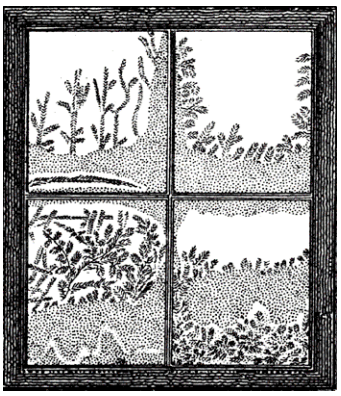

Everyday Environmental Stewardship

Saving Energy in Existing Buildings

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Key issue:
Winter Draftiness

Stewardship Opportunity: Interior Storm Windows

As people of faith, we believe that we should be stewards of God's creation. As heads of household and governance board members, we wince at energy bills that seem only to increase from year to year. Energy conservation is a great abstract idea, for both theological and practical reasons -- but improving the energy efficiency of our buildings (both homes and religious facilities) takes both money and effort, of which we never have enough. And when most of the typical solutions are installed, it still seems drafty in the winter. What to do?

Stewardship Opportunity — Interior Storm Windows
Exterior storm windows leak air because of moveable sashes, and weep holes that drain rain water in the summer let cold air in during the winter. Inexpensive flexible plastic film applied on the inside works, but is not very aesthetic and can harm paint. The best solution is to purchase pre-assembled or build sturdy lightweight interior storm windows.

How I Figured It Out
I've struggled with this dilemma for several decades, both at home in Watertown, MA, and on behalf of my church, St. John the Evangelist in downtown Boston. Our family moved to Watertown in the early 1980s, soon after the OPEC oil embargo and gas lines of the late 70s. Our house is somewhat elderly, wood framed, 3 stories plus basement, gravity hot water radiators fired (then) by a coal-converted-to-oil boiler.

Over the next 20 years, we had insulation blown into the exterior walls and attic, replaced the primary windows with double-paned glazing, and replaced the boiler with a modern gas-fired unit and added a circulation pump; all of these are big ticket, but standard energy-conscious upgrades for an old building. Yet, certain rooms in the house still felt cold -- which infuriated me: where could the heat be going? My wife says I looked ridiculous, crawling around on hands and knees while holding a lit candle, looking for cold air currents.

No more candle flame watching.
I use a **remote infrared thermometer with digital readout** (Raytek or Extech, available online, or local electronics stores). The thermometer even has a red laser pointer, to indicate the location at which temperature is being read. The reading changes almost instantly, rather than taking minutes like conventional thermometers. Scan slowly around

the edges of a window, and by watching the numbers climb or drop you can see which parts of the window are leaking heat. Scan up and down the inside of an exterior wall, and the point to which the blown-in insulation has settled is obvious -- there's a 5ºF-temperature difference across a very short distance.

The Flaw of Exterior Storm Windows
We do have exterior storm windows. However, closing the exterior storm windows, to my surprise, did not greatly improve the interior temperature readings! On the other hand, application of flexible plastic film (boxed kits from 3M, FrostKing, Niagara Conservation) on the INSIDE helped a lot, as long as the plastic film was airtight all the way around, especially along the bottom of the window.

How could this be? An exterior storm window with moveable upper and lower sashes leaks air, both at the middle and also around the edges. It also has to have "***weep holes***" to drain away condensation which otherwise would rot the window sill. The weep holes also leak air, reducing the insulating effectiveness of the storm window.

Plastic Film is cheap and works but is a pain
I liked the effectiveness of the plastic film kits, and they are quite inexpensive. But, they are a recurring pain to install, and needless refuse for recycling. Also, my wife didn't like either their appearance or the paint damage done by the double-sided adhesive tape used to mount the film to the window casing.

When St. John's boiler failed in 2003, in addition to heating system replacement (replacing steam with hot water, with high-efficiency boilers, radiators and in-direct fired domestic hot water), MIP&L recommended an interior storm windows, using rigid acrylic (Plexiglas™ or similar) plastic sheets, purchased separately, together with magnetic strips which adhere the acrylic to the window casing while also providing an airtight seal.

The concept intrigued me enough to do two things: to research other rigid-pane interior storm window systems on the Internet, and to buy material to try out.

Modern Plastics (www.modernplastics.com) offers a variety of plastic extrusions (Defender™) which clip onto the edge of an acrylic sheet for the purposes of mounting and sealing to a window casing, either by snapping mating pieces together or with magnetic strips. **Climate Seal™** (www.climateseal.com) offers a range of made-to-order, interior storm windows. The magnetically sealed inserts can be used for windows, doors and skylights, and come in different colors — including wood veneer options — that blend with the window frame. There are a wide variety of shapes, from standard windows with 90° corners to round, elliptical, triangular, pentagonal, octagonal, and so on. This range is especially beneficial to houses-of-worship that have varying window sizes and shapes.

But I also thought that I could make these myself…and that if I could, it would be possible for volunteer teams of congregation members to do so for houses-of-worship.

Attachment Option #1 — Magnetic Strips and Plastic Extrusion

My first window was a hybrid: *magnetic strip* for the sides and top, and a *plastic extrusion* for the bottom, which fits flat on top of a window sill (See diagram 1.) Works well, looks good, but somewhat expensive and time-consuming to build.

In hunting for acrylic sheet suppliers, I happened upon **J Freeman** in Dorchester (56 Tenean Street, www.jfreeman.com). There are probably similar specialty operators in other large cities. They will custom cut .093" clear acrylic sheets to fit, as compared buying a stock sized piece at a big-box supplier (such as Home Depot), which then has to be cut to size.

Attachment Option #2 — Screws and Weatherstripping

For the next set of windows, I decided to use mechanical means -- screws -- to fasten the acrylic, and ordinary weatherstripping for air tightness. This too worked well, was easier to assemble – fewer long, thin, adhesive-backed strips which need careful handling and alignment -- and less expensive: 50¢/ft for the edges. Different mounting arrangements are needed, depending on the window configuration. Standard twist drills can cause cracking when making holes in acrylic; a special drill bit for plastic (90º-tip angle instead of the standard 118º) helps avoid this.

Attachment Option #3 — Wood Frame with screws and weatherstripping

A sturdier version of option #2 is to mount the acrylic on a wood frame, with weatherstripping serving as a seal/gasket between the acrylic and the window frame. This option adds the cost of the wood, and the time to paint to match. However, it is sturdy, easily installed and will last many years. It also presents the opportunity to meet aesthetic requirements, blending the frame into the finish standard of the window and surrounding space.

What about really big windows?

One other set of windows is worth mentioning. These are extremely large (8 ft wide x 25 ft high) Gothic arched windows in the church façade. Temperature readings taken last

winter showed almost 100% infiltration, i.e. the inside readings at the window edges were basically equal to the outside temperature. It would be impossible to obtain single sheets of acrylic of that size, impractical to butt join multiple pieces. But it is possible to fabricate (by a congregation committee, maintenance person or a supplier) pieces to fit. One caveat: Beware of exterior applications on stained glass windows. These will trap moisture, and accelerate rust and deterioration of the window, accelerating the timing for major—and very expensive—restoration

Helpful Hints

If you want to undertake something like this for your home or house-of-worship, here are some practical hints:

- ✓ **Decide how the sheet will be mounted**: against which surfaces, with how much clearance or overlap required in each direction for the mounting and sealing mechanism (magnetic, adhesive, nails, screws, weatherstripping, etc.). A drawing helps you visualize whether the sheet dimension needs to be larger (overlap) or smaller (clearance) than the relevant window dimension. The drawing doesn't need to be to scale.

- ✓ **Measure carefully and often**. Especially in old buildings, don't assume that rectangular-looking openings are in fact exactly rectangular. Measure both top and bottom, both left and right. Measure both diagonals to make sure they are the same.

Do-It-Yourself vs. Professionally Built/Installed

The variations described above are all "Do-It-Yourself" – scope, measure, purchase materials, assemble, and install. A growing industry of manufacturers and installers are also available – for a price – to do this work for you. (Try a Google search on "interior storm windows"). However, the price is high. For a 3'x 5' window with 1/8" acrylic, a professionally built window would cost $250±, adding about $50 for professional installation. The alternatives described above, for the same size window, cost $50± for materials. Houses-of-worship and other non-profit organizations can save a lot of money with skilled volunteer labor. Either way, the installation of interior storm windows saves a lot of energy, reducing costs in $s and especially in emissions. And those savings mount up year after year.

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