Energy Design and PCs

Computers can help in lots of ways, but don't spend $500 on energy analysis to shave a few dollars off the heating bill.

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Despite 15 years of effort by governments, professional associations, engineers, and researchers, there is still no foolproof method to calculate the energy requirements of any given building.

Why? Buildings are complex systems that interact in complex ways with their occupants, energy systems, and climates. Specifying all this input data—if you can find it—for any method of calculation, takes a great deal of time, more than can usually be justified on a single project. Furthermore, more, few buildings are built precisely as designed. Consequently, predictions are often off by more than 50 percent of the building's actual energy consumption. Home energy software users are wise to qualify their results with strong disclaimers.

While it's hard to predict energy use for an individual building, the results averaged over many buildings are much better. For example, if you do energy calculations on 100 buildings, using actual weather data and carefully monitoring the building temperatures, some computer programs can predict results within 10 percent. Unfortunately, this can only be done after the building is designed, constructed, and in use. Builders generally want energy answers before purchasing the windows, not after.

Ideally, builders (and owners) would like answers such as "window A is 30 percent better than window B and has a payback of six years if window A costs $10/square foot more than window B." Up to a point, engineers and computer jockeys can provide answers like that. Unfortunately, the window performance data may be calculated from obsolete testing done in 1949. Furthermore, window A may not be available in that size, in that type, or with that option even though it's in the brochure.

Pocket Calculator or PC?

What a builder or designer really needs at this stage is general guidance, not precise answers. He needs to know when his energy choices are in the right ball park, and when they will get him into trouble either with comfort callbacks, heating systems that are too complex, or bad window design. He needs to know if the energy design will upset building code officials, or if the costs of the proposed energy features are out of proportion to the savings.

Fortunately, most energy problems have very flat optimization curves. That is, you can vary most input data significantly with little effect on energy performance or cost effectiveness. Ultra precise computer calculations are not needed. For example, doubling the level of ceiling insulation (from R-30 to R-60) might only change a building's energy consumption by 3 percent or $30 per year. Adding triple glazing or low-e to a sliding glass door saves $10 a year on the north but only $5 a year on the south (low-e and triple glazing each block some of the useful solar gain, with low-e blocking slightly more but having a slightly better R-value than triple glazing). On the other hand, some small changes are significant. For example, simply moving a sliding glass door from the north side to the south side on the plans is worth $80 per year ($40 net loss on north plus $40 net gain on south). This would be worth knowing about.

But whether these calculations are done on the back of an envelope with a four-function calculator or by a sophisticated computer program does not matter. I prefer the pocket calculator in most cases. They are certainly more cost-effective.

Where Software Can Help

Given the complex nature of energy calculations, their repetitive nature, and the increasingly sophisticated and powerful hardware and software available, one would think that computers could help answer energy questions for builders. To some extent they can.

They work best at the extremes: for either very detailed calculations or very simple ones. Highly detailed calculations are typically done on large numbers of buildings or a single large building, by research organizations, governments, or corporate clients with money to burn. *DOE-2.1C, Calpas3,* and *Trakload* are good examples. has a life of its own and does not always very simple computerized calculations where the printed results are more for marketing or code compliance than for predicting energy use. Examples of this are *Hotcan,* Cornerstone's *Gas, Oil,* and *Electric Heat,* and *F-chart.*

The more difficult area is the middle ground where an energy-minded client wants calculations more detailed than a simple annual fuel bill but simpler than a full-blown hour-by-hour analysis of every thermal zone in a building. *Sunhouse, Micropas,* and *F-load* make valiant and largely successful efforts at this. The problem is that $500 worth of energy analysis might show only a $100 annual saving in the energy bill for the building. This is even before considering the costs of making the energy improvements being modeled—such as foundation insulation, better windows, more insulation, or air-to-air heat exchangers. A rule-of-thumb or back-of-the-envelope calculation might make more sense.

Specialized areas of calculations are generally better served by computers. Examples include *Daylite* by Solarsoft for daylighting calculations, *Duct Sizing,* by Elite for sizing ducts, or *PVF-chart* for photovoltaic electric systems. However, you'd need to do a lot of these specialized calculations to justify the cost of the program,

Hardware Improvements

Hardware progress in recent years has been phenomenal. Calculations that took hours on my Z80-based Osborne are now done in seconds on IBM AT's or clones based on the 80286. Still, an IBM PC clone 8088 with 8087 coprocessor seemed adequate for most energy calculations. Often the problem is bound not by the hardware but by the user's ability to comprehend and interpret the vast amount of data generated from the more complex programs. Progress in hardware will no doubt allow the simultaneous drawing or viewing of the building with the energy results changing as the building is changed. Closest so far is *Calpas4* (still not released) and various CAD programs, although none I know of are very sophisticated in their energy analysis capability.

Software progress unfortunately lags behind hardware. No programs really utilize the 80286, let alone the recently introduced 80386. Another problem is that once software is written it is seldom updated to take advantage of new machines. A software company has to be really dedicated to updates to improve software for new machines. Usually they're too busy just fixing bugs in old versions.

Users

There are many types of builders: the get-in-and-get-out, the careful craftsman who forgets to charge enough, the tract developer with marketing knowhow, and the all around quality-minded small builder. Computer-assisted energy analysis may have a role to play for each type of builder, but its helpfulness will vary. For instance, the get-in-and-get-out type probably has no direct use for energy software. If they promote energy awareness at all, they will most likely use the results of studies, maybe glean a little from magazines, and make the same outrageous claims about energy that they do about quality.

The craftsman will probably overindulge with computers just as he does on the latest tool or finishing technique. These folks often get hooked and buy hardware and software just for energy calculation. They usually forget to charge for it, or if they do the client is unhappy with the cost. The tract-development builder is probably in the best position to profit from computerized energy analysis. After all, he can spread the results over several units and the effort is well paid. back in lower energy bills and better marketing literature that will stand up in the courts. Unfortunately, few tract builders seem to have the interest.

Finally, we come to the quality-

Here are the companies to contact for more information on any of the energy software mentioned in this article:

Calpas 3: • $795 (Price includes training program) • Berkeley Solar Group, P.O. Box 3289, Berkeley, CA 94703 *(415)* 843-7600.

Daylite • $289 (plus $5 shipping) • Solarsoft, 1406 Burlingame Ave, Suite 31, Burlingame, CA 94010 (415) 342-3338.

Ductsizing • Two programs with differing degrees of sophistication: $195 and $395 • Elite Software Development, P.O. Drawer 1194, Bryan, TX 77806 (409) 846-2340

Electric, $195; **Oilheat,** $95 (Just Reduced); and **Gasheat** $95 (Just Reduced) • Cornerstones Energy Group, P.O. Box 4904, Brunswick, ME 04011(207) 772-3900

DOE-2.1C • $495 • Acrosoft International, 3120 S. Wadsworth Blvd., Suite #1, Denver, CO 80227

F-Chart, $400; **F-Load,** $425; and **PV F-Chart,** $400 • F-chart Software, 4406 Fox Bluff Rd., Middleton, WI 53562 (608) 836-8536

Hotcan • $145 (Including $50 extra program that computes 140 U.S. weather sites) • Energy Analysis Software, P.O. Box 7081, Station J, Ottawa, Ontario, Canada K2A 3Z6 (613) 722-5091

Micropas • $795 (Options can add another $100) • Enercomp, 123 C Street, Davis, CA 95616 (916) 753-3400

Sunhouse • $99 (plus $5 shipping) • Precision Environments, P.O. Box 243, Helena, MT 59642 (406) 442-7942

Trakload • Basic version, $795; Full energy audit version, $1485 • Morgan Systems Corp. 1654 Solano, Suite C Berkeley, CA 94707 (415) 525-4736

conscious small builder. If that's you, you can benefit from trying out a couple of the simpler programs on your existing computer equipment. By running the program for a while, you'll probably learn or confirm things you already suspected, like air tightness is very important to annual energy use. And you'll be able to sell your homes as energy-efficient with reasonable confidence in their performance. You might even learn where to beef up your efforts and where you can cut back.

In short, if you have a computer and an interest in energy calculations, there are many reasonably good software programs at reasonable prices. If you don't expect too much, and don't spend too much, you'll be pleased by the results.

Why Computerize?

Precision. The computer can be very precise. It will tell you that you will use 432.68 gallons of fuel oil next year. This is impressive for marketing. However, for the many reasons outlined above, it is not accurate. The precision does allow you to examine the relative effects of small changes—such as moving a window or adding a little insulation—although since the changes are small this is mainly to satisfy your curiosity.

Relieve drudgery. If someone in your office has been doing detailed take-offs and manual energy calculations, inputting data and letting the computer calculate will seem interesting and effortless by comparison. On the other hand, having the computer available will tend to encourage you to do more calculations and input than are really necessary. The net result can be more drudgery, The key is to make efficient use *of* the computer calculations and avoid generating those that don't affect the design.

Marketing tool. Computer generated output impresses people. It is impressive in sheer quantity. And, if the computer did it, it must be right! Color graphics and bar and pie charts are amazingly useful at helping the client visualize the effects. The cost of some of the fancier outputs can be staggering, however.

Education. If you make enough computer runs, eventually you'll learn something about energy-efficient design. By trying ideas on paper you can get a pretty good idea of how changes affect performance and costs. However, it's important to remember that what you are learning is a computer model, not reality, and that this has its limits. You should find other ways to learn as well—for example, building models to test daylighting. As for real building performance, you'll learn the most by building real buildings.

Parameter study. Big projects or repeated projects can often benefit from the precision of the computer study. It allows you to quantify small percentage changes which add up to big dollar savings in a large project. Apartments, condos, panelized homes (Acorn has been using *Calpas* for years) and commercial buildings are prime examples.

Serve as check on intuition. I often use the computer as a check on my intuition and experience developed over the years, particularly on projects in areas that I'm not as familiar with as I should be. If my intuition and the program don't agree, I check out both more thoroughly.

Why Not Computerize?

Time Spent. Time costs money and the time spent fussing with hardware and trying to understand software can grow without end. (Do you really need another whole world of conferences, seminars, meetings, user groups and magazines?)

Cost of hardware and software. Prices have been dropping: there are now good AT clones with hard disks under $2,000. But would that money be better spent on a new table saw or half a pickup truck?

Solving the wrong problems. Programs can only solve the problems they are designed to solve. Therefore you often solve the problem your software handles rather than the one that needs solving. For example, a program may help you carefully figure out the wall area and R-value when the real problem is better estimating of the infiltration *(Sunhouse* does a nice job of this).

Diversion from other work. It's easy to get so interested in computers that you stop showing up on the work site. This results in a severe cash flow crunch and a dissatisfied spouse. Remember that the computer is only a tool and the real goals are quality, profitable buildings, and an enjoyable life.

Need for proficiency. Most small business people cannot devote the time necessary to become very proficient at all the details of computer use. And, if you use a program only occasionally, you'll have difficulty using it efficiently. This means you should seek out equipment and programs that are easy to use or "user friendly," in computer jargon. If your business is large enough, it helps to dedicate one person to research the field and become competent in the use of the machine and the programs. The person can become efficient and teach others as necessary.

Some final caveats:

1. It's important to understand exactly what the program does. (For example Right-J sizes equipment. It does not predict annual energy use.)

2. It's important to match the cost, sophistication, and completeness of the program and hardware to the specific job at hand. (You wouldn't use a chain saw to cut butter or a coping saw to fell a tree).

3. A little help from a consultant (who could be another builder who's solved the problem before, or an acquaintance at a conference) can go a long way in helping you solve the problem.

4. The proof is in the pudding. Did the energy analysis help you build a better building with higher value for less money? Only your fuel dealer knows for sure. ■

Drew Gillett is a registered engineer in New Hampshire and Massachusetts who helps residential and commercial builders solve intractable problems in foundation insulation, windows, vapor-barrier details, radon removal, moisture in pool buildings, photovoltaic systems, daylighting, and innovative heating systems. The programs mentioned above and many others are reviewed by Drew in more detail in the 12/84, 8/85, 10/86, 12/86, and 2/87 issues of Northeast Sun (Brattleboro, Vt.) available as back issues for $3 each. His farmhouse in Bedford, N.H. could use a builder yearround since he spends too much time in front of his computer terminal.