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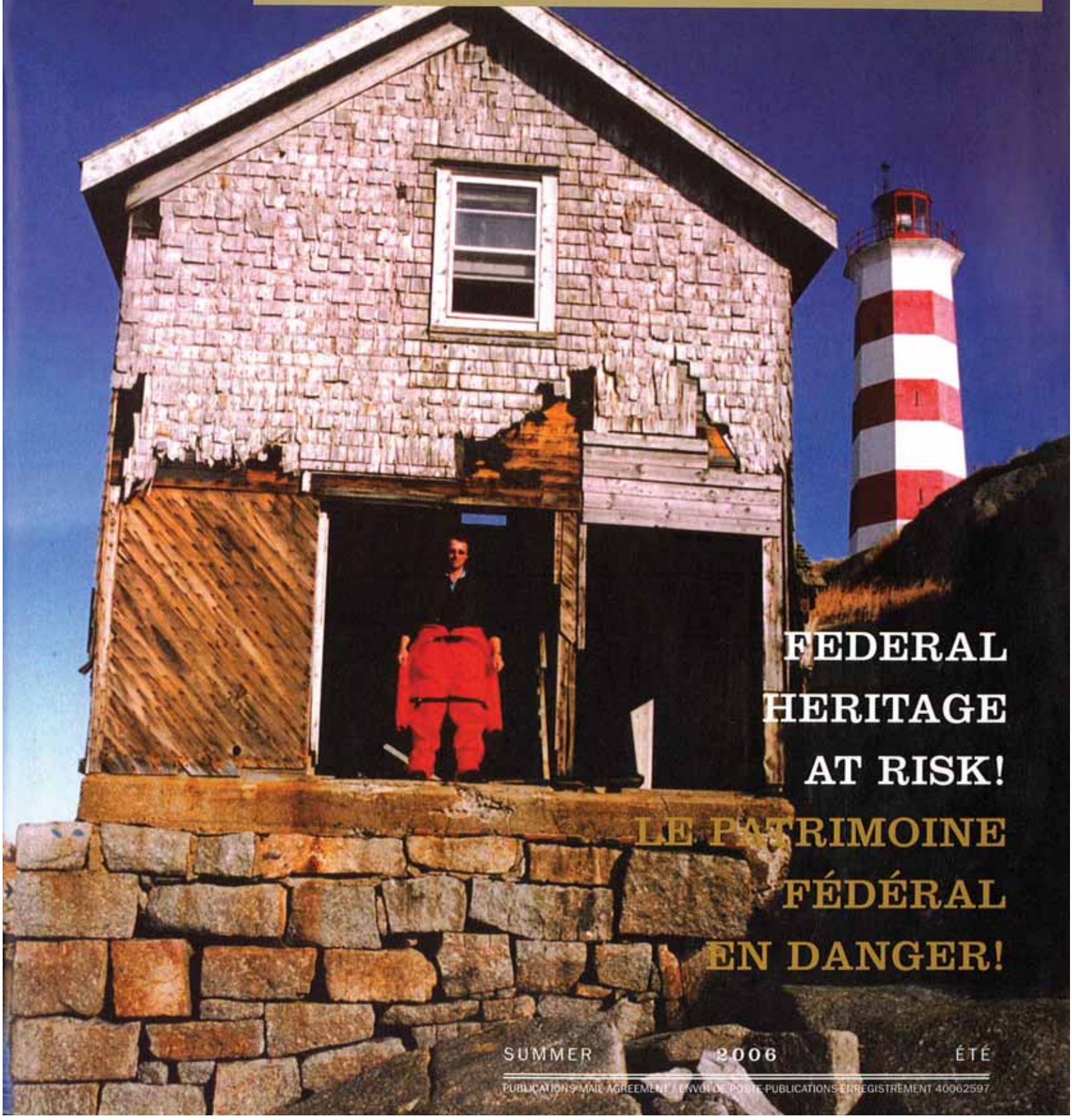

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Repair or Replace

Windows in Historic Buildings: Arriving at a Sustainable Solution

BY CRAIG SIMS AND ANDREW POWTER

We tend to take windows for granted. Yet we recognize that heritage buildings whose windows have been replaced have been diminished. The depth and thickness of frames and sills, the width and visual weight of sash components, the materials, the colour and the pattern of light reflecting off the glass—all complement and elaborate the architectural style, texture and age of a building. Much of this character is lost when windows are replaced with modern versions that lack these features.

Replacement of historic windows is often driven by a number of concerns. Peeling paint, broken glass or missing glazing putty can make them look unsightly. Some may be draughty because of a sloppy fit or difficult to operate due to deteriorating sash cords. Any exposed weathered wood is often described as "rot." One often-stated argument for replacing windows is the "desire" to improve energy performance and an "assumption" that this will be achieved by replacing the windows.

Despite the irreversible impact on the character and authenticity of the building, anticipated energy savings are rarely achieved over the long term. Removing historic windows should be a solution of last resort, not of first resort. In the residential sector the decision to replace is rarely preceded by analysis and serious investigation of the range of alternatives.

PHOTOS: CRAIG SIMS

Although not maintained for years, this 200-year-old window still shows the three-dimensional features of the drip cap and sill which are missing from most modern windows. / *Même si elle a été privée d'entretien pendant des années, cette fenêtre de 200 ans exhibe encore les caractéristiques tridimensionnelles du larmier et de l'appui de fenêtre qui sont absentes de la plupart des fenêtres modernes.*

Fortunately, it is not necessary to sacrifice our non-renewable cultural resources in order to preserve our non-renewable energy resources. Usually, the most effective ways of improving energy performance in a historic building are controlling all sources of air leakage and having an efficient heat source (furnace, boiler or other). Replacing historic windows with modern sealed glazing units is one of the most expensive, short-lived, least effective, yet most popular home improvements for reducing energy consumption in heritage houses.

There are no publicly available life-cycle studies or data in Canada which assess and compare the energy performance of rehabilitated historic windows versus retrofit new windows in historic buildings. Those studies carried out in the U.K. and Norway indicate that over an appropriate life cycle, window retention and rehabilitation might even be the greenest overall solution. Despite many years of debate, publicity and numerous articles on the subject, retention and upgrade versus replacement continues to be a conservation battle.

DETAILING AND DURABILITY

Historic window systems are usually built with good attention to detail (such as weather shedding) and with good quality materials (such as old-growth timber). Problems related to wear over time—peeling paint, broken glass and missing putty—can look unsightly but are easily put right. Residential wood windows can be in service for 100 years before requiring a major retrofit to remain in service for a second 100 years. Similarly, it is not unusual for modern windows to experience major, non-repairable failures to sealed units, vinyl welds, caulk joints and wood joints within 10 to 25 years. Today, most sealed units carry warranties of only 8 to 10 years.

DOES REPLACEMENT REDUCE HEATING COSTS?

Life-cycle cost analysis has shown that replacing historic windows in order to reduce heating costs is largely a myth.

MAKING SENSE OF PERFORMANCE RATING STANDARDS

CAN/CSA A440.1 M90 and .2 M91 are the performance rating standards for windows in Canada. They describe Air Tightness, Water Tightness, Wind Load Resistance, Condensation Resistance and Energy Rating. The Energy Rating is a measure of the window's overall performance (measured in watts per M^2) with regard to solar heat gain, to heat loss through the frames, spacers and glass, and to air leakage heat loss. Ratings are assigned by the manufacturer based on standard tests. CSA A440 was developed by the Canadian Standards Association (CSA) with the window manufacturing industry to provide ratings for its new products.

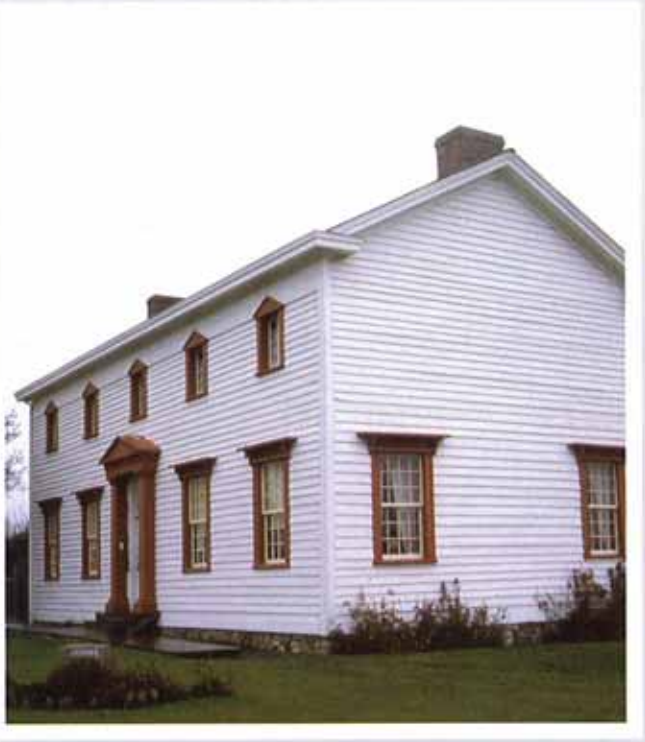
The *high performance window* is rapidly becoming the standard for the new-window industry. It usually includes low-conductivity frames, air seals and stops, and multiple glazed units with coatings and inert gases. It would have a rating of A1, B1 and C1 and an Energy Rating near zero.

The ratings contained in standards allow prospective buyers to compare new windows, but they don't provide information that would allow owners to compare existing windows with replacement options, to predict energy savings or to learn how to modify an existing window to improve its rating. Consequently, the CSA standard is of limited use when it comes to making environmental or cultural decisions about repair or replacement of historic windows.

The standard tests under CSA A440 are applied in a laboratory situation. Although there are recognized tests to quantify aspects such as air infiltration for an existing window, most homeowners will find less elaborate field tests more economical and useful (although qualitative). For example, the routes for air leakage can be assessed with smoke, water leakage by spray, and the remaining service life of a sealed unit can be predicted by frost point testing.

The performance rating standards apply to the new window on the day it is installed. They do not consider the quality of the installation, performance over time or durability. CSA A440 has been referred to by some as the "standard by which we have all agreed to lie." In short, a traditional window system with a well fitting and weather-stripped primary window plus storm window provides similar performance to modern systems. It should be included in the standard.

Refer to Natural Resources Canada publication M144-47/2004E-REV *Consumer's Guide To Buying Energy Efficient Windows and Doors.*



Maintaining the original windows of this historic house on Vancouver Island, B.C., preserves the texture and character. / *Le fait de conserver les fenêtres d'origine de cette maison historique sur l'île de Vancouver (Colombie-Britannique) préserve la texture et le caractère.*

This notion dates back to the energy crisis of the 1970s. Unfortunately, the message was repeated by every government agency involved in helping homeowners save energy. The window replacement industry was soon born. For homeowners seeking advice on how to deal with their old window problems, a trip to the yellow pages will still result in sales pitches for replacement windows and little else. Yet, life-cycle cost analysis has demonstrated that other means are more effective for improving building envelope performance.

Many aspects of the construction industry, including those related to heat loss, are measured and regulated by the Canadian Standards Association (CSA). Some years ago CSA, in tandem with the window industry, actually developed a Canadian standard to measure window performance known as CSA A440 (see sidebar).

The most significant factor relating to heating costs and human comfort is air infiltration, that is, cold air leaking in and warm air leaking out. Fortunately, it is also the easiest and cheapest problem to solve when retrofitting old windows. The use of sealants on fixed joints in combination with

The original bay window is a significant element of this Kingston, Ontario house. / *La fenêtre en baie est un élément significatif de cette maison à Kingston (Ontario).*

INSULATED GLASS (IG) UNITS

IG units are a complex and somewhat fragile assembly usually consisting of two pieces of glass with spacers, seals, and dessicants around the perimeter. In terms of thermal resistance, a single thickness of glass has an R rating of about 1, while a standard sealed glazing unit has an R rating of about 2 (comparable to a traditional window with a storm). By filling the IG unit with argon or krypton gas, and by adding low-E film to the glass, the thermal resistance can be increased to about 3.5 (a typical insulated wall might be rated from R 12 to R 20). CSA A440 requires that the spacer bar be visibly stamped with the name and date of manufacture.

Unlike single panes of glass, sealed units have a finite service life—and a rather short one at that. The edge seals fail when exposed to light or moisture. Both the National Research Council (NRC) and the Insulated Glass Manufacturers' Association (IGMAC) recommend that IG units be installed in a glazing channel that is both vented and drained to the exterior (the rain screen principle), but this is rarely done. Performance drops off once the gas leaks out, and condensation in the interstitial space is usually the first sign that the edge seal has failed. Despite the leak, two pieces of glass still have a rating of R2, but the condensation eventually leads to unsightly mould and scum within the space. When considering the "payback" period of window replacement be sure to consider that you will be replacing sealed units once, or even twice, during that period.

weather stripping on operable joints results in significant improvements, and usually the CSA standard can be met.

CSA A440 also rates weather shedding performance. Because the construction and detailing of traditional windows has evolved to include drip designs and angled sill slopes that ensure water sheds effectively, they tend to perform very well under these two parts of the standard. (Anyone who bought condominiums in British Columbia a decade ago will be aware of the importance of designed-in weather shedding.)

DOES REPLACEMENT REDUCE MAINTENANCE?

There is no question that historic wood window systems require maintenance. Windows have to be washed and painted on a regular basis. If painting is neglected for too long, then glazing putty may need touching up or replacing. Sometimes broken sash cords on double-hung windows have to be replaced—especially if they are brittle from being painted. The good news, however, is that historic windows are maintainable.

Modern window systems, by comparison, are usually touted as maintenance-free. Although they may not require painting or glazing putty touch ups, they still need to be washed and cleaned. A host of maintenance issues unique to modern windows arise. For instance, most modern window systems incorporate double glazing in the form of a sealed insulated glass (IG) unit. The integrity of the wet seals, i.e., small caulking beads around the perimeter of the glass inside and out, must be maintained to protect the edge seals of the IG units from light and moisture. When the seal fails, condensation and eventually scum and mildew within the interstitial space will result (see sidebar).

Because IG units are commonly installed as part of the window manufacturing process, their replacement often means replacing the entire sash. If the manufacturer still exists—and still makes that same window model—it may be possible to replace the sash; but if the models have changed, the entire unit has to be replaced. Finding the proprietary hardware can also be a problem.

"Maintenance-free" is often industry double-speak for un-maintainable or disposable. Vinyl- or aluminium-clad windows do not require the cyclical painting that wood does, but they scratch and fade, factory applied sealants fail, and joints may separate. These forms of deterioration cannot be halted by maintenance.

In the last few years the advice to homeowners from the window replacement sector has been that responsible homeowners should replace their windows about every 25 years. So much for payback!

ISSUES OF SUSTAINABILITY

What makes a "green" window? Green building is about using fewer non-renewable resources. It is not only about reducing your personal, government-subsidized monthly heating bill. It is about the overall impact on the environment. Wasting a window's *embodied energy*—the energy used to extract raw materials, manufacture, transport, install and maintain—is wasting a previous energy investment. When traditional windows are stacked on the curb for disposal, energy resources must still be expended. Fuel is required to take them to the landfill and to bulldoze them in when they get there.

The most energy-efficient window is one which is responsible for less consumption of energy across its entire *life cycle*, including its manufacture, shipping, time in service and

PHOTO: CRAIG SIMS

Top: the simple two-over-two glazing pattern of these original windows contributes to the Italianate features of the historic school building, whereas the overly fussy and fake appearance of the vinyl replacement windows (above) is a major distraction. / *En haut : Le simple motif deux sur deux du vitrage de ces fenêtres d'origine contribue aux traits italianisants de cet immeuble scolaire historique. En revanche, l'apparence exagérément recherchée et fausse de ces fenêtres de remplacement en plastique (ci-dessus) est une grande source de distraction.*

its eventual disposal or recycling—not just its performance rating on the day it was installed, which is how CSA A440 rates windows.

Remember, glass and aluminium are two of the most energy-dense building materials requiring the highest use of energy in their manufacture and recycling. Vinyl is a non-renewable petroleum product and is not bio-degradable.

What do we hear about payback? Payback is the time it takes for the money you save on heating fuel to equal the money you invested in your retrofit. Payback on replacement residential windows, if it can be determined at all, usually falls within 40 to 100 years. That is commonly two to four times the service life of the window you have just installed.

Window replacement is now a major industry that is supported by utilities, lenders and insurers (think of the inserts in your last electricity bill). Surprisingly, there is very little data which allows the homeowner to make a "business" comparison between various upgrade options and full replacement. Perhaps that is because what data does exist indicates that over a 25-year period, upgrading is a more affordable energy-saving alternative to full replacement.

To make an informed decision, homeowners need to be able to assess the performance of their existing windows, to be aware of the various retrofit options available to them and to estimate how much difference various improvements are likely to make.

Craig Sims is a heritage building consultant based in Kingston, Ontario. Many of his projects involve building envelope work, including the restoration and upgrade of windows.

Andrew Powter has been involved in heritage programs and projects both nationally and internationally throughout his career. His main areas of interest include historic wood structures, building envelope performance and sustainable heritage conservation practice.

Editor's Note: *Two more articles in the historic windows series will follow in upcoming issues. The first will address the most common maintenance and repair questions facing homeowners with wood windows; the second will look at the issues surrounding thermal upgrades such as additional layers of glass and weather stripping.*