

wonderful (but wasteful?) windows

by Adam Neugebauer

I grew up near Seattle, where floor-to-ceiling windows are the façade of choice for most downtown high-rises. The beautiful Emerald City skyline is practically made of glass. I've even heard that there are so many windows that a major earthquake could leave Seattle-ites wading through multiple feet of broken glass. As for my childhood house — a place I still call 'home' — practically every exterior wall surface that can accommodate a window does. This includes huge north-facing windows in the dining room, along with two large skylights. So I've definitely grown to appreciate the beauty and benefits of windows.

The wonder

Foremost amongst these benefits is the connection with nature. In western Washington, the color green is practi-



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cally omnipresent outdoors (this is one of my favorite parts of coming home . . . *after*, of course, spending time with my parents). Without all of these windows keeping us connected with the outdoors, the feeling of being cooped up in a school, office, or home all day could drive us crazy; but we've already got our contrast-resistant winters for that. Apparently, I'm not the only one who thinks so highly of this characteristic: a variety of studies have shown a correlation between greater daylighting and improvements in learning and attentiveness of children and, similarly, in the productivity of adults.

Well-designed daylighting can also result in savings to three phases of a child care center's life: construction, operation, and maintenance. During construction, fewer lights will need to be installed in daylit areas. Daylighting will help with the operation by reducing the need to turn on lights and by offsetting some of the space heating load during cold winter months. Finally, fewer lights being used less often means fewer bulbs needing to be replaced each year. If the windows are operable, they can potentially provide additional savings in all three building phases as there will be less need for mechanical ventilation systems to maintain indoor air quality.

The waste

As is so often true in life, these benefits have some strings attached. For starters, notice that I started my previous paragraph with the phrase 'well-designed.' Many of these benefits can quickly be lost by poorly designed or installed window systems. Too much daylighting can cause thermal discomfort and distracting glare for occupants, not to mention UV damage to furniture. Acoustic disturbances and visual distractions could also be a problem if not properly taken into account.

Then there is the issue more near-and-dear to my energy efficiency-loving heart: windows often represent the weakest link in the armor of what is known as a building's 'thermal envelope' — the group of surfaces that form a continuous separation between conditioned (indoor) and unconditioned (outdoor) space. Windows are generally rated for how much heat they let through by two separate mechanisms:

1. **Thermal conduction** — This is the heat transferred, by direct contact, through the building envelope. For example, this is like the heat felt when touching a cup of hot tea: heat from the tea is conducted to the cup and then to your hand.

2. **Solar transmission** — This is the amount of the sun's thermal radiation that makes it into the indoor space. You feel thermal radiation when putting your hand close to that same cup of tea.

Ratings for these mechanisms are represented by performance values called the U-factor and the Solar Heat Gain Coefficient (SHGC), respectively. For both, lower values mean less heat transfer. In general, the lower the U-factor the better, as this will help ensure the indoor conditioned air stays conditioned; on the other hand, lower SHGCs can be useful in some circumstances while higher are preferred in others.

To understand just how weak a link windows can be, compare their performance to that of a wall: the U-factor of a top-of-the-line window (such as one my company is having installed in a zero net-energy research home) is roughly equivalent to a simple wood-framed wall with standard cavity insulation; this same wall would transmit no appreciable amount of sunlight (a SHGC of 0), whereas the same high performance window could at best muster transmitting down to 20-25% of the sun's heat. In other words, the best windows in the market can be outperformed by fairly run-of-the-mill wall systems. So maintaining indoor comfort in a center with lots of inefficient windows (whether by design or installation) could be like keeping afloat a boat with a hull resembling Swiss cheese.

The resolutions

I'm not about to advocate for windowless centers, so what can be done to reduce or mitigate their weaknesses so that you can still enjoy all of their advantages? In new construction, there's a lot of designing that can be

done. For hot summers, low U-factor and low SHGC windows are a smart pick. Also, direct sunlight can be reduced with eaves, blinds, or natural shading from plants and trees; on top of reduced thermal gains, this can also address concerns about glare. For cold winters, consider higher SHGCs, especially for south-facing windows (or north-facing, for those in the southern hemisphere). If you expect both extremes, a combination of eaves and south-facing high SHGC windows can serve your needs.

In existing centers, even if you don't have the option of replacing old windows (an expensive retrofit), there are still some options available to you. Older windows can be quite leaky, letting out valuable conditioned air even when the windows are closed; there are some products (such as weather-stripping, removable caulks, and window films) that can help seal these leaks. There are also inexpensive, DIY window films that improve the performance of existing windows by

reducing their U-factor and SHGC, glare potential, and UV transmission. Beware, however, that most of these films can tint the window color and filter out the desired visible light; luckily there are some films available that provide improved window performance while maintaining the benefits for which the windows were installed. So, to be safe, give this potential solution a trial run before committing to a particular product and installing it throughout the center.

There is one last concern that I have not yet addressed: finger, hand, and face prints. Until they come out with a print-resistant window, I suppose the best solution continues to be a handy spray bottle and reusable cloth.

Resources

Heschong Mahone Group. (2003). "Windows and Classrooms: a Study of Student Performance and the Indoor Environment (Technical Report)," for the California Energy Commission.

Future installments of the Going Green series will talk about HVAC systems and when to consider going solar.

If you have questions or topics that you would like to see discussed in future Going Green articles, send them along to GreenNeugebauer@gmail.com.