How to turn blueprints green

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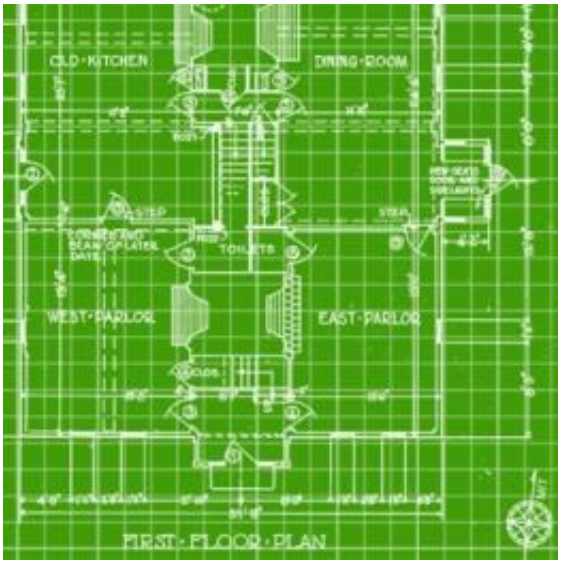

Graphic: Christine Daniloff

(PhysOrg.com) -- Even in today's increasingly energy-conscious world, it's rare for the subject of energy efficiency to be addressed in the early stages of designing a new building, whether it's a single-family home or a large factory or office building. Typically, issues about lighting, heating and insulation are left until after initial decisions about the size, shape and orientation of the building have been made.

Leon Glicksman, MIT professor of building technology and mechanical engineering, has long argued that that's the wrong way to go about it, and that in order to come close to optimizing energy use in buildings, it is essential to make those considerations part of the process from the very

beginning. And so Glicksman and some of his students have been developing a simple, open-source web application that allows people to do a basic analysis of a proposed building's energy usage in just a few minutes, making it possible to try multiple variations quickly to see what factors make the biggest difference.

The application, Design Advisor, has been available online for about five years, but just recently received its most significant upgrade. Previously, the software would only analyze an individual floor of a building, but a new component adds an analysis of the roof. Now, the resulting data give a relatively complete picture of the entire building's likely energy needs and performance, and the comfort of its occupants in different parts of a room and at different times of the day and in different seasons.

While many architectural firms use sophisticated software to perform more detailed analyses of buildings they design, these programs require much more extensive training and knowledge and take longer to use. Comparisons the team made between the leading programs and Design Advisor have shown good agreement in the results produced, to within about 10 percent, confirming the utility of the new tool. Detailed charts of these comparisons are available on the Design Advisor web site so that users can evaluate the accuracy for themselves.

Darryl Griffin-Miles is a graduate student in architecture at Hampton University in Virginia, and for his thesis project he is trying to design alternatives to conventional high-rise housing that make use of natural lighting and ventilation systems, to improve both energy efficiency and comfort. As part of that project, he has been using Design Advisor.

"The final designs will only be conceptual, not for an actual building," Griffin-Miles explains. Still, to make the results meaningful it will help to try out many possibilities and see which factors make the biggest difference — and that's where Design Advisor has helped.

Among other things, Griffin-Miles says using Design Advisor "made me think of a few aspects of my design that I may have overlooked." For example, he says, it made him think about the complexities involved in using natural daylight to supplement artificial lighting: "It made me consider the daylighting workplane, which describes the amount of luminance that is reflected and diffused off of working surfaces." And it also provided him with ways to estimate the amount of electricity that could be saved by using more natural light.

Making it easy

Simplicity has been a key design objective for the software since its inception, Glicksman says, but now "we're trying to make it even simpler, so more people can use it," including homeowners considering additions or modifications to their homes. Currently, about 7,000 building simulations per year are being carried out on the Design Advisor web site. Although the system allows users to compare many different factors, such as many different types of windows (single, double, or triple-pane, inclusion of blinds or not, different kinds of coatings), in the interest of simplicity it makes no attempt to estimate the relative costs of such choices.

The program is constantly being improved and updated. The new roof analysis recently added to the software was developed by graduate student Stephen Ray, who did the research as part of his thesis work. He developed comparisons based on three types of roofs: conventional dark asphalt roofs, cool roofs (such as white roofs) and green roofs (with a layer of soil and grass or other plants growing in it). He also included variables for the amount of insulation below the roofing material.

To validate the program, he studied actual data from several roofs in different climates, including different varieties of green roofs. "We used experimental roof data" to validate the software, Ray says. "We used the

model to predict surface temperatures on these roofs, and compared that with the actual data" and found a good agreement, he says.

Quite a few teachers and college professors have been using the web site for educational purposes, Ray says. "There are a lot of people who have continued to use it for classes they're teaching, or for their own research," he says. In other cases, some users are professional architects "who are trying to use it to get a second opinion on some of their simulations, to get some confidence in what they're doing."

Ray stresses that Design Advisor is designed for different purposes, and should not be thought of as a substitute for the more sophisticated software used by architects, such as a program called Energy Plus developed by the U.S. Department of Energy. Such programs, which often lack the graphical interface that makes programs like Design Advisor suitable for inexperienced users, have much more detailed capabilities for modeling complex building designs.

Ray says Design Advisor "was created for the early design stages" — the period when so many variables are undefined that it's often difficult to create a detailed model for the more advanced programs. The faster setup of the simple program makes it possible to try many variations, and see which factors seem to make the biggest difference in the building's energy use and comfort levels.

"Overall I believe the software has a lot of potential," comments Griffin-Miles. But he suggests that rather than making it simpler, adding some additional options would improve the system. "I believe any person with the need and ability to analyze the results the software is made to produce will also have the ability to handle more parameters," he says. "The user interface setup is great, but more user input options will be a great addition."

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