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Journal

Historic Window Rehabilitation

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A carpenter restores wood window casing using epoxy repair materials.

When is it cost-effective to repair or rehabilitate existing windows, and when should owners consider replacement? When planning treatment for windows on a historic structure, the first step in the decision process is to evaluate the architectural significance of the windows in terms of overall building appearance. If the windows are important to the historic character of the building, stock replacements that don't consider the aesthetic integrity of the structure might negatively impact the building's look—and diminish its value.

The benefit of refurbishing ornamental windows may be self-evident, but even simple windows on a relatively plain building can contribute visual interest in their repeating patterns, projecting planes, or slim profiles. On the flip side, throwing money at windows that are in very poor condition or which have only minimal bearing on the building image may not be worth the cost. The decision to restore or replace historic windows is both complex and situation-specific, demanding consideration of budget, schedule, building usage, operability requirements, energy efficiency, and durability, as well as appearance and architectural character.

History Lesson

It's easy to lose sight of the significance of a historic window when all it seems to contribute to the building aesthetic is peeling paint, rotting wood, corroding steel, or broken glass. To appreciate the architectural worth of aging windows, we must look back, briefly, at their origins.

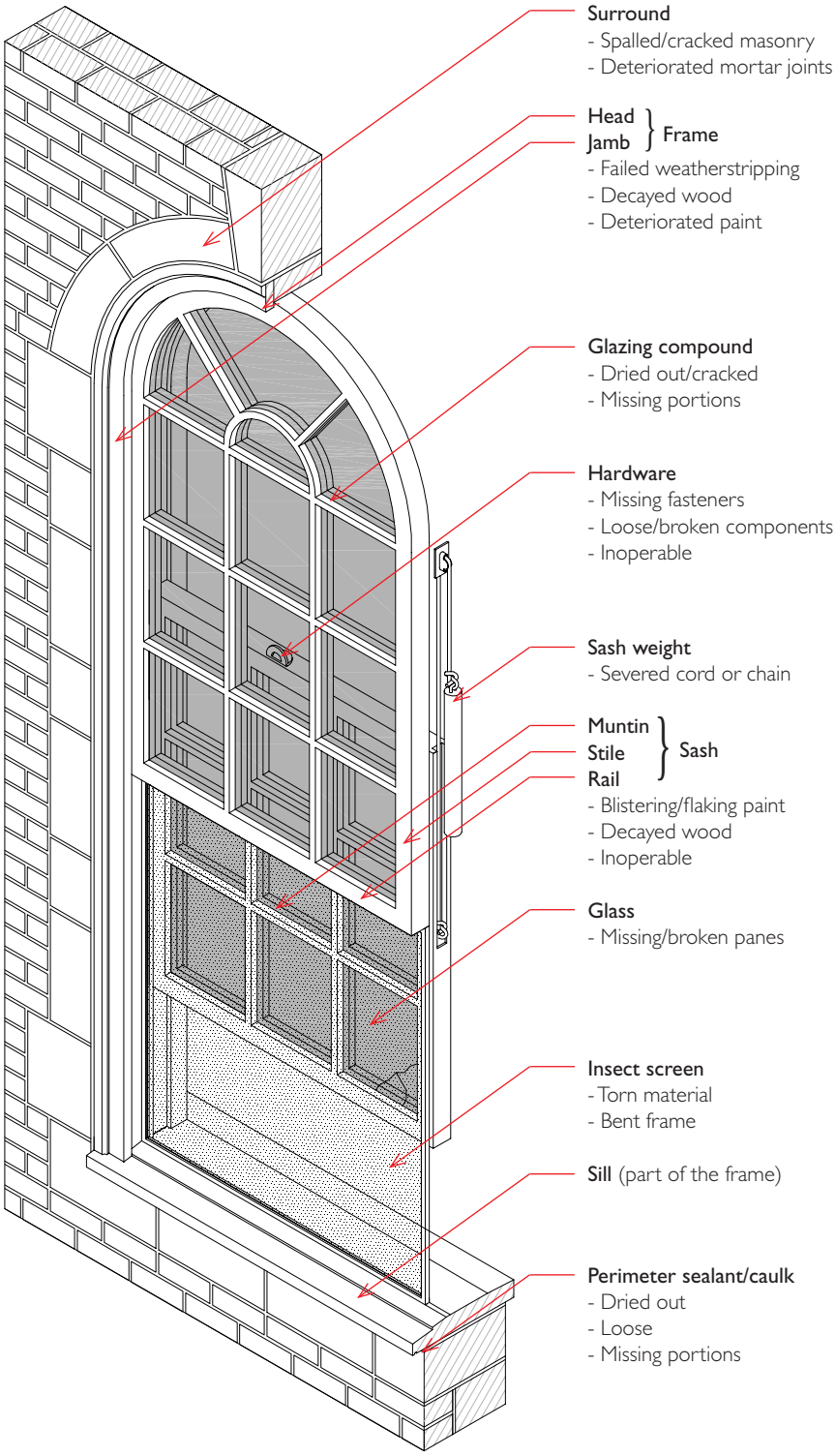
The earliest American windows were wood casement windows, hinged at the sides. By the early 1800s, sliding single- and double-hung windows had come into popular use. However, devastating fires in multiple U.S. cities during the late 19th century led to the widespread adoption of strict fire codes, which decreased the prevalence of wood windows.

At the same time, the Industrial Revolution brought about major advances in rolled steel, permitting the mass production of steel windows. These fire-resistant frames and sashes became the standard for factories and commercial buildings, as well as for larger residential buildings and universities, while wood windows continued to dominate the residential market.

Steel remained the primary material for industrial, commercial, and institutional windows in the United

Benjamin Robinson and Erin Aichler manage projects for Hoffmann Architects' Connecticut office. In collaboration with building owners and managers, they develop detailed investigation reports and identify window rehabilitation strategies to meet the specific challenges of historic buildings.

Representative Wood Window



States well into the 20th century. The strength of steel permitted larger expanses of glass, which enabled the thin profiles and repeated window patterns of Art Deco and early Modernist buildings. Then, after World War II, aluminum windows gained popularity due to their lower price and non-corroding properties. Toward the end of the 20th century, wood windows also fell out of fashion, as many homeowners replaced the original windows on their turn-of-the-century houses with vinyl, both for its inexpensiveness and for its promise of minimal maintenance.

Unfortunately, the replacement of original wood or steel windows with cheaper materials can significantly impact building appearance. Aluminum, for example, is much weaker than steel, requiring bulkier frame profiles that can destroy the delicate look afforded by multi-pane steel windows. Likewise, vinyl tends to discolor and warp over time, making it a far less durable material, long-term, than the original wood.

The good news for building owners is that options for treating deteriorated historic windows are plentiful. Energy-saving retrofits, repair, or parts replacement can restore existing windows to like-new functional condition. Should replacement be called for, it is often possible to locate or custom-make historic replicas that won't compromise building character.

Step 1: Existing Window Evaluation

Historic Significance

The first step in determining the right window program for your facility is to evaluate the condition and historical value of the existing windows. Although simple, unassuming windows might not seem significant on their own, windows should be viewed in

the context of the entire structure. Consider the architectural style of the building and the way in which the windows contribute to that style, as well as to the larger neighborhood, community, or region.

Even if the building is being adapted to a new use, windows that are original to the structure and which reflect the design intent, scale, proportion, detailing, craftsmanship, or history of the building should be considered for restoration.

Window Schedule

Successful treatment of historic windows begins with a comprehensive investigation into existing conditions, on a unit-by-unit basis. If the scope includes a large number of windows, it may be helpful to organize data into a chart that includes the following information:

- Window location (building, floor, and room)
- Elevation (e.g. north, south, east, west)
- Window type (e.g. casement, fixed, hopper)
- Frame and sash material and condition (including muntins, cames, rails, stiles)
- Size
- Glass type (e.g. single-glazed, insulated, frosted, stained glass)
- Glass and glazing compound conditions
- Finish condition
- Bowing or misalignment
- Hardware
- Screen type and condition
- Interior finishes
- Operability
- Masonry, concrete, or wood surround condition

The chart may be used to indicate not only the presence or absence of components and their general condition, but also the projected scope of repairs. Once complete, the window schedule can become part of the contract documents.

Condition

Once basic information has been recorded, elevation drawings or photographs that color-code the level of deterioration for each window may be useful in planning for rehabilitation. Include sidelights, basement-level windows, and those at towers and bulkheads. A sample classification scheme:

Good General Condition. While not perfect, the window operates effectively and has an appearance in keeping with a well-maintained building.

Weathered. No major signs of physical distress are present. Minor exterior corrosion or wood rot, deteriorated joint sealants, and peeling paint may call for maintenance.

Deteriorated. Exhibits isolated deficiencies, such as: cracked glass; broken lead cames, rails, or screens; bulging glazed panels; damaged or missing hardware; poor operation; corrosion; or failed sealant.

Severely Deteriorated. Shows extensive physical distress, which could escalate to Life Safety Risk if untreated. Shares defects in common with deteriorated windows, above, but has multiple signs of distress or failure.

Life Safety Risk. Presents defects that could harm either the operator of the window or a person outside the building, including: broken glass with exposed edges, missing or dried out glazing compound, insecure frames, and missing or broken operable sash hinges. Stabilize or replace immediately to avoid injury.

Probes can be beneficial in evaluating the construction of the rough opening and the condition of frame anchorage. For windows with moisture problems, probing into the exterior wall can identify sources of leaks and determine the condition of back-up materials. If the building has multiple types of windows, probes for each type may be appropriate.

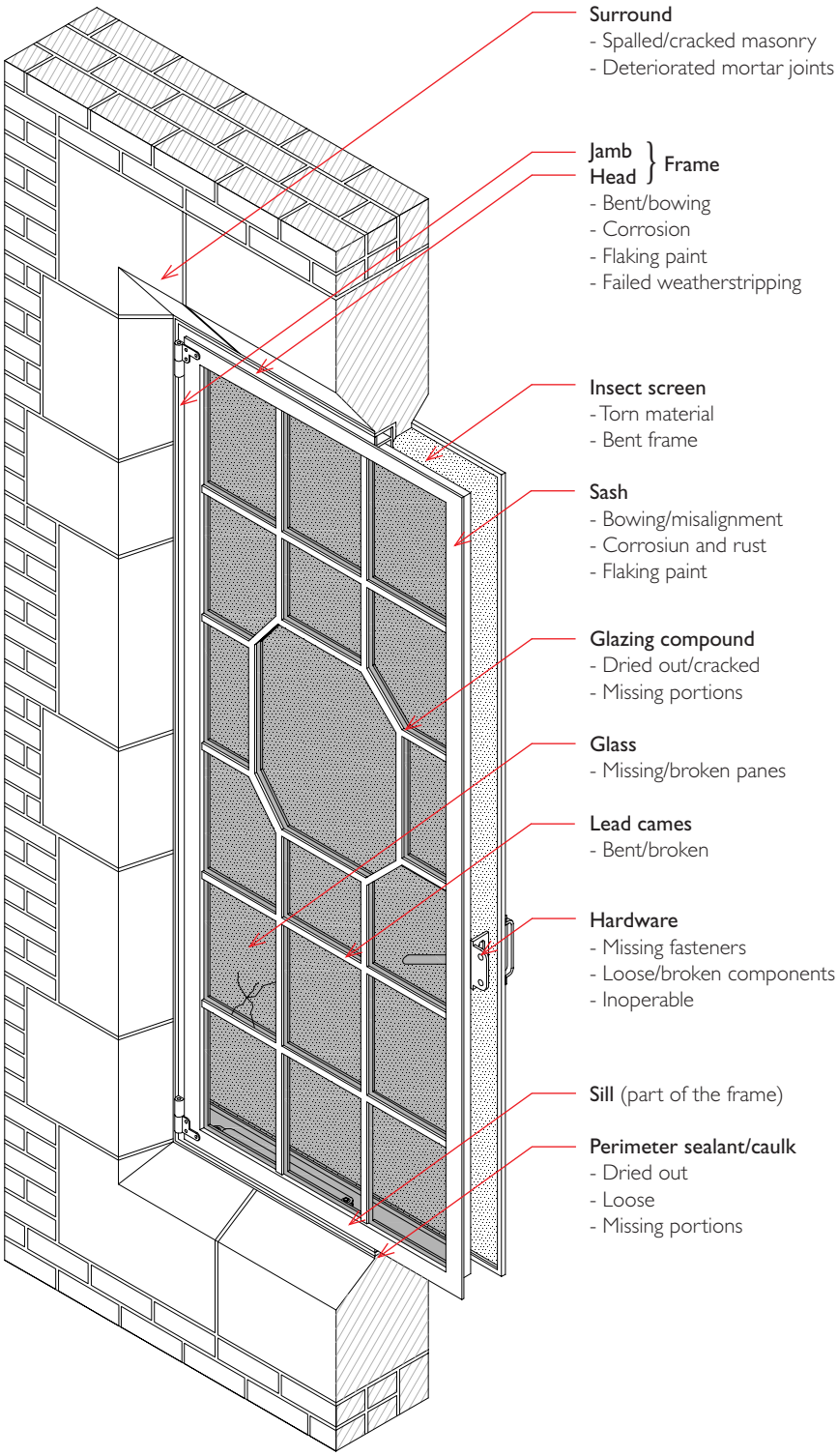
Step 2: Rehabilitation Planning

Before undertaking window rehabilitation, sources of moisture intrusion need to be identified and eliminated, and the building made as watertight as possible. For steel windows, moisture is the main cause of corrosion, and the presence of water leads to fungal growth and rot in wood windows. Therefore, failing to treat moisture entry through rough openings, facades, leaking roofs, or high-humidity interiors may mean rapid deterioration of newly restored or replaced windows.

Hazardous Materials

Health and safety risks associated with rehabilitation should also be considered. Commercially available fungicides for wood rot, as well as wood preservatives, pose health hazards. Timing restoration work to coincide with low occupancy periods and taking appropriate precautions during application are critical to minimizing exposure risk for building users. Windows installed before 1978 likely incorporate lead paint and/or lead cames, which produce toxic dust

Representative Steel Window



when disturbed. Sealants may contain asbestos or polychlorinated biphenyls (PCBs), both of which are known carcinogens. If any of these compounds are detected, proper procedures for abatement need to be considered as part of the budget and schedule.

Restore or Replace?

At a minimum, the repair/replace decision should consider the short- and long-term impact of proposed options in terms of each of the following:

Aesthetics. Preserving a historic structure is not only the purview of the owner; for local landmarks and buildings listed on the State or National Registers of Historic Places, preservation agencies may hold building management accountable to accepted restoration practices. Even where a historic commission is not involved, building users and the larger community may raise an outcry if window treatment is not in keeping with the design intent of the original structure.

Logistics. Beyond the up-front cost of repair or replacement, consider the expense of downtime during construction. When restoration is completed off-site, temporary protection of the openings is required, creating potential disruptions to occupants as well as throw-away costs. To minimize the impact on building users, extensive restoration projects are often divided into phases, sometimes over many years. Replacement of deteriorated windows can generally be completed in a shorter period of time, minimizing the site impact. However, lead time for new windows can be significant, with procurement periods as long as 16 weeks or more.

Performance. Many historic windows can be retrofitted to rival the performance of modern units; however, compromises often must be made

in terms of aesthetics, cost, or both. Storm windows, for instance, may improve window performance, but they can be unsightly, adding extra bulk to existing window profiles. Interior storm windows preserve the exterior appearance, but they may have issues with moisture condensation between panes.

Replacement of single-pane glazing with insulating glass units (IGUs) is another option, although the slim sashes of some historic windows may not be able to support the extra weight and increased thickness of IGUs without modification. Other materials on the market, such as thin vacuum-insulated glass, aim to resolve these issues, but the lifespan of such products is unknown.

Low-emissivity, or "low-e," glass improves energy efficiency by reflecting excess sunlight and reducing solar heat gain at the building interior. A major consideration for historic buildings is the reflective appearance of most low-e glazing, which can give windows an undesirable shine. Replacing all glass throughout an elevation can minimize this effect.

Adding weather stripping is a simple way to mitigate heat transfer at the window perimeter. Many types are available, from felt and vinyl to sealant beads and spring clips. By considering low-cost, low-tech retrofits, owners may be able to realize gains in performance without major capital projects. Before making a repair or replace decision based on performance, estimate the projected energy cost savings and determine how long it would take to recoup the initial investment.

Maintenance. The long-term expense and difficulty of maintaining windows is often a prime concern for building owners. New replacements may offer enticing warranties that cover premature failure; however, warranties do not cover all types of problems. Even for defects that are covered, building users still need to be inconvenienced while the window is serviced.

Hardware should be selected not only on the basis of historic accuracy, but also for its functionality, durability, and ease of maintenance. When impatient occupants force uncooperative windows open or shut, frame and sash can become misaligned or damaged. Hardware needs to be up to the task of outperforming building users.

With these considerations in mind, building owners and architects can work together to arrive at a solution that balances historic integrity and appearance with practicality and cost-effectiveness. Each building and situation is different, so it's worth taking the time to consider rehabilitation options in light of your facility's priorities and functional objectives.

Step 3: The Rehabilitation Process

Restoration

The methodology for restoration of historic windows depends upon the type of window and its condition. Below is a typical scope of repair for varying levels of deterioration.

For weathered windows: Maintenance and isolated repairs are all that is usually necessary to bring a basically sound window up to good general condition. Programs generally include:

- Removal of excessive or flaking paint.
- For steel windows, removal of light corrosion.
- Removal and repair of wood sashes and reinstallation.
- Repairs to frames.
- Priming of metal frames with rust-inhibiting coating.
- Replacement of cracked or broken glass.
- Weather stripping installation.
- Repainting.
- Cleaning and lubrication of hardware.
- Repair and caulking of window surround.

Removing peeling or built-up paint is important not only to the operability of the window and to its appearance; it also facilitates refinishing by providing a clean surface for the adhesion of new primers and paints. Corrosion of steel windows recurs very shortly after exposure to air, so metal should be primed immediately after cleaning.

For deteriorated windows: Deteriorated wood windows can usually be restored through consolidation, patching, or building up of weathered surfaces. Decayed wood may be dried and treated with fungicide, then coated with a water-resistant material, such as boiled linseed oil, and reshaped with wood putty. Semi-rigid epoxies may also be used to consolidate damaged wood.

Metal windows that are corroded—but not to the degree that they suffer structural damage—may be cleaned using anticorrosive acid cleaning compounds or sandblasting. Be sure to take precautions against toxic dust and damage to glass and masonry. Misaligned metal windows that are not too out of shape may be restored in place through the use of applied pressure. Once the frame has been reshaped and the metal cleaned of corrosion, pitted and uneven areas may be restored with steel-based epoxy or other patching material.

Once corrosion, rot, and misalignment have been treated, the repair procedures described above for weathered windows should be undertaken to restore the window to good working condition. Flexible caulk applied at window surrounds prevents air and water infiltration and moisture-related

Contractor removing lead-based paint wears personal protective equipment.

deterioration. Opt for caulk that permits differential movement of frame and surround, and which adheres well to both materials.

For severely deteriorated windows: Repairs to this class of window are usually sufficiently challenging to require an experienced craftsperson. As such, they are likely to be expensive and time-consuming. However, the right methodology may permit even badly deteriorated windows to be salvaged, at least in part. The critical determinant of time and expense is likely the proximity of a carpenter or metallurgist who is capable of reconstructing parts too damaged to be saved. In some cases, windows may need to be shipped thousands of miles to the workshop of a master artisan or specialized manufacturing facility, which may be the only option for historically accurate parts replacement and refurbishment.

Structurally compromised sections of frame and sash must be cut out and reproductions spliced in place, and it can be difficult to find an exact match for the repair. Salvaged windows from the building are the best option, but these are often unavailable. If extensive parts replacement is necessary, restoration may become cost-prohibitive.

Even where windows require major rehabilitation, restoration may still prove cost-effective through the economy of scale. Large numbers of windows may make it worthwhile for a woodworking or rolling mill to take on the project at a reduced cost. If most of the windows at a large facility are in reasonably good condition, it may also be possible to distribute the expense of more extensive repairs across the budget for hundreds of windows.

Replacement

When deterioration is widespread and it is impractical or prohibitively expensive to repair the existing windows, replacement may be considered. In selecting replacements, consider how the windows contribute to the facade appearance, as well as how they reflect the architectural style, period, and regional qualities of the building design. To retain historic character, match the new windows with the existing as closely as possible, taking into account:

- Frame material
- Color
- Operability
- Configuration
- Number and size of panes
- Proportions of frame and sash
- Profile
- Glass characteristics
- Details and decorative elements

Some manufacturers still carry windows that were in common use in the late 19th and early 20th centuries, but travel and shipping costs need to be factored into the replacement budget. A number of mass-production window companies have the capability of replicating original windows; some employ skilled craftspeople to make custom windows by hand. However, such bespoke windows come at a premium. Selecting an historical model from a manufacturer's standard product line can realize cost savings while maintaining existing sight lines and frame profiles.

More complex window replacement projects may include modification of the existing opening to accommodate a larger or smaller frame. Bear in mind, though, that altering the size of the rough opening requires detailing at the head, sill, and jamb, as well as appropriate finishing with flashings, sealants, and weep holes. Consider, too, potential structural implications.

Mockups

For a tangible sense of what restored, retrofitted, or replacement windows will look like, the building owner may wish to review mockups of proposed options. Mockups are models used to obtain feedback and refine the design concept. In some cases, a freestanding model is placed in front of the facade; in others, samples are installed.

Together, owner and architect assess the pros and cons of each design, evaluating mockups on the basis of aesthetics, function, and conformance with project objectives. Sometimes, subsequent rounds are called for, often hybrid mockups that combine desirable characteristics from previous rounds. Once a rehabilitation strategy has been selected, the project team can move into the contract document phase confident that the result meets the owner's expectations. For owners, mockups offer the security of knowing just what they are going to get.

Step 4: Ongoing Maintenance

Once a historic window project is complete, it's tempting to walk away and not look back. However, routine maintenance of frames, hardware, joints, and seals is critical to extending the life of the window as long as

(continued on page 8)

representative projects

Historic Windows

Historic and landmark structures demand special consideration. When it comes to window rehabilitation, Hoffmann Architects considers not only the building's historic character, but also the durability, energy performance, and cost of available options. We guide building owners and managers through the design and construction process to see that the chosen approach achieves the desired result.

Our architects and engineers have developed window solutions for diverse historic structures, including:

United States Capitol (1829/1866)
Washington, District of Columbia
Dome Window Restoration

Broad Exchange Building (1902) in New York, New York. *Window Study and Restoration Design.*

The Washburn Shops (1868)
Worcester Polytechnic Institute
Worcester, Massachusetts
Dormer Window, Slate Roof, and Tower Rehabilitation

Scholastic Inc. Headquarters (1889)
New York, New York
Landmark Window Rehabilitation

Old Town Hall (1905)
Stamford, Connecticut
Exterior Restoration and Window Replacement

Tower Court Complex (1915-30)
Wellesley College
Wellesley, Massachusetts
Building Envelope and Window Rehabilitation

The Loomis Chaffee School (1916)
Windsor, Connecticut
Investigation of Chapel Windows

Bellarmine Hall (1920)
Fairfield University
Fairfield, Connecticut
Window, Facade, Roof, and Terrace Restoration

Burr Hall (1921)
Eastern Connecticut State University
Willimantic, Connecticut
Window Replacement

Andrew Mellon Library (1925)
Choate Rosemary Hall
Wallingford, Connecticut
Cupola Window Replacement

Robbins Hall (1928)
New York Institute of Technology
Central Islip, New York
Exterior Restoration and Window Replacement

LoRicco Tower (1928)
New Haven, Connecticut
Window Restoration and Replacement

Folger Shakespeare Library (1932)
Washington, District of Columbia
Window Evaluation

The Bank of New York (1931)
New York, New York
Window Performance Assessment

Capital Community College (1938)
Hartford, Connecticut
Window, Facade, and Roof Rehabilitation

Former Southern New England Telephone Headquarters (1938)
New Haven, Connecticut
Steel Window Refurbishment

University of Connecticut's Benton Museum of Art (1920) in Storrs, Connecticut. *Exterior Restoration and Window Replacement.*

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possible. Regularly inspect and treat windows to address:

- Broken or missing hardware
- Incomplete closure
- Chipped paint
- Corrosion
- Failed sealant or glazing putty
- Cracked panes
- Broken muntins and caming
- Damaged or missing weather stripping

Without prompt attention to repair items, even the best constructed windows can succumb to deterioration and failure. The longer a window is permitted to languish in a state of disrepair, the more difficult and costly it will be to restore it to sound condition.

Right Solution, Right Price

Windows are a critical component of building appearance, and historic windows are no exception. A well-considered, appropriately implemented window project not only draws attention to the design and craftsmanship of the windows themselves, but also brings into relief the architectural character of the building as a whole.

For historic windows, the right approach blends sensitivity, performance, cost-effectiveness, and feasibility. A poorly executed restoration can damage existing windows and facades irreparably; likewise, unsatisfactory replacement units may ruin a building's design integrity. Taking the time to thoughtfully consider a variety of options, manufacturers, products, and methods can make the difference between a fresh-faced historic structure and a patchwork of ill-fitting parts. ■

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