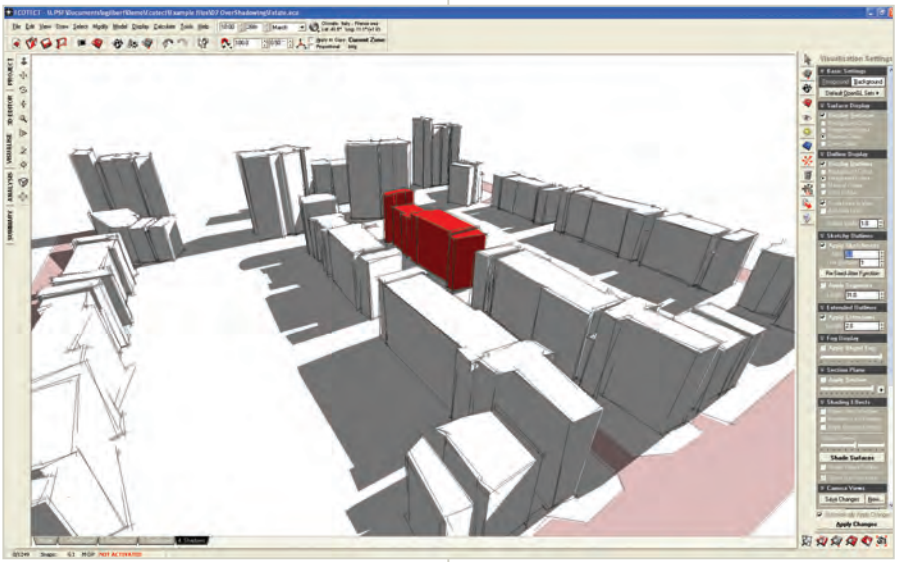
# Towards Predictable Sustainable Design with Building Performance Analysis

*by Martyn Day*

It's now accepted fact that building construction and operation has an enormous direct and indirect impact on the environment. As economies and populations expand, architects face a unique challenge to meet green building codes on new and refurbishment projects to minimise the impact on the environment. This is not only the consumption of energy and raw materials, but to limit the atmospheric emissions over a building's lifetime.



*1. Overshadowing: Here the red building's overshadowing shadow is being assessed in Ecotect.*

While there is increasing interest in and legislation for sustainable design most core Computer Aided Design (CAD) packages only aid the architect's ability to produce 2D documentation, not in assessing the performance and economy of a design. It could be argued that these 2D CAD systems are in fact just replacements for drawing boards, not true design tools. In the automotive industry, CAD systems feed back performance characteristics to the engineers highlighting inefficiencies and designs that will fail in highly competitive environments like Formula 1. With the environmental issues we face, it's time for architectural practices to deploy this kind of capability and get back some control over the engineering of their structures.

One of the leading, stand-alone, applications in building performance is ECOTECT, by Square One. The software is a 'Swiss-army knife' for building performance analysis and combines a basic 3D modeller with a wide range of environmental analysis tools for a detailed assessment of solar, thermal, lighting, shadows & shading, energy & building regulations, acoustics, air flow and cost.

While many practices are still heavily reliant on 2D, there is a slow but increasing move towards adopting 3D modelling systems such as Graphisoft ArchiCAD. While co-ordinated documentation is the immediate benefit of deploying these 3D products (you alter the model and all the 2D

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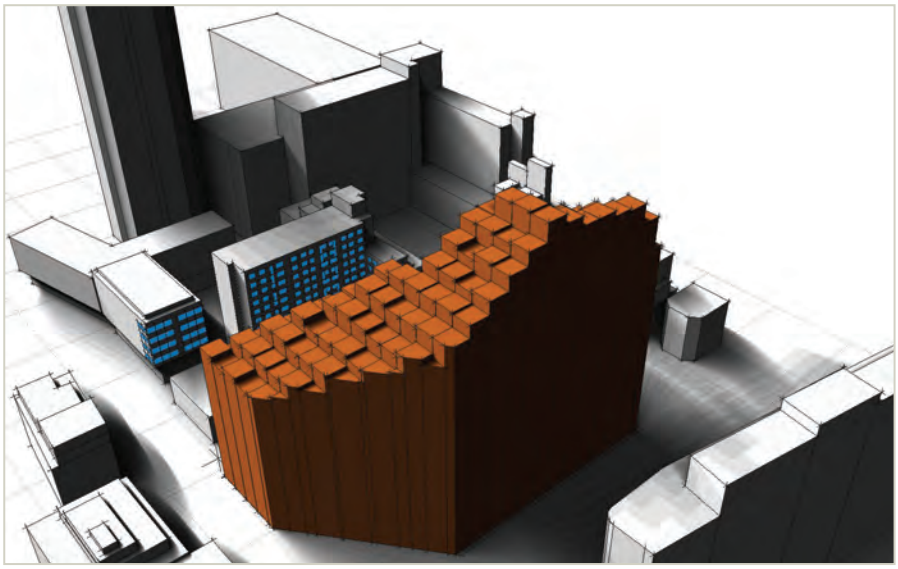
*Martyn Day – AEC Industry and AEC Technology Journalist*



*2. The block model generates in real time as Ecotect defines a conforming Rights to Light envelope based on the proposed site.*

sections and elevations update), by creating a detailed 3D model, you can also analyse the building's performance. If you were having trouble justifying a move to 3D, the benefit of environmental performance analysis is compelling.

**In use**

To get a model into ECOTECT, the software has its own basic modeling environment, but it isn't as intuitive as a typical 3D CAD system and best used only for generating basic layouts. There are a number of import options including 3DS but this just imports dumb geometry and all the room areas still have to be defined and zoned for analysis. This is where ArchiCAD users have a major advantage over other 3D CAD systems as its models come into ECOTECT automatically zoned and ready to go. Using ArchiCAD for the original model definition speeds up this process and it may even be worth owning a copy to generate the concept models to feed into ECOTECT and cut the preparation work. Once these have been identified you are ready to start building up the material definition of the building, what's it made out of, where it is on the planet, its orientation, what time of day it is and what month you are interested in.

**Materials and Environment**

The most important part of analysis is making sure the software has enough information to carry out a meaningful calculation. For instance, the walls, glazing, partitions all need to be assigned materials for any thermal and energy analysis and the software comes with a big library which provides all the 'U values' and numerical-based characteristics that the equations need. Information on cooling systems and plant should be added here too, providing ECOTECT with any man-made environmental measures that have been anticipated. Enter the model's orientation and position on the planet (by latitude and longitude, time zone), the software provides all

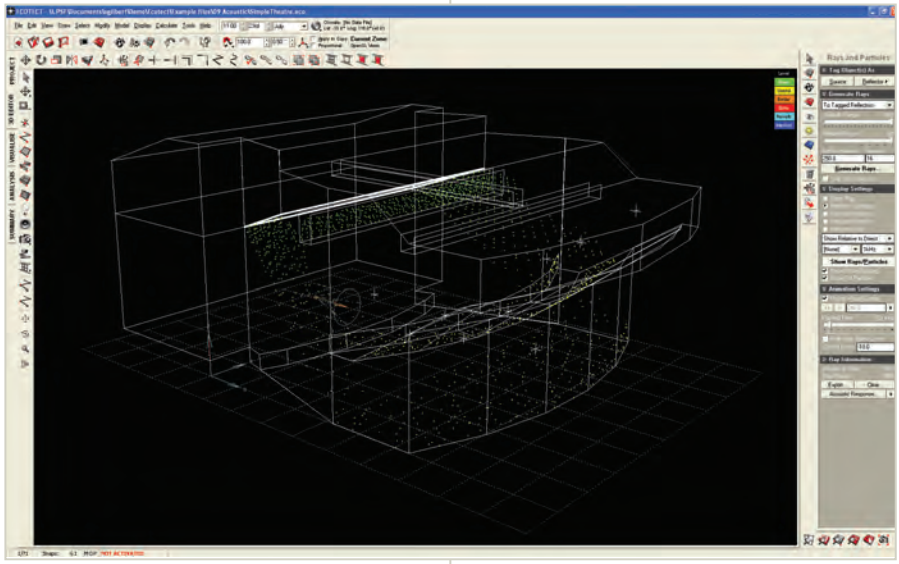
Martyn Day has written about Computer Aided Design (CAD) for over 17 years, running various magazines and websites coving design technology utilised in Manufacturing, Architectural, Structural and Civil engineering. He is currently researching future strategies for deploying intelligent 3D design systems in Architecture.

the yearly average environmental conditions. With the model zoned, materials allocated and environment and global position assigned, it's possible to start running some calculations to get a wide range of performance characteristics, including solar radiation, right to light, over-shadowing and conformance to British Regulations Part L.

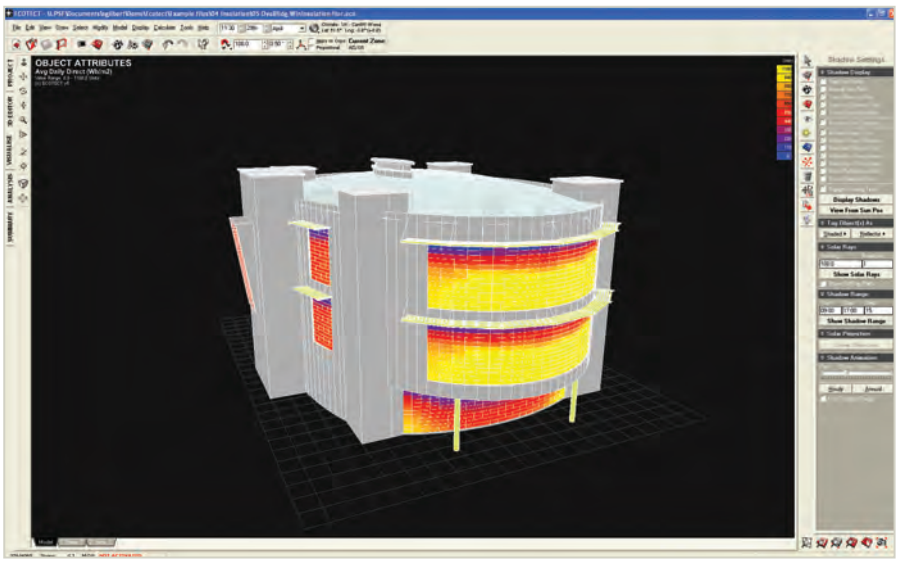
**Analysis**

ECOTECT offers a stunning array of analysis possibilities and offers the results in a very graphical way, giving even novice users a feeling to how well a model has fared in the analysis from projecting 3D colour maps onto the model, as well as graphs and reports.

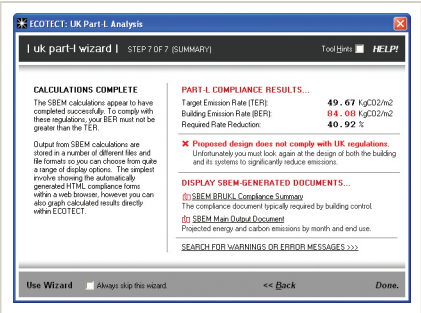
The big analysis is that of compliance with the UK Building Regulations Part L (Conservation of fuel and power), Scottish Building Regulations Part 6 and Northern Ireland Building Regulations part F. Here, through easy, step-by-step wizards, ECOTECT takes into consideration many different aspects of a multi-zoned, multi- floor building, from glazing to ventilation systems, to thermal transfer (gains and losses). ECOTECT performs full Elemental, Target U-Value, Whole Building and Carbon Emission methods of Part L. The calculation produces a table with all the results indicating a



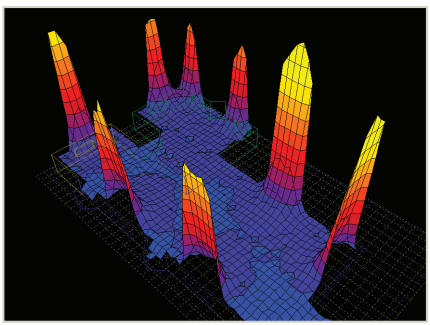
*3. A shot taken during the real time acoustic analysis, the dots represent acoustic rays, changing colour as they bounce of faces with applied materials.*




*4. An image displaying the Solar Incident Radiation on a building's facade*




*5. The Wizard result from a Part L compliance test, indicating a fail.*



*6. An exaggerated 3d result from a lighting analysis. The yellow and red 'spikes' indicate where the most light enters the building. The core seeing little natural light here.*

Part L pass or fail and will highlight exactly where the failures occurred. The software can also generate the notional building that it uses to generate the Target Emissions rating for the building – this is what it uses to compare the actual building design to for compliance. (a building that is the same size but has compliant glazing ratio's on each façade based on solar and internal gains in each zone, sets thermal zone conditions and thermal zone occupancy). This notional building can highlight facades that have too much or too little glazing. ECOTECT also supports some aspects of LEED compliance which is based around a set of conformance requirements, and not a specific calculation like PART L. ECOTECT enables the user to prepare analyses that demonstrate the degree of compliance to LEED standards.

The Solar components in ECOTECT are amazingly useful, providing the shadowcast by the model at specific times, or throughout a specific day of the year. There is a very accurate model of the Sun's path that can be moved, casting shadows in real time. You can also analyse the light penetration into your building and place this against building standards conformance. This feedback will also prove effective in ceiling lighting design, or window placement. The reverse of this is used in the program to design building envelopes – it's possible to calculate the maximum envelope of a building on-site, that would provide the statutory rights to light for adjacent buildings. It does this analysing rays from the Sun model. You actually see the envelope refine and form in the analysis.

Architectural components can be tested, for instance a facade with Louvres, to assess the performance of the screen at various times in the year, to optimise the louvre position and coverage, taking into account the sun's position over a year. Again a coloured map of energy absorption is projected on the building and louvre design. The solar dynamic of a building and its orientation is also of increasing importance in designing natural ventilation and attaining low carbon emissions.

Acoustic analysis is very straightforward and relies on the faces and materials within a building. Rays are sprayed from a sound source specified by the user. They can then be seen clearly bouncing from surface to surface as they decay. The decay is based on the acoustic properties of the surfaces within the model. It is then possible to consider altering surfaces to aid absorption and reduce the possibility of echoes.

**Conclusion**

ECOTECT offers an amazing breadth of analysis tools and it really puts something in the hands of architects that empowers better building design from the concept to the sign off stages. With the movement towards naturally ventilated, low power, low emission designs, the performance of any structure and system will become absolutely paramount in gaining planning permission. This is essential, forward-looking technology for any architectural practice and will hasten a move to 3D. Forget 3D for the sake of co-ordinated documentation, 3D is all about better building design.

Martyn Day is a journalist at AEC Industry and AEC Technology publications.

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Graphisoft UK Ltd. 21-25 Church Street West, Woking, Surrey GU21 6DJ
Tel: +44 (0)1483 263 154 Email: mail@graphisoft.co.uk www.graphisoft.com