be re-exported to applications, such as TAS - EDSL and IES, etc!

The most important change, though, is the software's accreditation as a Level 5 DSM (dynamic simulation modeller) and its support of ASHRAE standards and the US LEED program for sustainable buildings. LEED is equivalent to the UK's BREAM, although it is beginning to take some precedence over it, especially in places like the Middle East. www.bentley.com/uk-green.