

treating historic windows

A PROVEN SIX-STEP APPROACH



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Replacement of severely deteriorated historic windows should consider historic character, architectural style, and integrity of the building design.

LEARNING OBJECTIVES

After reading this article, you should be able to:

- + **IDENTIFY** deterioration conditions at historic wood or steel windows in order to plan for appropriate treatment.
- + **EVALUATE** repair and replacement options in terms of aesthetics, logistics, maintenance, and energy efficiency to develop a rehabilitation strategy that blends practical considerations with material and energy conservation.
- + **APPLY** accepted practices for abatement of hazardous materials to the treatment of historic windows, to reduce exposure risk and protect the surrounding environment from the accidental release of toxic compounds.
- + **SPECIFY** design options for windows classified as weathered, deteriorated, severely deteriorated, and life safety risk that improve thermal performance and safety without compromising historic character.

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When is it cost-effective to repair or rehabilitate existing windows, and when should you recommend that building 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.

The following is a step-by-step methodology for treating deteriorated historic windows, based on numerous projects conducted in the field by experts at Hoffmann Architects.



EVALUATE WINDOW CONDITION

The process starts with a review of the historic significance of the windows, the documentation of window types and materials, and a detailed look at their condition.

Historic significance. To determine the right window program for your facility, begin by evaluating the 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 that reflect the design intent, scale, proportion, detailing, craftsmanship, or history of the building should be considered for restoration.

Window types and materials. Successful treatment of historic windows must include 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 basic data about the window types and materials into a chart that includes the following information:

- Window location (building, floor, and room)
- Elevation (north, south, east, west)
- Window type (e.g., casement, fixed, hopper)
- Frame and sash material and condition (including muntins, comes, 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 of windows. Once the 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 side lights, basement-level windows, and those at towers and bulkheads. A sample classification scheme:

A BRIEF HISTORY OF windows in america

It's easy to lose sight of the significance of historic windows when all they seem 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 a number of U.S. cities during the late 19th century led to the widespread adoption of strict fire codes, which decreased the prevalence of wood windows.

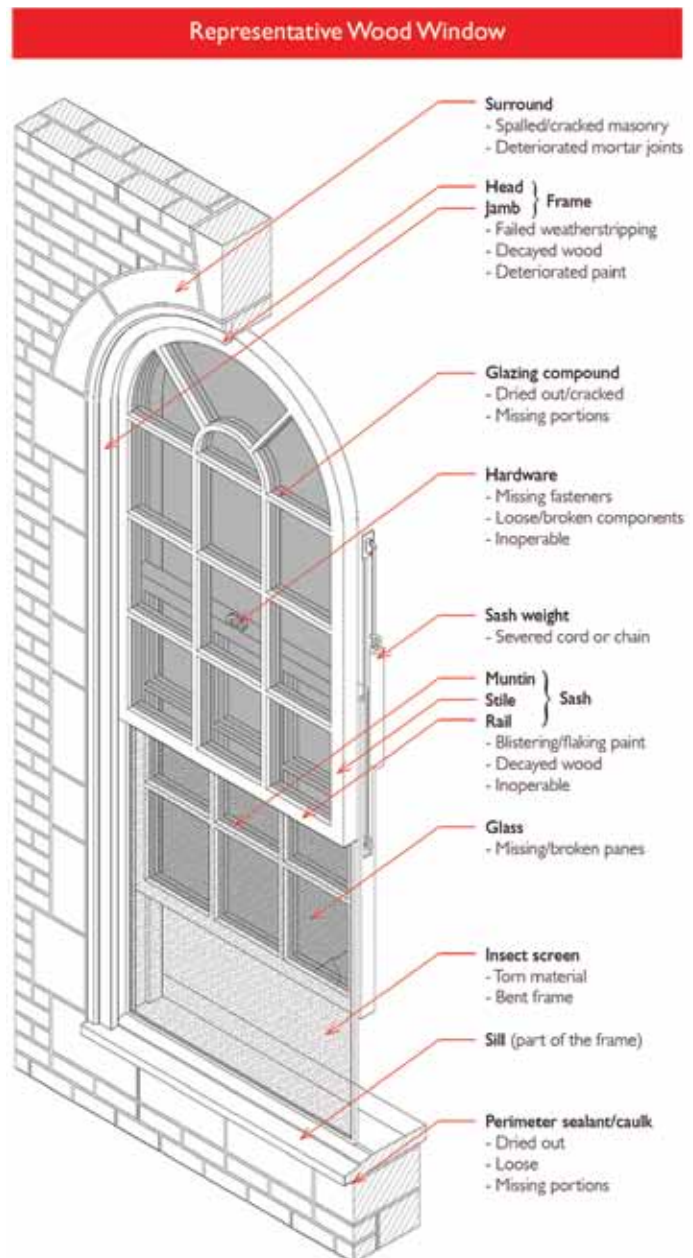
At the same time, the Industrial Revolution brought about major advances in rolled steel, permitting the mass production of steel windows. These fire-resistant frames and sashes became the standard for factories and commercial buildings, as well as for larger residential and university buildings, while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

Steel remained the primary material for industrial, commercial, and institutional windows in the United 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 may discolor and warp over time, making it a far less durable material over the 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.



- *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 comes, 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, 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. These windows should be stabilized or replaced 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 backup materials. If the building has multiple types of windows, probes for each type may be appropriate.



step 2

DEFINE PROJECT TEAM ROLES

Before embarking on a historic window project, it's useful to define the responsibilities of each party involved, so that project goals accurately reflect the owner's objectives, the end users' experience, and the expertise of the Building Team's enclosure consultants.

The owner sets forth the project goals and establishes the budget. What are the key priorities? What are the constraints? Some

owners may enter into a historic window project with set strategies and objectives in mind, while others may prefer the guidance of a design professional in identifying and evaluating available options. The owner's responsibility is to gather information and make an informed decision.

The architect identifies existing conditions, prioritizes repair needs, and presents the owner with recommendations, along with cost implications for various options. Involving the owner in the design process is essential. The architect communicates with the owner to understand the project goals and identify the best strategy for meeting those objectives, while providing a structurally, functionally, and historically cohesive solution.

The contractor assists the design professional in determining the best restoration or replacement methods, both through exploratory work in the pre-design phase and, on the design end, through mockups and testing. Contractors with experience in historic preservation often have firsthand knowledge of restoration strategies and can offer valuable input.

Maintenance staff should also be included in the rehabilitation process. As those with the most direct experience in day-to-day operations, maintenance personnel are best positioned to provide insight into the shortcomings and benefits of various repair or replacement options. Ask the maintenance staff: What are the current window conditions? What's the worst problem you encounter with the existing windows? Often, it's the maintenance staff who identify issues with window operability and performance that might otherwise elude the Building Team.

Coordinating these various viewpoints and responsibilities often falls to the architect or engineer, who then uses input from other members of the Building Team to steer the restoration or replacement design approach. Clearly defining project roles and responsibilities can help to avoid conflict down the line by providing channels of communication, realizing a project outcome that satisfies all parties and meets stated objectives.



Before, during, and after photos show the restoration of historic wood windows. Strategies may include removal of flaking paint, consolidation or patching of weathered surfaces, and treatment with water-resistant material. Local and state regulations for acceptable materials and details vary widely, so check with the authorities.





step 3

PLAN THE REHABILITATION

Before undertaking window rehabilitation, you must identify—and eliminate—sources of moisture intrusion and make the building as watertight as possible. For steel windows, moisture is the main cause of corrosion; the presence of water leads to fungal growth and rot in wood windows. Therefore, failing to treat moisture entry through rough openings, façades, 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 must be given careful consideration. 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 or lead comes, which produce toxic dust 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 must be considered as part of the budget and schedule.

The ultimate question: Restore or replace?

At a minimum, the repair/replace decision should consider the short- and long-term impacts 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 State or National Registers of Historic Places, preservation agencies may hold building management accountable for 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 upfront cost of repair or replacement, consider the expense of downtime during construction. When restoration is completed off site, you will have to provide temporary protection of the openings, thereby creating potential disruptions to occupants as well as throwaway costs. To minimize the impact on building users, you should consider dividing extensive restoration projects 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 or cost. 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 be conducive to the formation of 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 address these concerns, but the lifespan of such products is unknown.

Low-emissivity (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. Many low-cost, low-tech retrofits can achieve 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 concerns.* 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 will 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, architects, and project teams 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 the facility's priorities and functional objectives.



step 4

CONSULT THE HISTORIC/LANDMARK AUTHORITY

Before settling on a repair or replacement strategy, it's critical to consult with the relevant authority having jurisdiction over historic and landmark buildings.

Depending upon the location and situation, there may be restrictions on the available treatment options. For instance, most historic commissions favor restoration over replacement, and will consider replacement only when the restoration is impossible. Buildings not subject to such restrictions may have more options, such as low-maintenance PVC frames that look like wood but don't peel, splinter, or rot. Some landmark requirements may stipulate only that replacements mimic the existing windows in appearance, with the same sight lines but not necessarily the same materials.

Because regulations vary by jurisdiction, confer with the State Historic Preservation Office (SHPO), local landmark commission, and other relevant authorities. In addition, refer to the Secretary of the Interior's Standards for the Treatment of Historic Properties from



Wood frames too badly deteriorated for consolidation or surface treatments may be restored using a so-called “Dutchman” repair, whereby rotted wood is cut out and a new piece of wood is spliced in its place. Proper treatment often depends on the availability of a skilled carpenter to construct the parts.

the National Park Service, which provides guidelines for addressing deteriorated historic windows.



ESTABLISH THE REHABILITATION OR REPLACEMENT PROCESS

The methodology for restoring historic windows depends upon the type of window and its condition. The following provides a typical scope of repair for various 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. Many repairs can be done in place, without necessitating window disassembly and reinstallation. Removal of excessive or flaking paint and, in the case of steel windows, light corrosion, can all be accomplished without removing the window. Not only is removing peeling or built-up paint important to the window's operability and appearance, it also facilitates refinishing by providing a clean surface for the adhesion of new primers and paints. For metal frames, application of a rust-inhibiting coating can help to prolong the lifespan of the window and prevent unsightly oxidation from developing. Corrosion of steel windows recurs very shortly after exposure to air, so metal should be primed immediately after cleaning.

Where historic window sashes can be removed relatively easily, it may be more effective to restore the sash separately from the frame and surround. Removing the sash also facilitates replacement of cracked or broken glass, which can more readily be accomplished off-site. To improve energy performance, weather stripping installation and caulking of the window surround may be included in the scope of restoration. Finally, cleaning and lubricating the hardware gives the window a fresh look while improving functionality.

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. In some cases, warped wood windows may be softened in steam chambers and reshaped. “Dutchman” repair—that is, splicing in new wood segments to replace rotted wood—is another option. Once painted, the repair area blends in with the original frame or sill.

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.

After 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 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 difficult to require an experienced craftsman, so they're likely to be expensive and time-consuming. However, the right methodology may permit even badly deteriorated windows to be salvaged, at least in part. In terms of time and expense, a lot depends on the availability of a skilled carpenter or metallurgist who is capable of reconstructing parts. Without such a specialist nearby, you may have to ship windows 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 somewhat 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.

The replacement option. When deterioration is widespread and it is impractical or prohibitively expensive to repair the existing windows, your only remaining option may be replacement. In selecting replacements, consider how the windows contribute to the façade 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
- Sight lines
- Glass characteristics
- Details and decorative elements

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.

Window manufacturers are often an excellent resource when evaluating replacement options. Questions to ask a manufacturer:

1. Could you examine our existing windows and propose replacement options?
2. Do you have skilled workers available who can build exact replicas of the existing windows?
3. If you can't match the existing windows, what options are available that are consistent with the historical period of the originals?
4. What is the cost savings of your standard product line versus custom-crafted replacements?
5. What energy-saving options are available?
6. Is it possible to reuse the existing hardware with the new windows?
7. What is your experience in working with historic preservation authorities to gain approval for replacement windows?
8. What is the relative cost and lead time for each replacement option under consideration?

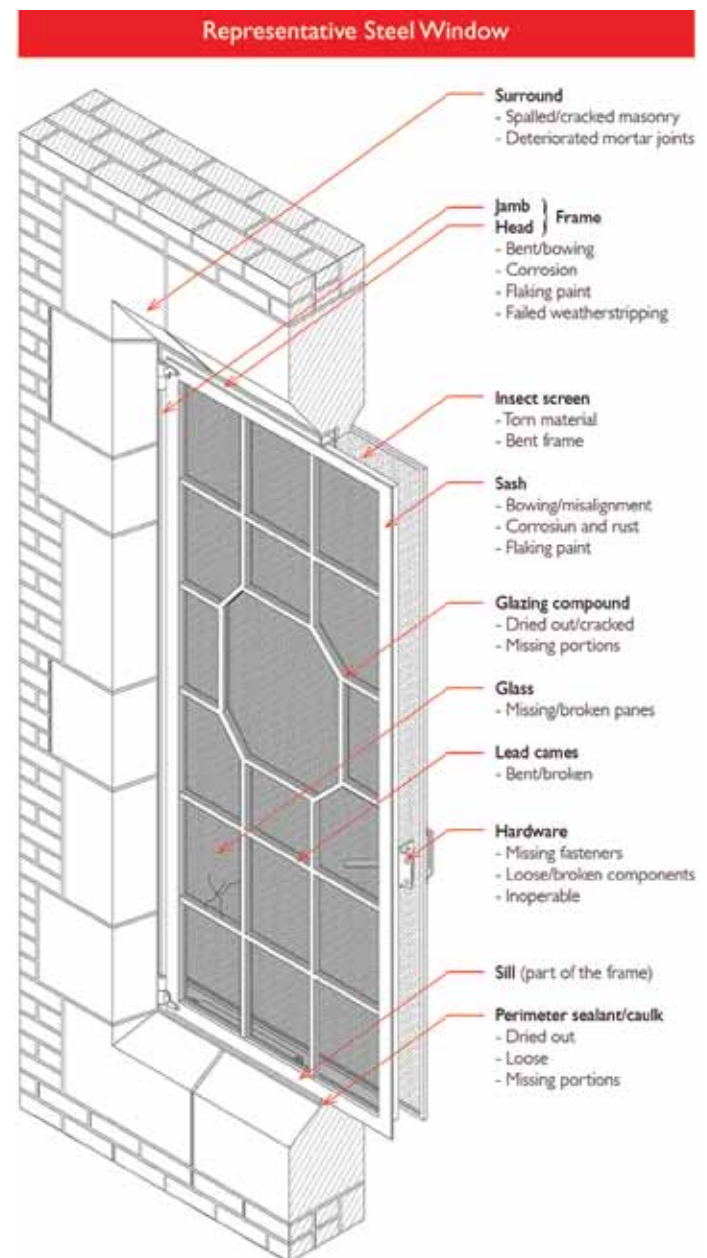
With the owner's goals in mind, the design professional and project team should consult a number of window manufacturers before selecting a replacement window.

Some manufacturers still carry windows that were commonly used 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 can replicate original windows; some employ artisans to make custom windows by hand. However,

bespoke windows come at a premium. Selecting a historical model from a manufacturer's standard product line can realize cost savings while maintaining existing sight lines and frame profiles.

Building usage and function can also impact selection of appropriate replacement windows. For instance, at a college residence hall or apartment building, where window operability is a key consideration, the historic accuracy of hardware may be less important than its durability and user-friendliness. If maintenance personnel are constantly repairing bent hinges or jammed latches, authenticity may need to be jettisoned in favor of functionality.

Location on the building also plays a role in replacement selection. Windows at a belfry or cupola that are viewed only from ground level



may be effectively unchanged from an aesthetic point of view if re-constructed in polyvinyl chloride instead of the original wood; moreover, they will likely benefit from improved long-term appearance if their hard-to-reach location makes it difficult to maintain them.

In contrast, windows at eye level tend to demand more attention to authenticity than to maintainability, as deviations from original materials or construction will likely be apparent even to casual observers at such close range. Fortunately, windows that are low enough for scrutiny also tend to be readily accessible for maintenance, permitting attentive stewardship of those windows most closely on view.

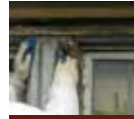
Using mockups. For a tangible sense of what restored, retrofitted, or replacement windows will look like, the building owner may wish to review mockups of proposed options. Mockups are physical models used to obtain feedback and refine the design concept. In some cases, a freestanding model is placed in front of the façade; in others, samples are installed. In general, it's a good idea to test options from more than one manufacturer.

Together, the owner, architect, and other members of the Building Team should assess the pros and cons of each design, evaluating mockups on the basis of aesthetics, function, and conformance with project objectives. Maintenance personnel are a good resource, as they can attest firsthand to the operability and durability of windows under consideration. Discovering a problem, such as defective hardware or screens, during the mockup process enables design changes to be made before hundreds of windows are installed.

For some particularly sensitive projects, multiple rounds of mockups may be called for, with "hybrid" mockups that combine desirable characteristics from previous rounds. Obtaining feedback from maintenance staff and building users is an important part of this process. Once a rehabilitation strategy has been selected, the Building Team can move into the contract document phase confident that the result meets the owner's expectations. For owners, mockups offer the security of having a much clearer picture of what they're going to get.



Mockups of proposed window restoration or replacement designs permit on-site evaluation of hardware, operability, aesthetics, and performance.



step 6

PROVIDE FOR ONGOING MAINTENANCE AND REPAIR

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 possible. Building owners and managers, in consultation with the design professional and others on the Building Team, should 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 casing
- Damaged or missing weather stripping

Without prompt attention to repair items, even the most carefully 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 façades 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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> EDITOR'S NOTE

This completes the reading for this course.

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