the came (Fig. 13). Came can have a flat, rounded, or "colonial" profile, and aside from a few specialty and perimeter cames (U-channel), is based on a variation of the letter "H" and ranges from 1/8" (3.2mm) wide to 1½" (38mm) wide. The cross-section strength of came varies depending on the thickness of the heart and flanges. Occasionally, came with reinforced (double) hearts or a steel core was used for rigidity, usually in doors and sidelights. Such came added strength at the expense of flexibility and was typically used for rectilinear designs, or for strategically placed reinforcement within a curvilinear design.

How the cames are joined in a leaded panel is crucial to their long-term performance. Poor craftsmanship leads to a weak assembly and premature failure, while panels fabricated with interlocking (weaving) cames and lapped leads add strength. Soldered joints often reveal the skill level of the artisan who assembled the window, and can give evidence of past repairs. Solder joints should be neat and contact the heart of the came--wherein lies its greatest strength. Came joints should be examined closely; large globs of solder commonly conceal cames that do not meet. (Lead cames typically crack or break along the outside edge of the solder joint; stronger zinc cames frequently break the solder itself where it bridges junctures.)

Leading patterns designed with inadequate support also contribute to structural failure. Panels with a series of adjacent parallel lines tend to hinge or "accordion," while lines radiating in concentric circles tend to telescope into a bulge. Stronger leading techniques, support bars, or specialty cames are sometimes required to correct poor original design. Minor sagging and bulging is to be expected in an old window and may not require immediate action. However, when bulges exceed 1½" (38mm) out of plane, they cross into a precarious realm; at that point, glass pieces can crack from severe sagging and pressure. If the bulged area moves when pressed gently, or if surrounding glass is breaking, it is time to address the problem before serious failure results.

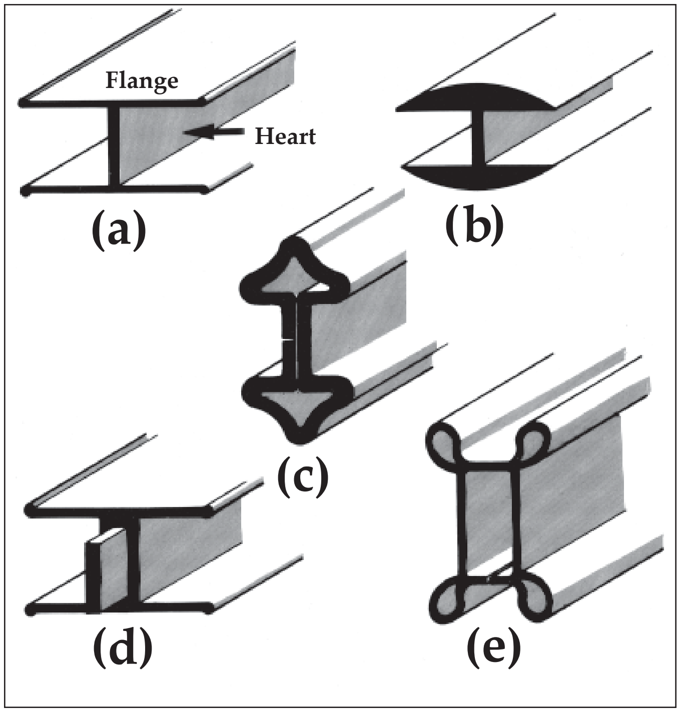


Figure 13. A wide variety of came has been used for ornamental glass in America: (a) flat lead came; (b) round lead came; (c) "Colonial" zinc came; (d) double-heart lead came with a steel core; (e) "Prairie School" zinc came.

Cleaning, Repair and Protection

The level of cleaning, repair, or protection depends on the condition, quality, and significance of the glass, and, as always, the available budget. Hastily undertaken, overly aggressive, or poorly executed repairs can cause more damage than does prolonged deterioration. Repairs should, therefore, only be undertaken after carefully evaluating the condition of the glass—and only by professionals. Minor cracks, sagging, and oxidation are part of the character of historic leaded glass, and require no treatment. More extensive cracks, major bulges (generally, more than 1½" [38mm]), and other signs of advancing deterioration may call for intervention, but caution must always be exercised. And each window must be evaluated separately. In some cases, windows have bulged up to 4" (102mm) out of plane without harming the pieces of glass or risking collapse.

Cleaning

Perhaps the greatest virtue of stained glass is that its appearance is constantly transformed by the ever-changing light. But dirt, soot, and grime can build up on both sides of the glass from pollution, smoke, and oxidation. In churches the traditional burning of incense or candles can eventually deposit carbon layers. These deposits can substantially reduce the transmitted light and make an originally bright window muted and lifeless. Simply cleaning glass will remove harmful deposits, and restore much of its original beauty, while providing the opportunity to inspect its condition closely (Fig. 14). The type of cleaner to use depends on the glass. Water alone should be tried first (soft water is preferable); deionized water should be used for especially significant glass and museum quality restorations. If water alone is insufficient, the next step is to use a non-ionic detergent. Occasionally, windows are covered with a yellowed layer of shellac, lacquer, varnish, or very stubborn grime that requires alcohol, or solvents to remove. Most unpainted art glass can be treated with acetone, ethanol, isopropyl alcohol, or mineral spirits to remove these coatings if gentler methods have failed. All chemical residues must then be removed with a non-ionic detergent, and the glass rinsed with water. (All workers should take normal protective measures when working with toxic chemicals.)

Painted glass must never be cleaned before the stability of the paint is confirmed, and only then with great caution. If the paint is sound, it can be cleaned with soft sponges and cloth. If the paint was improperly fired or simply applied cold, paint can flake off during cleaning and special measures are required such as delicate cleaning with cotton swabs. Occasionally, paint is so fragile the owner must simply document and accept the windows in their current state rather than risk losing the original surface. Fragile paint typically calls for an experienced glass conservator and more costly restoration measures.

Acidic, caustic, or abrasive cleaners should never be used. They can damage glass. Most common household glass cleaners contain ammonia and should not be used either. Cleaning products should have a neutral pH.

Repair

As with all elements in older and historic buildings, maintenance of leaded glass units is necessary to prevent more serious problems. It is essential to keep the frame maintained regardless of the material. Often, this simply entails regular painting and caulking, and periodic replacement of the glazing compound. Wood frames should be kept painted and caulked; new sections should be spliced into deteriorated ones, and epoxy repairs made where necessary. Masonry frames must be kept well pointed and caulked to prevent moisture from corroding the steel armature and anchors within.

Windows that leak water, are draughty, or rattle in the wind (or when gently tapped) may indicate that the waterproofing cement ("waterproofing") and sealants have deteriorated and maintenance or restoration is needed. Waterproofing is a compound rubbed over the window—preferably while flat on a table—and pressed under the came flange to form a watertight bond between the leading and the glass. Traditionally, waterproofing was made of linseed oil and whiting, and a coloring agent. (Hardening agents should not be included in the mixture; solvent-based driers should be used sparingly.) The waterproofing allows leaded glass in a vertical position (e.g., in windows) to be used

Figure 14. The external glass plate has been removed to clean the interlayer of this plated Tiffany Studios window.

as a weatherproof barrier. It does not provided adequate protection for leaded glass in a horizontal or arched position; leaded glass ceilings and domes must always be protected by a secondary skylight or diffusing skylight.

Glazing and sealants (e.g., putties, caulks) are used to seal the leaded panel against the sash, and to seal any open joints around the window frame. Sealants improved dramatically in the mid-twentieth century. But these sealants are not without problems. Some release acetic acid as they cure. Acetic acid can harm lead, and should never be used on leaded glass. Instead, "neutral cure" sealants should be used. These high-performance construction sealants are not sold in consumer supply stores.

The appropriate type of sealant depends on the materials to be bonded and on the desired appearance and longevity. When windows are to be restored, the contractor should explain what types of waterproofing and sealants are to be used, and how long they are expected to last. On large projects, a letter from the product manufacturer should be obtained that approves and warranties the proposed application of their product. When in doubt, a traditional linseed-oil based glazing putty is often best.

Leaded panels will generally outlast several generations of waterproofing. When the waterproofing has failed, the window should be removed from the opening and waterproofed on a bench. Leaded glass cannot be adequately waterproofed in place. Removing the windows will provide an opportunity to perform maintenance on the window surround and to secure the reinforcement. This is far less expensive than totally releading the window, which is typically required if maintenance is deferred. When waterproofing or sealants break down, many building owners attempt to resolve the problem by installing protective glazing, when the window only needs maintenance. Protective glazing is not an alternative to maintenance; in fact, it impedes maintenance if not installed properly and can accelerate the deterioration of the stained glass.

A very common—but extremely harmful—practice in the American stained glass industry is performing major window repairs in place. The practice is routine among churches where the cost of restoring large windows can be prohibitive. However, undertaking major repairs in place provides only a quick fix. A window cannot be properly repaired or restored in place if it is bulging or sagging far out of plane, if over 5% of the glass is broken, or if solder joints are failing. Unscrupulous glazers can introduce a great deal of stress into the glass by forcibly flattening the window in place and soldering on additional bracing. At a comfortable distance the window may look fine, but upon close inspection the stress cracks in the glass and broken solder joints become obvious. Windows subjected to this treatment will deteriorate rapidly, and complete, much more costly restoration will likely be necessary within a few years (while a proper repair can easily last two generations or more).

Major repairs to windows are sometimes part of a larger preservation project. In such cases, the risk of damaging the windows can be very great if their removal and reinstallation have not been carefully planned. When major building repairs are also to take place, the windows should be removed first to prevent damage during other work. Windows should be reinstalled as the next-to-last step in the larger project (followed by the painters or others working on the finishes surrounding the stained glass).

And glass should be protected whenever other work is undertaken on buildings--whether or not the windows are also to be repaired. External scaffolding, for example, erected for repointing or roofing projects, may offer vandals and thieves easy access to windows and, through them, to building interiors. Stained and leaded glass should always be well protected whenever chemical cleaners are used on the exterior of the building; some products, such as hydrofluoric-acid cleaners, will cause irreversible damage.

Repairs to Glass

Minor repairs, such as replacing a few isolated pieces of broken glass, can be performed in place. This work, typically called a "drop-in," "stop-in," or "open-lead" repair, entails cutting the came flange around the broken piece of glass at the solder joints, folding it back to repair or replace the old glass, and resoldering the joints. Repairing a zinc came window is not as easy. Zinc cames are too stiff to open up easily, so they must be cut open with a small hack saw and dismantled until the broken area is reached. The glass is then repaired or replaced and the window is reassembled. New cames can be patinated to harmonize with the originals--but only with difficulty. Repatination should never be attempted in place, since it is impossible to clean off harmful residues trapped under the came.

Original glass should be retained whenever possible, even though it may be damaged. Replacement glass that exactly or closely matches the original piece can be very difficult to find, and costly to make. An endless variety of glass colors and textures were produced, and given the delicate chemistry of glassmaking, even samples from the same run can be noticeably different. The traditional

Photographing Stained Glass

Historic stained glass windows, laylights and domes should be documented to help ensure the best-quality restoration in the event of vandalism, fire or other loss. Photographic documentation is also important for insurance and investigation purposes when vandalism or theft is involved. Given the highly photogenic nature of stained glass, photographs can also serve as artwork for guidebooks or other interpretive or publicity purposes; quality photographs can be especially worthwhile in fundraising efforts.

Photographing stained glass is both challenging and rewarding. Windows and domes lit by daylight can seem to be ever changing in visual appearance. They can appear dramatically different in any given photograph depending not only on the photographic equipment and settings used, but also on the time of day, degree of cloud cover, the ambient interior light, and a multitude of other factors. Moreover, photographs may differ depending on the aspect to be captured. Painted flesh areas and highly translucent Prairie School windows often "burn out" if photographed in bright sunlight, while faceted jewels and very dense or plated opalescent glass often look best in direct sunlight.

Generally, exposures should be bracketed to capture the full range of the stained glass; the variation in images can permit different images to serve different purposes. Under most circumstances, interior lights should be turned off, and the stained glass should be photographed in both transmitted light (no flash) and reflected light utilizing a flash. The flash should ideally be positioned away from the camera to provide a raking light and to avoid reflected "hot spots." Although photographing with a flash will neutralize the transmitted light and black out the glass, it reveals the location and condition of the lead cames, braces, tie-wires, and other structural elements.

A tripod should be employed for a sharp image whenever using long exposures and higher apertures. The subject should be shot as level as possible to minimize the distortion known as "parallax." Occasionally, when shooting a group of windows, it is beneficial to develop a cardboard, Ecuboard, Masonite or similar cutout material to mask the window being photographed. Adjacent windows or windows on the opposite side of the room may need to be shaded or blocked to avoid "front lighting" on the window from competing with the transmitted light. Windows should also be photographed from the outside if there is no protective glazing to interfere with the view. This is particularly important with opalescent glass, which often was intended to be read from the exterior as well as the interior.

Some glass projects warrant a visual representation of the stained glass window to be in place during restoration. After establishing the existing window dimensions, a photograph of the stained glass window can be enlarged to full scale and copied on adhesive-backed transparent film. In essence a decal, it can then be applied to acrylic or polycarbonate sheets and used as a temporary replacement to fill the opening (above). Such film decals are sensitive to light and will not last indefinitely. However, they are reasonably convincing from a distance and can last a year or longer while the actual window is being restored.

Figure 15. To permit repair of the cracked glass, the original lead overlay is first salvaged from this historic leaded panel of silhouette glass to retain as much of the original work as possible.

Figure 16. A valuable historic piece of original hand-painted glass is carefully edge-glued with epoxy.

secrecy that shrouds the glassmaking trade to this very day, as well as environmental bans of historically popular ingredients such as lead and cobalt for deep blues and greens, further hinders accurate reproductions. Therefore, *it is nearly always better to use an imperfect original piece of glass than to replace it* (Fig. 15). If the paint is failing on a prominent feature of a window, a coverplate of thin, clear glass can be painted and placed over the original. (The coverplates must be attached mechanically, rather than laminated, so that they can be removed later if necessary.) A reverse image of the fading feature should be painted on the backside of the coverplate in order to get the two painted images as close together as possible. With repetitive designs, stencils can be created to produce multiple duplicates.

Sometimes replacement is the only option. Fortunately, custom glass houses still exist, including the company that originally supplied much of the glass for Tiffany commissions. Stained and leaded glass has also experienced a resurgence in popularity, and American glassmakers have revived many types of historic glass.

When missing, shattered, or poorly matched glass from later repairs must be replaced, the new pieces should be scribed on the edge (under the came) with the date to prevent any confusion with original glass in the future.

Glass cracks will enlarge over time as the contacting edges grind against each other, whenever the window is subject to vibration, thermal expansion and contraction, and other forces such as building movement. Therefore, it is important to repair cracks across important features as soon as they are detected and while a clean break remains. Years ago, cracks were typically repaired with a "Dutchman" or "false lead" by simply splicing in a cover lead flange over a crack. Although this conceals the crack, it creates an even larger visual intrusion and provides no bond to the glass. Today, there are three primary options for repairing broken glass: copper foil, epoxy edge-gluing (Fig. 16), and silicone edge-gluing. These techniques differ in strength, reversibility, and visual effect, and the appropriate repair must be selected on a case-by-case basis by a restoration specialist.

Copper Foiling: Copper foil has the longest history and, unless the glass is unstable, is generally the best option when a piece of glass has only one or two cracks. Copper foil is a thin tape that is applied along each side of the break, trimmed to a minimal width on the faces, and soldered. A copper wire can be soldered on where additional strength is required. However, copper foil repairs should not be used on unstable glass, since heat is required that can cause further damage. Copper foil produces a strong repair, is totally reversible, and has a negligible aesthetic impact (a 1/16" [1.6mm] wide line).

Epoxy Edge-Gluing: This technique produces a nearly invisible line and is often used on painted glass, particularly focal points of a window such as a face, or a portion of sky intended to be one continuous piece. Epoxy can even be tinted to match the glass. It is also used for infusing shattered glass or microscopic cracks caused by intense heat from a fire. Epoxy produces a very strong repair, but will deteriorate in sunlight and requires secondary glazing to protect it from UV degradation. Epoxy is the least reversible of the three techniques, and usually the most expensive.

Silicone Edge-Gluing: This repair method has the lowest strength and should be used when a flexible joint is desirable—if, for instance, the window will be under continuous stress. Silicone repairs are easily reversible, and can be removed with a razor blade—when they are done correctly, that is. Silicone edge-gluing is not the same as smearing silicone all over the glass. This unfortunate practice, seen throughout the country, is useless as a repair technique, and usually causes more damage than if the glass were left alone. Silicone is almost clear, but it refracts light differently from glass and is, thus, easily detectable. Silicone is not affected by temperature, humidity or UV light. Silicone repairs are typically the least expensive repair option.

Repairs to Structural Support Systems

Windows may have detached from the saddle bars and begun to sag, bulge, and bow extensively. This point varies from window to window. Generally, however, a window sagging or bulging more than 1½″ (38mm) out of plane has reached the point where it should be removed from the opening to be flattened out. Under these conditions, it is essential to note if the support system or leading pattern has failed so it may be corrected before the window is reinstalled. The window must be allowed to flatten over a few weeks in a horizontal position. This will minimize stress on the solder joints and glass. A moderate weight and controlled heat will help coax the window back into its original plane. The process requires patience. Once the window has flattened, the original support system should be reattached and additional support added as necessary. It is crucial to consider the original design so the new support bars do not intrude on important window features. Sometimes small thin braces or "fins" can be manipulated to follow existing lead lines exactly. These give support, but are almost invisible. Flattening windows also provides a good opportunity to apply new waterproofing to help prevent further deterioration. Today, a wide variety of traditional and synthetic compounds are employed.

Windows should only be removed when they need to be flattened, waterproofed, reinforced, or releaded. Allow plenty of time for careful, thorough work. Large projects can take several months, especially if complete releading is necessary. Owners, consulting professionals, and construction managers must therefore ensure that vacant openings will be weathertight for an extended period—whether the openings are covered by plywood, acrylics, or polymer film. If desired, images of the window can be printed on adhesive film and applied to rigid plastic and installed in the openings as temporary facsimiles during studio restoration.

Rebuilding or releading a window is an expensive and involved process. The releading process requires that a window be disassembled before it can be reassembled (Fig. 17). The glass pieces must be removed from the cames, the old cement must be cleaned from each piece of glass, and all the pieces must be rejoined precisely. At every step the process involves the risk of damaging the glass. Furthermore, exceptional studios had unique leading techniques, and thus the cames should not be replaced casually. Total releading should only be undertaken when necessary to avoid or slow the loss of historic fabric. (It is essential to request a copy of all window rubbings if the windows are to be completely releaded.)

Lead and zinc cames, however, are intended to be a sacrificial element of a glass unit assembly, as mortar is to brick and paint is to wood; came will break down long before glass and must ultimately be replaced; came typically lasts 75 to 200 years depending on the window's quality, design and environment. A common preservation conflict arises in releading historic windows: whether to retain historical accuracy by using the existing profile, or to use came with a stronger profile for greater longevity. The decision must be carefully weighed depending on the significance of the window, the contribution of the came profile to the overall design, and the severity of the deterioration caused by a thin or weak came. In most windows, the came profile is essentially lost in transmitted light, but occasionally shadow lines are important and should be reproduced. Furthermore, it is important to correct technical problems that arise from flimsy original came. Occasionally, a slightly heftier came may be the best solution to resolve weak panels that have not proven the test of time. Under these circumstances, the thicker lead came (even if only 1/64″ [0.4mm]) will cause a re-leaded panel to swell slightly, and the frame or perimeter leads may have to be trimmed to fit the opening. (Trimming the glass should be the very last resort.) This would not be an appropriate solution in a museum-quality restoration or for a highly significant window.

Protective Glazing and Screens

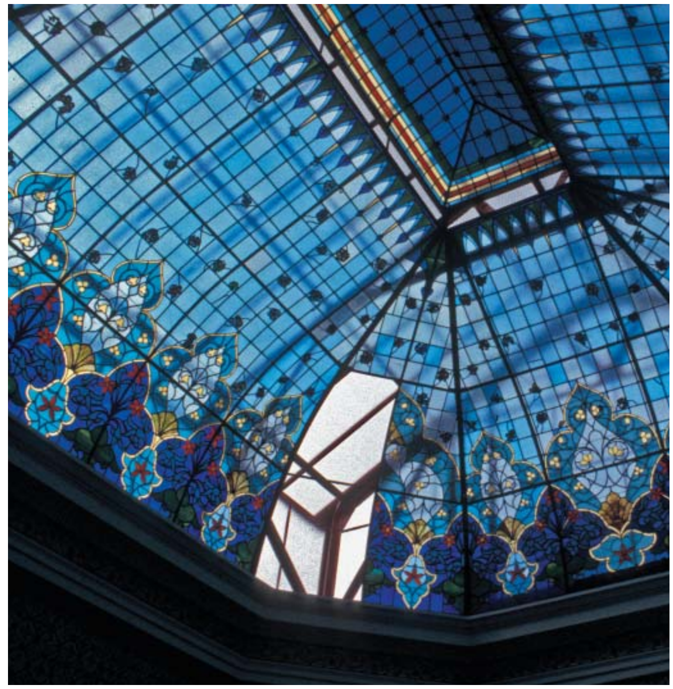
The use of protective glazing (also known as secondary or storm glazing) is controversial. Potential benefits of protective glazing are that it can shield windows from wind pressure; increase energy savings; protect against environmental pollutants and UV light; provide vandalism and security protection, and reduce window maintenance. Potential drawbacks are that it can promote condensation; cause heat to build up in the air space and thereby increase the window's expansion/contraction; eliminate natural ventilation; reduce access for maintenance; offer a poor energy payback for the cost, and significantly mar the building's appearance. Protective glazing is often presented as a cheaper alternative to full-scale restoration. And all too often protective glazing is installed as a routine matter when there is little threat of damage from vandalism or other causes. Protective glazing, especially when improperly installed, may hasten deterioration of stained glass windows.

Figure 17. Total releading is very time consuming and costly and should only be undertaken when the original lead is exhausted beyond repair.

Domes and Ceilings

Stained glass domes and ceilings were very popular throughout the Victorian and Classical Revival periods. They are often principal interior features of churches, hotels, restaurants, railway stations, and civic buildings. The loss or unsympathetic alteration of leaded glass ceilings and domes is a widespread problem. Poorly planned rehabilitation projects sometimes cause the unnecessary removal or alteration of overhead leaded glass in order to comply with fire codes or to achieve perceived energy savings; occasionally, they are even concealed above suspended ceilings.

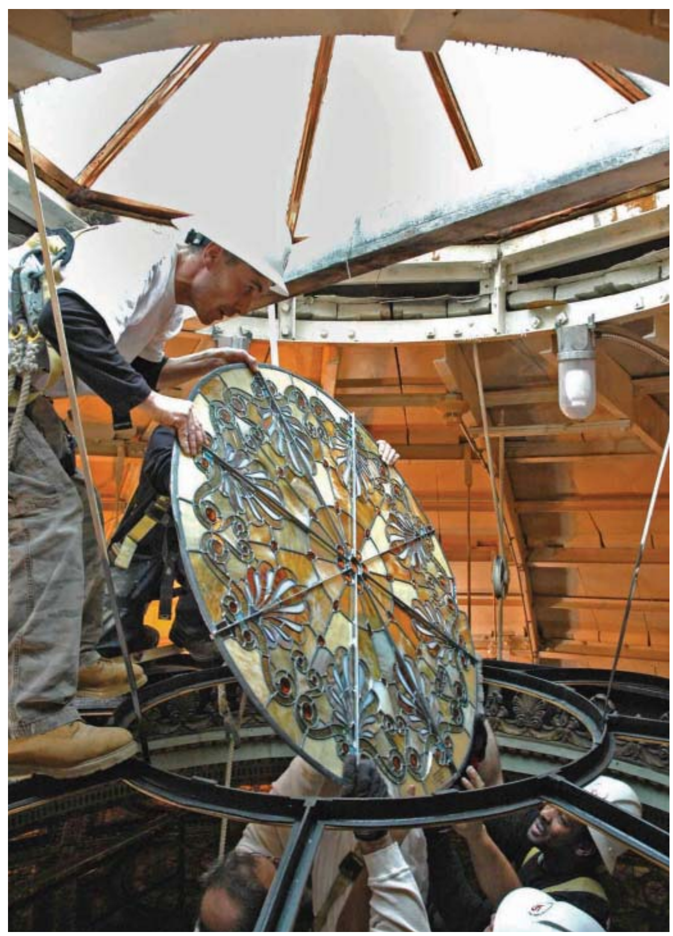
Moreover, stained glass in the horizontal position readily collects dust and dirt over the years and is relatively inaccessible for cleaning. It is also more likely to "creep" or slump when the reinforcement is inadequate. Most importantly, leaded glass cannot be sufficiently weatherproofed in a horizontal (or arched) position. It must *always* be protected by skylights or "diffusers"—rooftop features that diffuse the natural daylight into the attic or light shaft, and protect the leaded glass ceiling or dome from the elements (a).



(a) Stained glass ceilings and domes are often principal interior features of churches, hotels, restaurants, railway stations, and civic buildings. This vaulted ceiling illuminates the Cypress Lawn Memorial Gardens mausoleum in Colma, California. The panel removed reveals the diffusing skylight above.

Due to the inferior quality of glazing sealants of the late 19th and early 20th centuries, and to deferred maintenance, glass ceilings have frequently been removed or covered with roofing materials. Artificial lighting is then required to backlight the ceiling or dome, which robs the stained glass of its life–the vibrant effects created by ever-changing natural light. All types of artificial lighting can be found from floodlamps to fluorescent tubes. Outside sensors are even used to modulate the light level in an attempt to simulate changes in daylight. However, daylight is impossible to emulate. Moreover, it's free. Artificial lighting requires maintenance, introduces an additional fire hazard in the attic, increases the building's electrical load, and is supplied only at a financial and environmental cost.

Stained glass ceilings and domes that have been sealed off from natural light should be investigated for restoration. Once natural light is restored and the stained glass is cleaned, the lighting effect on an interior can be extraordinary. Improved skylight designs and major advances in glazing sealants since World War II (particularly silicones) encourage the restoration of skylights without the fear of inheriting a maintenance nightmare (b).



(b) Workers install a jeweled art glass oculus of a Healy & Millet dome. The diffusing skylight was restored overhead to reintroduce daylight to the historic 1897 dome after being roofed over since the 1940s.

Figure 18. On this pair of neo-gothic church windows, the aluminum frame grid used for protective glazing disregards the original tracery of the window on the left. The grid mars the appearance of the window inside and out. It also impairs the overall historic character of the building. The plastic storm glazing has been removed from the adjacent window to restore the original window appearance.

Various types of metal grills or screens are also used. They add security and vandalism protection but also impair the appearance of the window (inside and out) by creating new shadows that telegraph on the stained glass or diffusing transmitted light. As a general rule, protective layers should not be added on historic buildings unless the glass setting was designed for storm glazing. In most cases the potential drawbacks outweigh the potential benefits.

Under some circumstances, however, protective glazing or screens may be necessary. (This applies to windows. Domes and ceilings present a special case. See "Domes and Ceilings"). A real vandalism or security threat warrants protective glazing, such as when the windows can be reached easily or are in an isolated location. Protective glazing is also warranted when employed historically on a particular window as original plating (Tiffany Studios, for example, often used plate glass to keep dirt and moisture out of their multi-plated windows). Unusual circumstances (such as when the windows are painted on the outside) may also dictate the use of protective glazing. Finally, protective glazing is warranted when a UV filter is needed to prevent epoxy glass repairs from breaking down.

A variety of protective glazing materials are available. They include polycarbonates, acrylics, laminated glass, plate glass, and tempered glass. The plastic products are very strong, lightweight, and relatively easy to install, but will scratch, haze, and yellow over time, despite UV inhibitors. They also have a high coefficient of expansion and contraction, so the frames must be designed to accommodate change induced by temperature fluctuations. Poor installations in restrictive frames cause distorted reflections from bowing panels often damaging the historic frame. Protective panels of glass are heavier and more difficult to install, making them more expensive than plastic. However, glass will not bow, scratch, or haze and is usually the best option in aesthetic terms; laminated glass provides additional impact resistance.

A common error in installing protective glazing is to create a new window configuration (Fig. 18). Insensitive installations that disregard the original tracery destroy the window's aesthetics—and the building's. When protective glazing is added, it should be ventilated. If a window is not ventilated, heat and condensation may build up in the air space between the ornamental glass and the protective glazing (creating a "greenhouse effect").

When absolutely necessary, protective glazing should be installed in an independent frame between ⅝" (16mm) and 1" (25mm) from the leaded glass. This allows the protective panel to be removed for periodic maintenance of both the historic window and the new glazing. The conditions of the air space between the two layers should be monitored on a regular basis; condensation should never collect on the window.

No ideal formulas have been developed for venting the air space between the ornamental glass and the protective glazing, but it is typically vented to the outside (unless the building is air conditioned most of the year). Generally, a gap of several inches is left at the top and bottom when glass is used, or holes are drilled in the protective glazing at the top and bottom when polycarbonates and acrylics are used. Small screens or vents should be added to keep out insects. Finally, it is important to realize that most original plating was "rough plate" or "ribbed" and never had a modern polished reflection. Some glass tinted the transmitted light intentionally, as originally designed: in this case any new or replacement plating should simulate this effect to respect the artisan's intention.

Conclusion

Much of the Nation's stained glass and leaded glass has recently passed, or is quickly approaching, its 100th anniversary—yet much of this glass has not been cleaned or repaired since the day it was installed. With proper care, the stained and leaded windows, transoms, and other elements that add so much to historic buildings can easily last another century.

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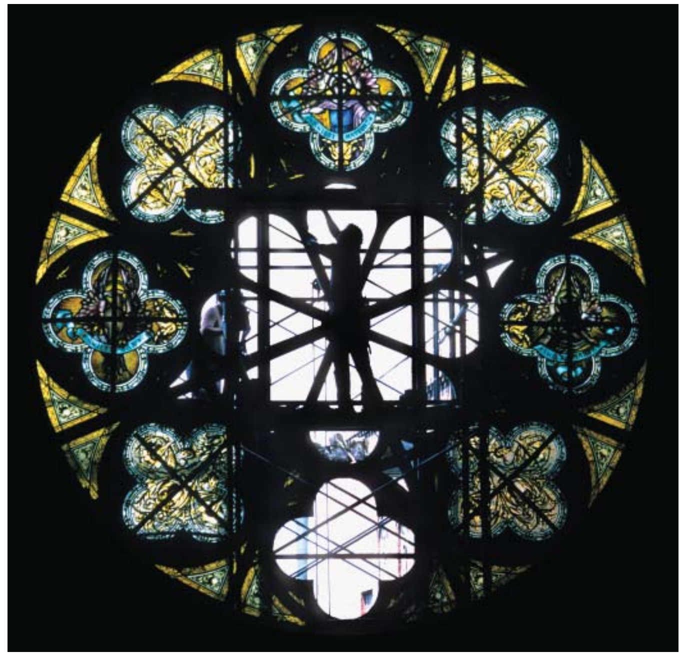

Wooden frame of the rose window undergoing repair (exterior view).

Cover Photograph: Tiffany Studios opalescent art glass frame from 1914, originally installed in a dome over the Men's Grill in Marshall Field's, Chicago.

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34 PRESERVATION BRIEFS

Applied Decoration for Historic Interiors
Preserving Composition Ornament

Jonathan Thornton and William Adair, FAAR

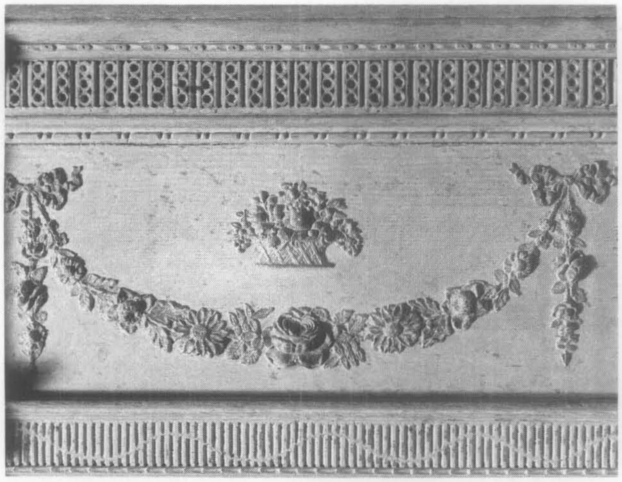
U.S. Department of the Interior
National Park Service
Cultural Resources
Preservation Assistance

Anyone who has ever walked through historic houses and large public buildings, visited an art gallery, picked up a picture frame in an antique shop, or even ridden on an old carrousel has been close to *composition ornament*, but has probably not known what it was or how it was made. This is not surprising, since composition or "compo" was conceived as a substitute for more laboriously produced ornamental plaster and carved wood and stone, so was intended to fool the eye of the viewer (see Fig. 1). The confusion has been heightened over time by makers who claimed to be the sole possessors of secret recipes and by the variety of names and misnomers associated with the material, including *plaster, French stucco,* and *Swedish putty,* to name a few.

Many natural or man-made materials can be made soft or "plastic" by the application of heat and are called "thermoplastics." Composition is a thermoplastic material used to create sculptural relief. It is soft and pliable when pressed into molds; becomes firm and flexible as it cools; and is hard and rigid when fully dry. Typically formulated with chalk, resins, glue, and linseed oil, this combination of materials gives compo its familiar light-to-dark brown color. It is the only one of the so-called thermoplastic materials to be used extensively in architectural decoration because of its low cost.

Figure 1. An American mantelpiece in the Adam style dating from the early 19th century illustrates composition ornament's reputation as a first-rate imitator of wood. Only the allegorical design, flower baskets, floral swags or festoons, flanking fleur-de-lis ornamentation and pilaster capitals are compo; the panels and simple moldings are carved wood. Photo: Courtesy, Philadelphia Museum of Art: Given by Mrs. Thurston Mason in memory of her sister, Miss Anna P. Stevenson.

Generally adhered to wood, historic composition ornament is most often found decorating flat surfaces such as interior cornice and chair rail moldings, door and window surrounds, mantelpieces, wainscot paneling, and staircases—indeed, anywhere that building designers and owners wanted to delight and impress the visitor, but stay within a budget. While composition was cheaper than carved ornament, it was still meticulously hand made and applied; thus, it was more often used in "high style" interiors. But the types of structures historically decorated with composition ornament were more democratic, encompassing residential, commercial, and institutional buildings, and even including specialty applications such as the social saloon of a steamship (see Fig. 2).



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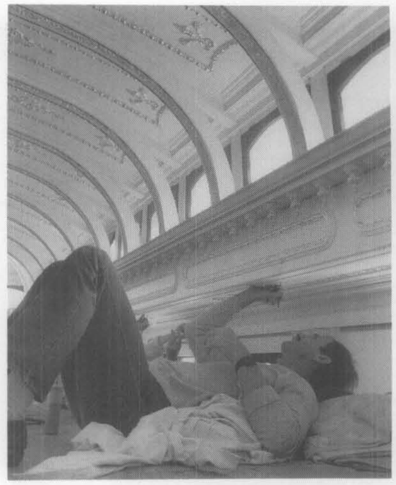

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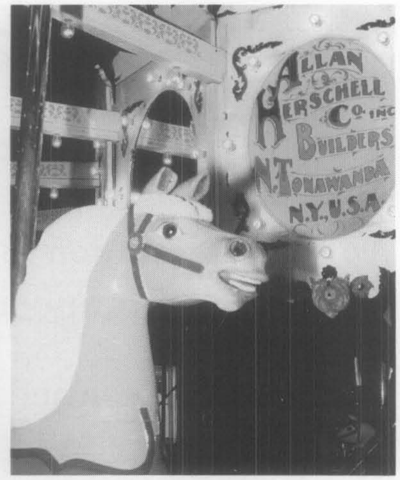

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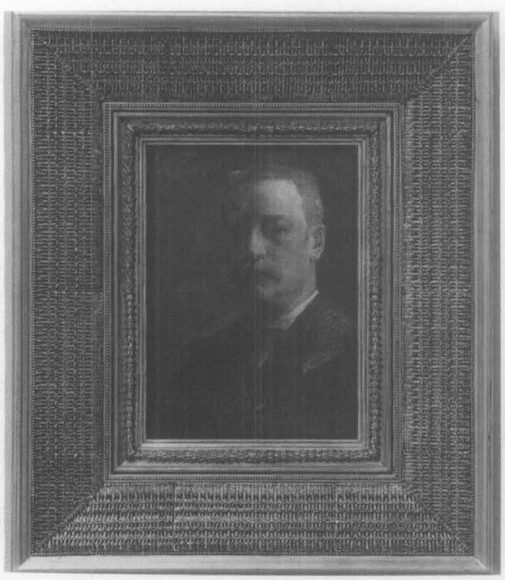

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Figure 2. Composition ornament has been used in America for over two hundred years in a variety of applications: (a) a floral festoon and basket in the Adam style for an 1803 mantelpiece; (b) the social saloon of an 1866 steamship, S.S. China; (c) scenery panels on a 1916 Allan Herschell carrousel; (d) ceiling decoration in a 1920s hotel; (e) the coffered ceiling of the National Archives library, 1938; (f) a modern reproduction of a Stanford White-designed frame; and (g) 1990s compo ornamentation for a re-modeled residence. (a) Courtesy, Gold Leaf Studios, Inc.; (b) Philip L. Molten; (c) Elizabeth Brick; (d) Courtesy, J.P. Weaver Co.; (e) Courtesy, National Archives; (f) 06.218: Self Portrait of Thomas Wilmer Dewing (1851-1938). American, 1906. Oil on wood panel: 50.8 x 36.8 cm. Courtesy, Freer Gallery of Art, Smithsonian Institution, Washington, D.C.; (g) Courtesy, J.P. Weaver Co.

With proper understanding of the material, historic composition ornament may be successfully cleaned, repaired, or replaced in sections. Unfortunately, because composition is often misidentified as plaster, stucco, or carved wood, the use of inappropriate methods for removing paint is a major cause of its loss (see Fig. 3). The purpose of this Brief is to to assist historic property owners, managers, architects, craftsmen, and preservationists in identifying existing composition ornament, determining the extent of repair and replacement needed and, finally, selecting the most sensitive, non-destructive method of treating it.

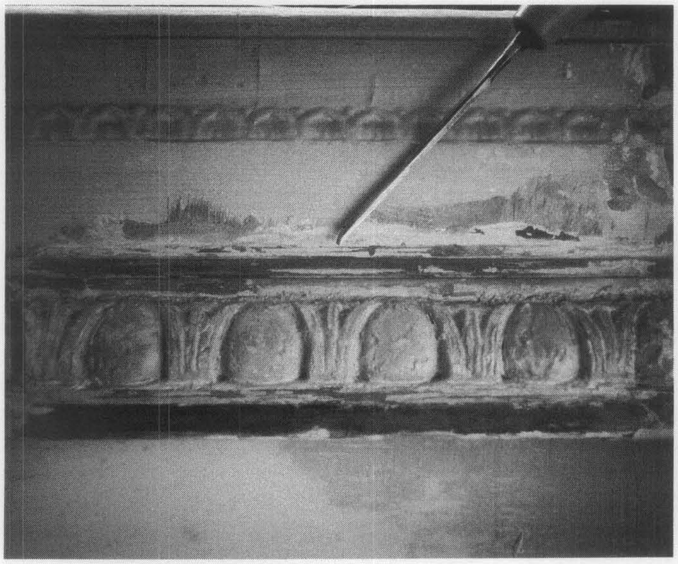

Figure 3. When this historic composition window surround was mistakenly identified as plaster, then treated with a caustic paint stripper, a section of it was destroyed. Photo: Byran Blundell.

De-Mystifying the Mix

While various types of moldable composition date to the Italian Renaissance, architectural use of composition did not begin to flourish until the last quarter of the 18th century. During this period, many composition ornament makers in Europe and America supplied the public with complex sculptural decoration. Also, the overly complicated and often intentionally mysterious earlier recipes were now reported to be comprised of a few basic ingredients: animal glue, oil (usually linseed), a hard resin (pine rosin or pitch was cheapest), and a bulking or filling material, generally powdered chalk or whiting (see also Sidebar, ***Compo: The Basic Ingredients)***.

Compo mixes have been the subject of a good deal of variation and there has never been a set recipe, but the ornament manufacturers of the later 18th and early 19th centuries understood in general terms what their material was and what it could do (see Fig. 4). The advantages of the material were described by a prominent American maker, Robert Wellford, in his advertising broadside of 1801:

"A cheap substitute for wood carving has long been desirable for some situations, particularly enriched mouldings, etc., and various were the attempts to answer the purpose, the last and most successful is usually termed Composition Ornaments. It is a cement of solid and tenacious materials, which when properly incorporated and pressed into moulds, receives a fine relievo; in drying it becomes hard as stone, strong, and durable, so as to answer most effectually the general purpose of Wood Carving, and not so liable to chip. This discovery was rudely conducted for some time, owing to Carvers declining every connection with it, till, from its low price, it encroached so much upon their employment, that several embarked in this work, and by their superior talents, greatly improved it."

In brief, compo is perhaps best understood as an early thermoplastic that allowed the rapid reproduction of complicated detail for popular use.

Making Composition Ornament: A Process Unchanged

Since the craft has essentially remained the same over time, a description of its historic manufacture is also applicable today (see Fig. 5).

In one container, chunks of amber colored pine rosin or the cheaper black pitch were heated in linseed oil until they melted together and combined completely. In another container (often a double-boiler), previously soaked chunks of animal glue derived from skins and hides were cooked and blended into a uniformly thick solution. The two liquid components were then stirred together. This "batter" was made into a pliable "dough" in a way familiar to any baker. It was poured into a cratered pile of whiting and first mixed with a spatula until it was thick enough to be kneaded by hand. Vigorous folding and kneading in of more whiting was done until the composition had a consistency like modeling clay and was completely uniform.

To mold a decoration, the compo was first warmed in a steamer, and the mold prepared with a thin coating of oil and a dusting with talcum powder. A piece was then kneaded and folded to produce a smooth and wrinkle-free surface on one side. The good side was placed down over the rigid mold, and pressed in loosely with the fingers,

ZANE, CHAPMAN, & Co.'s
AMERICAN MANUFACTORY OF
Compofition Ornaments,
At the Sign of the Canifter & Hand-faw, No. 23, South, Second-ftreet, between Market and Chefnut-ftreets,
PHILADELPHIA,
Containing a Variety of original Patterns
FOR DECORATING

CORNICES,	STAIRCASES,
FRIEZES,	IONIC, CORINTHIAN, AND COMPOSITE COLUMNS,
ARCHITRAVES,	PILASTER CAPITALS,
PILASTERS,	KEYSTONES,
SHUTTERS,	TRUSSES,
PANEL BASES,	OVAL AND ROUND PATERAS:
SURBASE AND CORNICE MOULDINGS,	

CHIMNEY PIECES COMPLETED TO ANY SIZE,
And many other ornaments for infide or outfide work of public or private buildings, anfwering, effectually, the general intention of wood-carving.

Orders, from any part of the continent, punctually attended to, and a generous allowance made to wholefale purchafers.

ZANE, CHAPMAN, & Co.—inform their friends, that this factory was firft eftablished by William Poyntell & Co. and conducted by an able artift from London, who learned under, and followed the bufinefs there a number of years in company with, the original inventor of the art; and, that the feveral patterns, being from the neweft defigns, are of mafterly workmanfhip, executed, at a great expenfe, under his immediate infpection, and form, altogether, as complete a collection as the London artift has produced.

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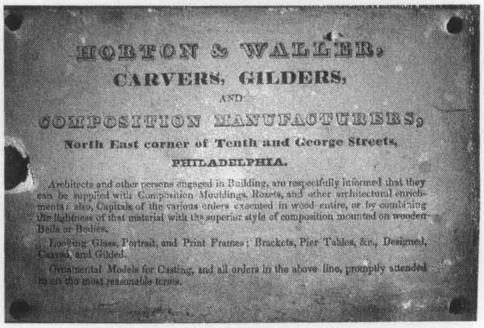


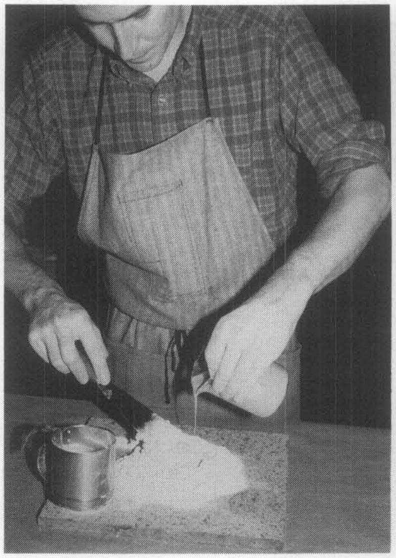
HORTON & WALLER,
CARVERS, GILDERS,
AND
COMPOSITION MANUFACTURERS,
North East corner of Tenth and George Streets,
PHILADELPHIA.

Architects and other persons engaged in Building, are respectfully informed that they can be supplied with Composition Mouldings, Rozets, and other architectural enrichments; also, Capitals of the various orders executed in wood entire, or by combining the lightness of that material with the superior style of composition mounted on wooden Bells or Bodies.

Looking Glass, Portrait, and Print Frames; Brackets, Pier Tables, &c., Designed, Carved, and Gilded.

Ornamental Models for Casting, and all orders in the above line, promptly attended to on the most reasonable terms.

Figure 4. Compo ornament could be applied to simple and complex surfaces, including cornices, friezes, architraves, pilasters, and chimney pieces and to looking glass and picture frames. Manufacturers' ads such as these were commonplace in 19th century America, particularly in eastern cities. Left: Zane, Chapman, & Co. Right: Horton & Waller. Photo left: Courtesy, Jonathan Thornton. Photo right: Courtesy, Gold Leaf Studios, Inc.



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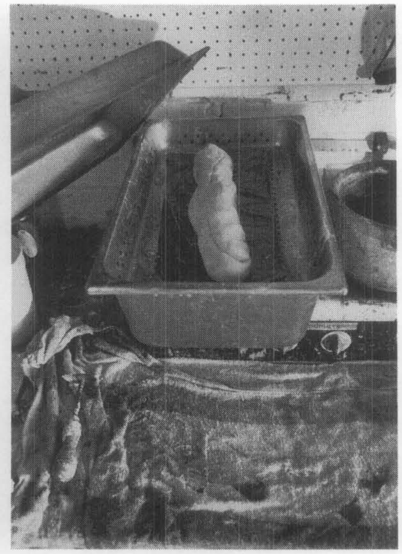

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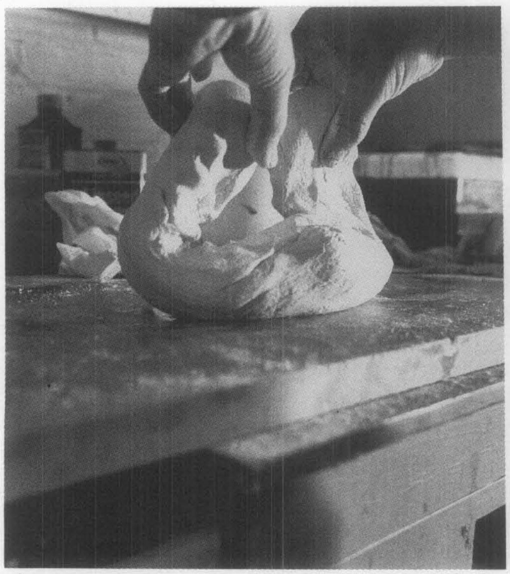

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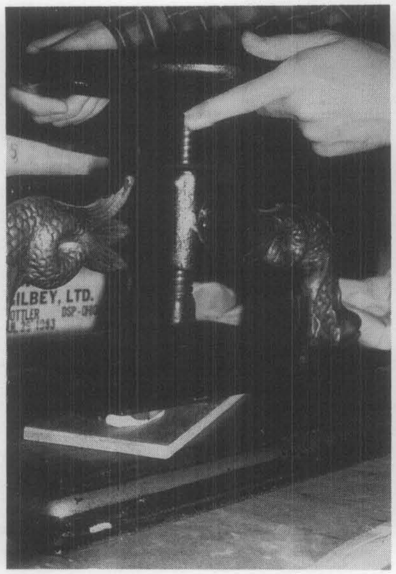

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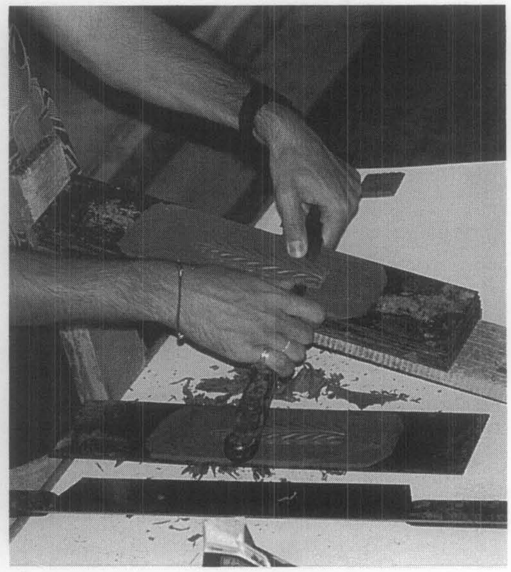

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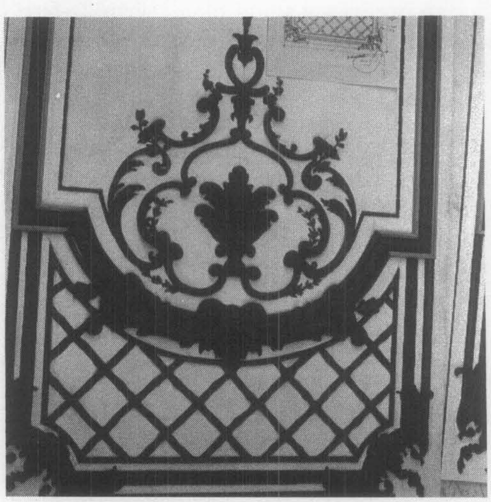

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Figure 5. The steps of making composition ornament: (a) pouring compo "batter" into a pile of whiting on a warm granite slab; (b) an almost finished ball of composition; (c) warming compo in a steamer; (d) kneading compo; (e) pressing or squeezing compo into a mold using a screw press; (f) slicing ornament from a pressing board; and (g) a compo design made up from several "squeezes." Note its familiar brown color prior to painting, staining, or gilding. Photos: (a)(b) Jonathan Thornton; (c)(d) William Adair; (e) Jonathan Thornton; (f)(g) Lenna Tyler Kast.

leaving excess above the surface of the mold. A damp board was placed over this and the "sandwich" placed in a screw press and squeezed so as to force the compo into the finest detail. It was then removed from the press and turned over so that the mold could be lifted straight up, leaving the compo stuck to the board. Upon cooling to room temperature, the compo gelled, becoming tough and rubbery (the gelling property is due to the glue component which is chemically identical to edible gelatin). At this stage, it was sliced off the board with a thin-bladed knife. The remaining mass of composition still adhered to the board could also be sliced off and reused.

Composition ornament was often fixed to an already prepared wooden substrate at the factory while it was still fresh and flexible, but could be dried and shipped to the final user, who would make it flexible again by steaming on a cloth stretched over a container of boiling water. Instructions for doing this, as well as suitable brads for "fixing," were supplied by some manufacturers. Because of the glue component, steaming the backs of ornaments would make them soft and sticky enough to self-bond without additional glue. Soft ornaments were softened nailed through or pressed down on top of previously driven headless brads (also called sprigs). Strings and wires were often included in the mass during pressing to serve as internal armatures and reinforcements. These measures preserved the integrity of the ornaments even if they cracked.

Originally meant to copy other materials such as wood, plaster, and stone, composition had its own unique properties and advantages that were soon exploited in both technical and artistic terms. It has distinct characteristics in each of its three states: pliable, rubbery, and hard. When warm and pliable, it can be modeled by a skilled worker and it is capable of receiving the finest detail when squeezed into a mold. After it has chilled to room temperature and is gelled, it is rubbery, flexible, and tough. The detail is essentially set and cannot be easily damaged as the ornaments are manipulated (see Fig. 6).

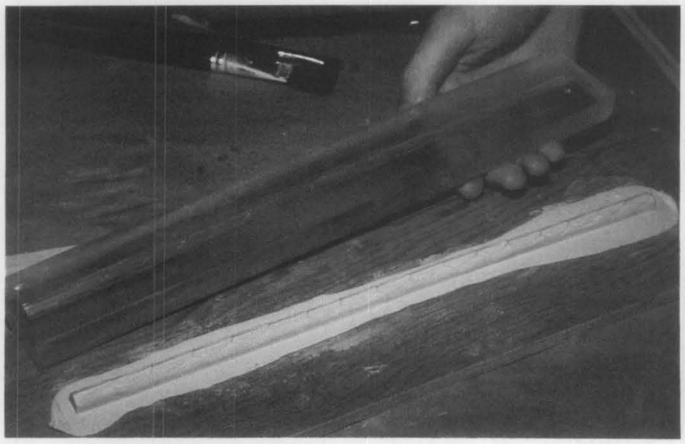


Figure 6. This finished length of compo molding is stuck to its pressing board. The newly made piece will be sliced off the board, then applied. Photo: Jonathan Thornton.

Gelled composition ornaments can be easily bent over curved surfaces without cracking, and unlike a rigid cast material such as plaster, they can be stretched or compressed somewhat to fit a design without damaging the detail. An egg and dart motif, for example, could be made to come out evenly at the corners without making a partial egg or dart. The sculptural vocabulary from the maker's mold collection could be re-arranged at will into larger decorative schemes. In fact, any smaller component of a decoration from a single mold could be sliced free and inserted into any location.

Composition could be carved to heighten detail, correct defects, or undercut ornaments—that were, of necessity, straight-sided—so that they would release from the rigid molds. This could be done in the gelled state or, with more difficulty, after it had finally hardened to stone-like solidity.

Finally, when completely hard, it could be given a polished marble shine with nothing but a damp cloth. It could be stained, coated with any sort of paint, varnish, or oil gilded without any further preparation (see Fig. 7).

Molds and the Creation of Patterns

A technical discussion of composition is not complete without an examination of the molds used to create the ornament. These were the ornament maker's largest investment in time and expense, and were the key to the craft (see Fig. 8).

Figure 7. The coffered ceiling of the 1938 National Archives library in Washington, D.C. features egg-and-dart composition molding finished with a dark brown stain. While compo design is more often light and delicate, here, it has a bold, massive quality. Photo: Bryan Blundell.

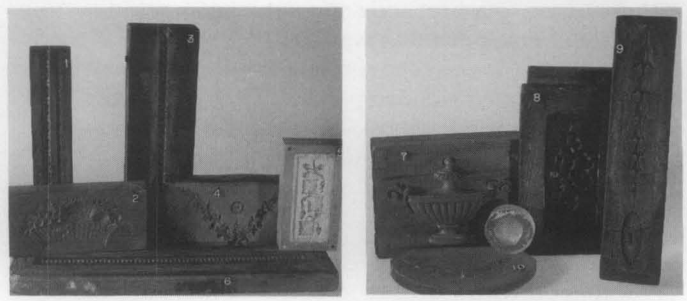


Figure 8. Several historic and reproduction compo molds are shown to underscore the variety of materials used to make them: 1. applewood mold 2. pearwood mold 3. boxwood mold encased in beech 4. boxwood mold 5. sulfur mold encased in maple 6. pewter mold encased in pine and oak 7. positive pattern for pitch mold carved in pearwood 8. pitch mold encased in oak 9. composition mold encased in maple 10. epoxy and polyester molds reinforced with glass fabric. Photos: Jonathan Thornton.

Composition molds were always made of rigid materials that would withstand the considerable pressure used in pressing the ornaments. All of these materials and methods have been used in sculptural crafts since the Renaissance. The comparative listing that follows helps explain their advantages and disadvantages.

Wood was carved in reverse to create a negative matrix. This was highly skilled work often performed by a specialist carver, and required a large initial investment in time, but wooden molds would essentially last indefinitely if properly maintained. A further design advantage of reverse carving is that fine incised lines will show up as fine raised lines in the final ornament. (Fine raised lines are notoriously difficult to carve or model in relief.) Molds carved from dense and close-grained fruit woods such as apple and pear seem to have been common in the 18th century. In the 19th century, the most intricate molds were carved in boxwood, often encased or framed by larger and cheaper pieces of timber for ease of handling and to prevent splitting.

Metal alloys such as brass, bronze, and pewter made excellent molds capable of yielding the highest level of detail and were virtually indestructible in use. They were expensive due to the intrinsic value of the metal and because their production involved a variety of complex and skilled steps performed by modelers, pattern makers, and founders. Few historic metal molds have survived, possibly as a result of wartime scrap drives.

Sulfur melts into a clear fluid at about 115° C and could be poured over a positive clay model or another compo ornament. A sulfur mold resembles hard plastic, but is more fragile. Even when framed in wood and reinforced with iron fillings, as was common practice, it was especially vulnerable to breakage. A figural design, such as a frieze of *The Three Graces,* was much easier to model in relief than to carve in reverse, and sulfur was one of the few materials that could be used to make a hard mold from a clay model.

Composition itself could be squeezed over a hard relief pattern (such as another manufacturer's ornament) to make a mold. Composition shrinks as it hardens and so the mold was always smaller than the original. It is also fairly brittle when hard and, like sulfur molds, would tend to crack in the press. Composition "squeeze molds" were ideal for pirating another maker's patterns!

Pitch molds became popular during the late 19th and early 20th centuries. A warm and soft mixture composed primarily of pine pitch was poured into a recess in a wood block or frame. It was then turned over and squeezed down onto an oiled wooden pattern. Pitch molds might crack with age or in the press, but as long as the carved pattern was retained, they could be easily re-made.

Historical Survey

Early History and Renaissance. Press-molded decoration has been used with various soft plastic materials for centuries. For example, it is known that medieval sculptors press-molded organic mixtures to decorate painted sculptures. But because mixtures based on organic binders such as glue, oil, resins, and waxes are prone to various sorts of degradation, actual survivors are rare.

The direct ancestors of the composition craft are most likely found in the Italian Renaissance; however, composition mixtures were not extensively used for architectural decoration during this period, probably due to building traditions as well as relative expense. It is worth nothing that this was an age of experimentation with materials and rediscovery of Greek and Roman designs. Press molded mixtures called pastiglias were used to decorate wooden boxes and picture frames as early as the 14th century (see Fig. 9). Moldable compositions were discussed by various Renaissance writers. The recipes are extremely varied and include, among their more common and understandable ingredients, gypsum, lead carbonate, wood and marble dust, eggs, pigments, sheep's wool, and various oils and resins.

The 18th Century. The first flowering of architectural composition in America took place at the end of the 18th century when ornaments were both imported from England and produced by makers in every major eastern city. All of the conditions were right: molding technologies were well established (architectural *papier mâché,* which, like composition, was produced in molds, had gained widespread acceptance during the middle decades of the century). The raw materials were produced or imported in volume, so the cost of the composition ingredients came down as the cost and availability of highly skilled labor went up. Economic and social conditions favored

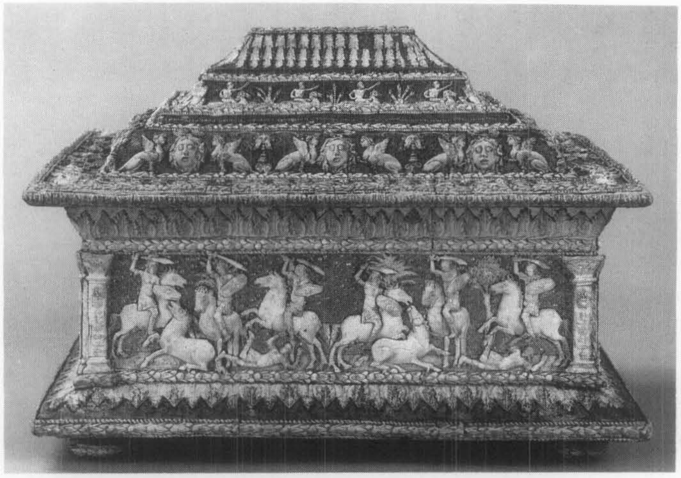


Figure 9. A 16th century pastiglia box from Italy features battle scenes from ancient Rome. Pastiglia was a forerunner of composition as we know it today, and one of a family of press-molded and applied interior ornamentation materials. Photo: Pastiglia Casket. White lead pastiglia decoration on gilt alder, 1.29.9 cm. Italy, Venice, 1st half of 16th c.© The Cleveland Museum of Art, John L. Severance Fund, 81.8.

centralized "manufactories" in the production of various arts and crafts.

Design trends also fed into a favorable reception for composition. A more faithful reinterpretation of Greek and Roman design eventually termed "Neoclassical" had taken hold in Europe, championed in England by the architect, Robert Adam, after his return from study in Italy in 1758 (see Fig. 10). Although Adam played no direct role in the "invention" of composition ornament, as has sometimes been said, he patronized English craftsmen who were making it and was generally receptive to new and innovative materials. One early maker, sometimes cited as the "inventor" of composition by his contemporaries, was John Jaques. His name appears in London advertising by 1785, but he was probably in business before then (see Fig. 11).

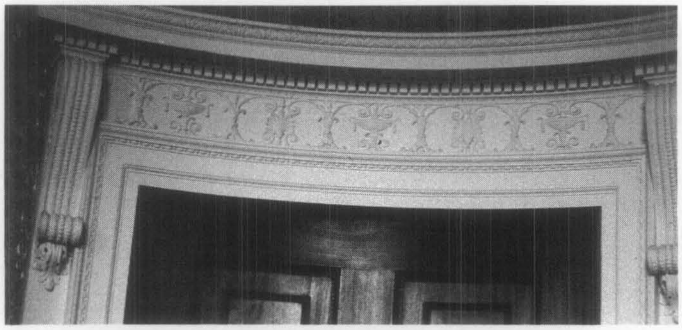


Figure 10. Shown is an elegant Robert Adam composition overdoor design in Kedleston Hall, Derbyshire, England. Adam had an enormous influence on 18th century Neoclassical design in England and America. Photo: Jonathan Thornton.

As a result of Adam's influence, designers of applied ornament in both Europe and America began to take advantage of a molding process that was ideally suited to producing the detailed, but repetitive, motifs of classical decoration—acanthus leaf, egg and dart, festoons, swags, and paterae—as well as classical themes depicting Greek and Roman gods and goddesses (see Fig. 12). And as the Neoclassical style became more popular, composition ornament makers increased in number.

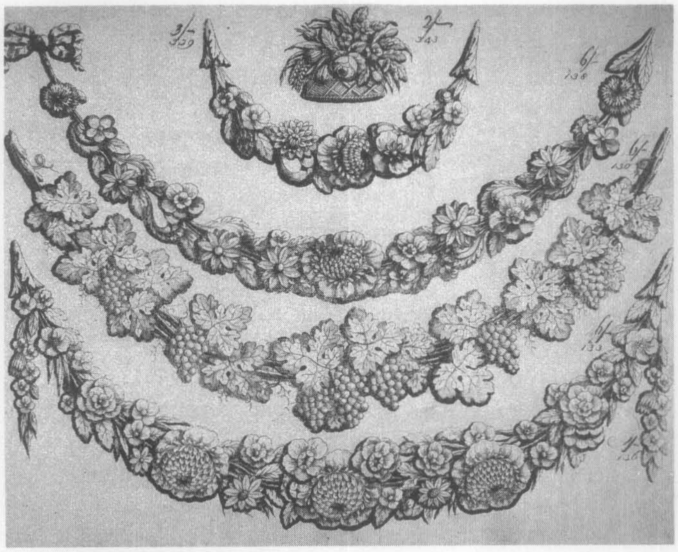


Figure 11. This page of festoon designs is from a Jaques catalog published in England and imported to America in the first decades of the 19th century. Note the similarity of these designs to those shown on the mantelpiece in Fig. 1. Photo: Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

Figure 12. The Nightingale-Brown House, in Providence, Rhode Island, was built in 1792. Original composition ornament can be seen in the flat area above the door molding; matching ornament was used in the room over the mantel. Photo: Courtesy, Irving Haynes and Associates.

The 19th Century. During the early decades of the nineteenth century, Neoclassical—encompassed in America by the terms Federal, Empire, and Greek Revival—was in the ascendancy. Composition makers continued to increase and also to find new uses for their material. Composition picture and mirror frames became common and some makers advertised the suitability of composition ornaments for casting iron firebacks and stoves. Composition ornament was explicitly advertised for exterior use as well, although very little has survived. The interiors of houses and public buildings in every prosperous American city were decorated with composition (see Fig. 13).

When the classically derived Federal and Empire styles gave way to the various revival styles—Rococo, Gothic, Renaissance, and Italianate—composition makers simply made new molds to accommodate them. (Although Rococo and Renaissance styles were not common for architecture in America, they *were* common for furnishings and interior decoration and, in consequence, for composition ornament.)

Along with a proliferation of styles in the mid-to-late decades of the century, there was a parallel growth in the number of moldable and castable materials that shared

Figure 13. Top: Since rooms with fireplaces were centers of social activity in early American houses, mantelpieces often received special decorative attention. This early 19th century mantelpiece in a Philadelphia residence features a panel depicting A Country Dance flanked by floral swags and sculptural busts of Milton and Shakespeare. Bottom: Several American and English makers produced versions of a frieze entitled, The Triumph of Mars. This one, ca. 1800-1810, is in a modest "single" house on John Street in Charleston, South Carolina. Note how several layers of paint are obscuring the detail. Photo top: Gold Leaf Studios, Inc. Photo bottom: Jonathan Thornton.

some features of the composition craft, such as *carton pierre, gutta percha, fibrous plaster, shellac compositions* and, eventually, *celluloid* and *hard rubber*. Composition continued to be the preferred material for detailed decoration on wood where the size of the ornament did not make its cost prohibitive. The publication of practical books by and for craftsmen, beginning in the 19th century, disseminated recipes and procedures to a broad audience and de-mystified the craft. Period composition ornaments called "imitation wood carvings" were widely advertised in manufacturers' catalogs (see Fig. 14). Balls of prepared compo became available from some art supply shops in large cities for use by small volume craftsmen.

During the later years of the century, the Arts and Crafts Movement—as preached by William Morris and his associates and followers—became increasingly important in design and philosophy. Morris stressed honesty to the material in design, exalted spirituality of hand work and rejected manufacturing, mass production and the distinction between "high" art and craft. These trends were

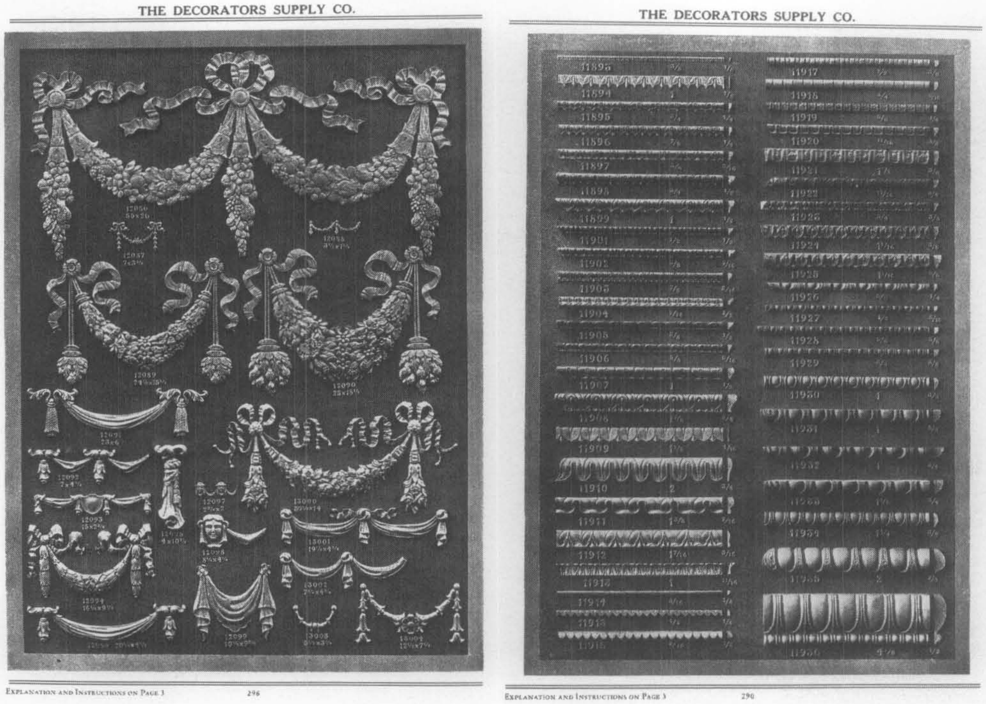


Figure 14. Shown are two pages from a current manufacturer's catalog, Ornaments for Woodwork-Furniture featuring festoons and clusters, fabric swags, and egg-and-dart molding. The Decorators Supply Corporation in Chicago, Illinois, was established in 1893, and is in business today. Photos: Courtesy, Decorators Supply Corporation.

Figure 15. Naturalistically carved lily pattern molds reflect the early 20th century Arts and Crafts movement in the United States. Photo: Jonathan Thornton.

to affect both technology and design in the 20th century. Composition ornament would have been anathema to Morris and his elite clients; most composition production during the last years of the century is best described as Victorian Eclectic.

The 20th Century. The Arts and Crafts and related styles, such as the more decorative Art Nouveau, were well rooted in America by the beginning of the century (see Fig. 15). Pitch molds made from relief-carved patterns had become common in America. The carving tool marks could be accentuated in these patterns in keeping with current vogue. Open-grained woods, such as mahogany, were often chosen so that the finished composition ornaments would have a wood-like grain that showed through stains and varnishes (see Fig. 16). A uniquely 20th century application of composition ornament was in the lavishly decorated movie palaces of the Depression era (see Fig. 17).

As interest in architectural embellishments declined, particularly as a result of the austere post-World War II styles, so did the composition trade. Many old firms went out of business and their molds were dispersed or destroyed. The few that remained concentrated on restoration projects or were sustained by diversification into other materials. By the 1950s and 60s, composition as a material and craft had been all but forgotten.

An upsurge in hand craft production that started in the late 60s and has continued to the present—as well as increasing interest in historic preservation—has led to the renewed study of old methods and materials, including composition. The few manufacturers that remain have seen a large increase in their business, and an increasing number of people recognize composition as a unique ornamental material and want to conserve, restore, or create it (see Fig. 18).

Compo Deterioration and Damage

To some degree, the longevity of historic composition ornament is related to the ratio of ingredients in the original mix and to the skill of the craftsman in applying it. But it is far more dependent upon interior climatic conditions and the long-term effects of heat and dampness on both the compo and the wood substrate.

Figure 16. The Austin Morey residence, in the Indian Village Historic District of Detroit, Michigan, was designed by architect Louis Kamper, and built between 1902 and 1903. Part of Kamper's design included this grand oak staircase that was decorated with composition ornament. Note the "ghost marks" of missing composition in the close-up. Photo: Robert J. Rucinski.

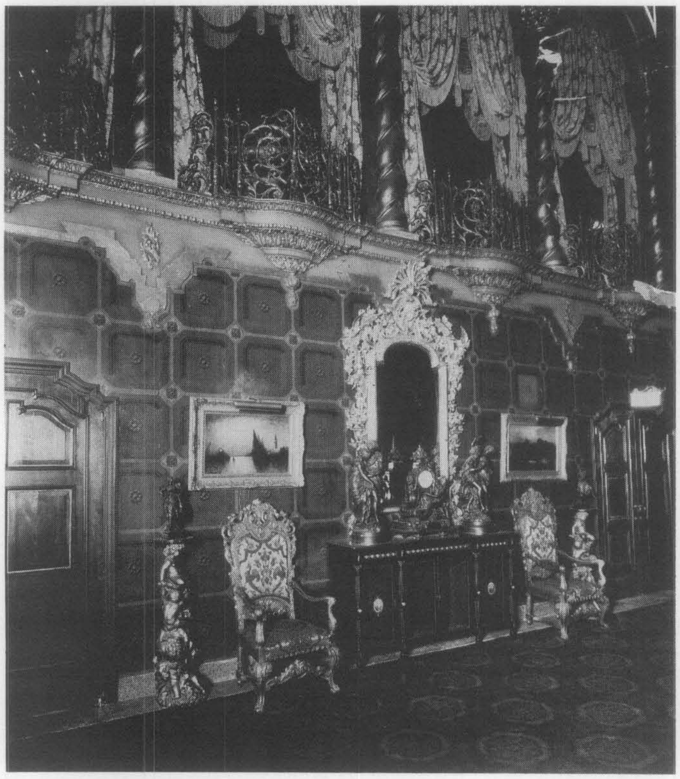


Figure 17. The Ohio Theater in Columbus, Ohio, was lavishly decorated with gilded plaster and composition ornament. Walls, ceilings, mirror frames, furniture, and carpets—predominately red and gold—were designed by noted theater architect Thomas W. Lamb in 1928. Photo: Rapid Photography Inc.

Figure 18. Shown is the contemporary studio of the J.P. Weaver Company, currently located in Glendale, California. The company has manufactured and sold architectural composition ornament continuously since 1917. Note the long work table and well organized mold storage units behind. Photo: Lenna Tyler Kast.

Variables in mixing and application. Dried compo is inherently hard and somewhat brittle; its increasing brittleness over time is primarily due to the oxidation and hardening of the linseed oil component. The drying oil, in turn, contributes to age cracking. Thus, during initial manufacture, if the oil content was low and the dry filler content (chalk) high, shrinking and cracking over time is less likely to occur. Originally, the compo was probably attached using small, headless brads (1/4") that penetrated the hardening compo as well as the wood substrate. They were used to keep the compo from shifting or warping after it was set in place. If an insufficient number of brads was used by the craftsman during the application process, the compo simply falls off as cracks develop.

Interior environmental conditions. Compo was conceived as a durable substitute for hand-carved wood or marble and decorative plaster; its potential for structural failure is generally due to substrate failure rather than to the compo mix itself. Theoretically, composition will move with atmospheric changes due to the moisture-sensitive glue component. Its breakdown typically occurs when the wood base expands and contracts at different rates than the compo during extreme temperature and humidity fluctuations. Especially when it is close to a source of heat, such as directly over a fireplace, compo develops fissures or shrinkage cracks. Contemporary heating systems in old buildings also contribute to the drying and cracking syndrome.

Planning for Treatment

Simple stabilization and repairs to existing ornamentation can most likely proceed based solely on an analysis of existing conditions (see paragraphs on ***Surface Cracking*** and ***Delamination,*** below).

Historical research. For more complex work, a building owner, curator, or conservator should research the history of the building to find out when it was originally designed and constructed; who lived in it at various times; how the building was used; and which features were original and which were added later or removed (see Fig. 19). Some of this information may be found in the National Register of Historic Places.

Questions about the building's interior spaces and their decorative detailing also need to be asked, particularly when portions of the ornamentation will be replaced. Have the interior spaces evolved with successive occupancies or uses? In addition to compo, were other decorative materials used and are there differences in patterns that help date the work? For example, plaster and compo may have been used in the same room, but applied at different times. Receipts from workmen's bills may often be used to establish the dates of decorative detailing.

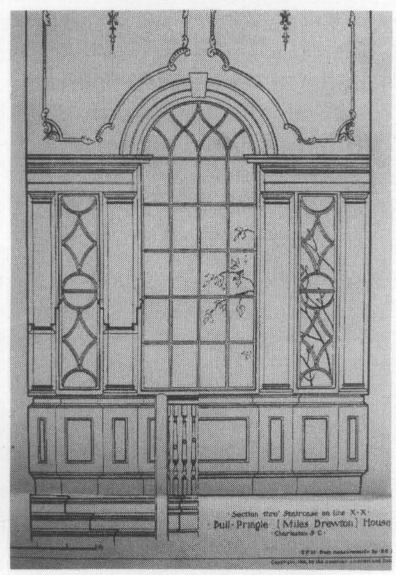


Figure 19. A drawing from the 1930s shows original ornament on the wall above a Palladian window in the 1760s Miles-Brewton House, Charleston, South Carolina. When the ornament was subsequently removed and lost, this scale drawing was used as documentation to fabricate matching ornament. Photo: Jonathan Thornton.

The historical research dealing with the original construction of the building and its use over time should, in turn, be linked to the scope of work that will take place. Stabilization, conservation, and repair are maximized within the treatment, Preservation. Generally speaking, restoring decorative ornament to a specific earlier period is not recommended unless its historical significance outweighs the potential loss of extant ornament that characterizes other historical periods. But if a significant interior is missing original features and physical and documentary evidence are conclusive, replication may be appropriate in order to interpret a particular time.

Existing conditions analysis. After historical research is conducted, but before starting work, an analysis of the surface and substrate should be undertaken. These are some of the issues a conservator considers. First, if a surface is painted, the ornamentation material needs to be identified. Is it wood, plaster, composition ornament, or some other type of applied ornamental material? Usually, some of the ornamentation is chipped or broken. Close examination of the exposed material is the first step. If it is white through the entire thickness of the ornament, then it could be plaster or stucco; if it is a darker brown material, it is more likely to be composition.

After having identified the presence of composition ornament, its overall condition can be evaluated. Layers of paint may obscure fine detailing as well as deterioration problems. Degrees of damage and deterioration should be recorded. These are typical questions that need to be answered. Is the surface merely "crazed", requiring no action or limited repair, or are the cracks severe enough to require replacement? Are pieces missing? Are the attachment brads rusted or missing? The condition of the substrate is also important. Is the wood surface intact, or is it in need of repair? After answering key questions, the conservator will make random tests to differentiate original compo from later repairs, some of which may well have been done with plaster, rather than compo (see Fig. 20).

Deciding how to proceed depends upon the overall interpretive goals of treatment. For example, is the interior being restored to an earlier time? In this case, later repairs may be removed and the original appearance replicated. Or is the interior being preserved with limited replacement of lost or damaged historic materials? Not all conditions are foreseeable in conservation work and contingencies must be incorporated into the treatment plan to be considered realistic. As the project progresses, the conservator generally determines the work that needs to be done, and the order in which it should be undertaken.

Treating the Problem with Care

The scope of work is generally based on several factors, including the historical significance of the building's interior, the degree of damage or deterioration of the compo, and the overall interpretive goals of project work. Several examples of repair and replacement follow in order

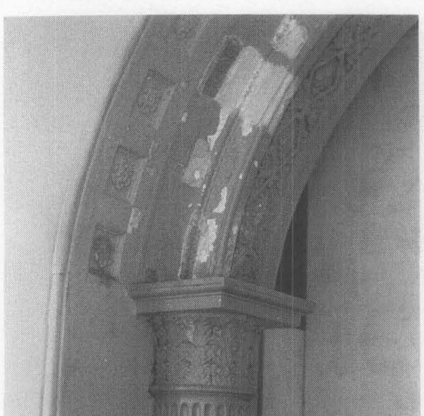


Figure 20. The Octagon House, in Washington, D.C., was constructed between 1801-1802. During recent project work, it was discovered that early repairs to the composition ornament in this doorway had been made with plaster. The plaster repairs were removed during restoration of the doorway to its original appearance. Photo: Lonnie J. Hovey, AIA.

Compo: The Basic Ingredients *(clockwise from front center)*

***Chalk*:** Chalk is whiting in solid form. It is a type of white, soft limestone.

***Glue*:** Before the invention of synthetic adhesives, glue meant animal or hide glue. This was made by boiling animal skins to extract a protein—collagen—in water, then condensing and drying the collagen until it was in solid form. A variety of types and grades were, and are still, available. Two are shown here.

***Linseed oil*:** This is a yellowish drying oil obtained from flaxseed that is used in paint, varnish, printing ink, and linoleum; it is a key ingredient in composition ornament.

***Resin*:** Resins are organic materials present in wood and exuded from various trees and shrubs. In unrefined form, they often consist of a mixture of solid natural polymers, oils, and volatile aromatic substances.

to suggest a typical scope of work within preservation and restoration projects. Treatments are listed in hierarchical order, from the least intervention to the greatest.

Paint removal. Interior ornament is usually painted many times over during its lifetime and, as a result, the sharp surface detail of the original pattern is obscured. Before attempting to remove paint, it is always advisable to obtain professional advice on the ornamental material to be cleaned as well as the nature of the coatings that are covering it. And whatever the project work goal, at least one sample of intact, well-adhered paint layers on a feature should be preserved for future historical research.

Based on the purpose of treatment, these are some of the questions a conservator routinely asks. How many layers of paint are there? Is it important to trace one layer to a particular occupancy of the building? If so, the stratigraphy (or layering scheme) will be determined prior to paint removal. After the correct layer is identified, the color can be matched. Or, is the building being rehabilitated? If this is the case, period-typical paint colors may be appropriate.

For purposes of this Brief and the guidance paragraphs that follow, it is assumed that all layers of paint are being removed in order to reveal the fine detailing of the composition ornament (see Fig. 21).

Figure 21. The same theme on two early mantelpieces, A Country Dance, dramatically illustrates the visual difference between cleaned and uncleaned composition ornament. When old paint layers are removed, the exquisite detailing is revealed. Left: George Read II House, 1801-1803, New Castle, Delaware; Right: First Harrison Gray Otis House, 1796, Boston, Massachusetts. Photo left: Gold Leaf Studios, Inc. Photo right: David Bohl. Courtesy, Society for the Preservation of New England Antiquities.

The next step is to consider various methods of removing paint from the ornament without damaging it, or without being exposed to dangerous substances in the strippers or in the old paint itself! It should be noted from the standpoint of health and safety that most Federal and Empire period compo was meant to imitate marble; thus, the highly toxic white-lead paint was by far the most common original coating.

Caustic strippers based on lye should be avoided for two reasons. First, they will damage and dissolve compo both because they "chew up" the protein structure of the glue and, second, because they are water-based and compo remains soluble in water (see also Fig. 3). If a stripper will damage the protein of your hands, it will do the same to compo!

A conservator will more often use organic solvents, such as methylene chloride, in conjunction with small implements such as a dental tool or toothbrush. (A small area is always tested first to establish the safety and effectiveness of any technique. Improper use of stripping tools can damage intricate surfaces beyond repair.) A solvent is applied according to manufacturer's recommendations, permitted to soak into and soften the paint, then re-applied as necessary, as the conservator gently removes paint from the intricate carved surfaces (see Fig. 22).

It should be emphasized that any amount of exposure to toxic chemicals without proper precautions can cause severe health problems. A hooded, air-fed, personal unit is desirable when using methylene chloride-based strippers if fume hoods or paint spray booths that exhaust effectively to the outside are not available. Organic vapor masks may not be as effective in protecting against methylene chloride exposure because the filters quickly become exhausted; however, a vapor mask with properly rated organic solvent cartridges can provide an acceptable level of safety when cartridges are regularly changed (see Fig. 23).

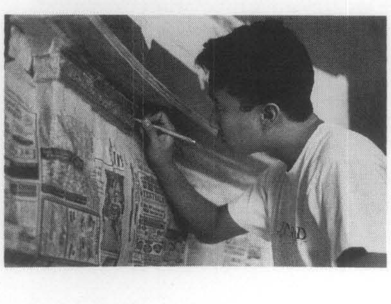


Figure 22. Careful dry scraping of a chimney piece to remove paint residue signaled the successful conclusion of a conservation project at the Octagon House, in Washington, D.C. Photo: Lonnie J. Hovey, AIA.

Some conservators have had excellent results heat-stripping excess paint layers using *heat guns* and dental tools. This is highly skilled work and its success depends upon the composition ornament being much older than the paint layers that lie on top, but has the capability of working as well or better than chemical methods in the hands of an expert. Precautions must be taken against lead fumes where removal of lead paint is involved.

Cleaning mixtures based on *enzymes* are also used by conservators. This is an effective method because enzyme mixtures can be formulated for very specific purposes (i.e., to dissolve only oil-based paints from protein-glue based compo). They dissolve paint without affecting the wood substrate. But, on the other hand, work can be very slow and the expense would only seem justified on small and rare or important museum objects. Enzymatic cleaners are

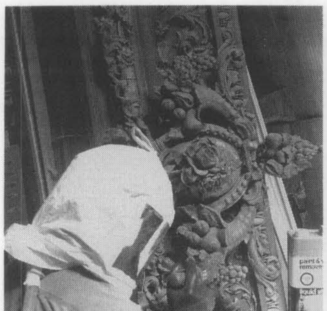


Figure 23. Methylene chloride fumes can be deadly, so protecting the worker is imperative. Left: a hooded, air-fed unit. Right: a vapor mask with organic solvent cartridges. Photo left: William Adair. Photo right: Lonnie J. Hovey, AIA.

dependent on a high level of skill, technical knowledge and professional training, but they are earning a solid place in the repertoire of professional conservators.

Increased concern about the environment may well render the toxic methylene chloride strippers obsolete in the near future. Manufacturers have already produced "safer" strippers based on *dimethyl esters*, and further research will probably yield other alternatives to chlorinated solvents. Slower acting solvent-type strippers may well be safer to the underlying composition ornament, but additional research and use are needed before making definitive statements.

In summary, most damage to compo occurs during the removal of layers of paint; this is a critical process and should not be attempted without consulting a conservator and should not be undertaken by painting contractors unless they are highly skilled and have had extensive experience in this very delicate procedure.

Proper disposal of residual chemicals and debris must be undertaken to avoid contaminating the environment with solvents and lead, and such disposal is, in fact, now required by federal, state, and local ordinances. The company responsible for removing chemical waste should be licensed to dispose of it, otherwise the property owner may be held accountable if disposal laws are violated.

Refinishing compo ornament usually follows stripping. According to historic evidence uncovered and depending on the existing and desired appearance of the room, compo can be stained, painted, gilded, marbleized, or glazed. Paint types may include distemper, alkyd oil, or latex. A thin coating is recommended so the intricate surface detail is not clogged.

Surface cracking. Surface cracking indicates age and, thus, the history of the ornamentation itself (see Fig. 24). It does not necessarily mean that cracks have to be fixed. But if cracking interferes with the overall design pattern, then the conservator may elect to fill the cracks with suitable fill material. For example, "light weight" spackles bulked with microballoons are excellent because they are soft and compressible and will accommodate changes in the size of cracks due to moisture fluctuation. After stabilization, the surface is finished to match the existing area.

Delamination. Delamination or separation of the compo from the wood substrate is the simplest repair problem to remedy. The conservator begins by testing cracked areas with slight finger pressure to determine which parts of the design need consolidation. Compo sections that have separated from the substrate, but are otherwise intact, can be glued back in place using emulsion type adhesives such as "white" glues or a clear, solvent-release adhesive (see Fig. 25). For vertical surfaces, the glue is painted onto the back of the delaminated compo as well as the wood base and, when slightly tacky, re-attached, and held with clamps until dry.

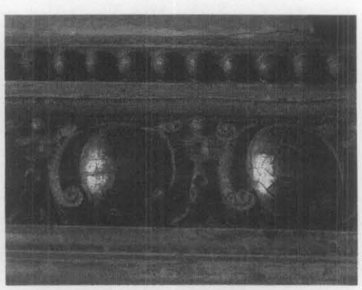
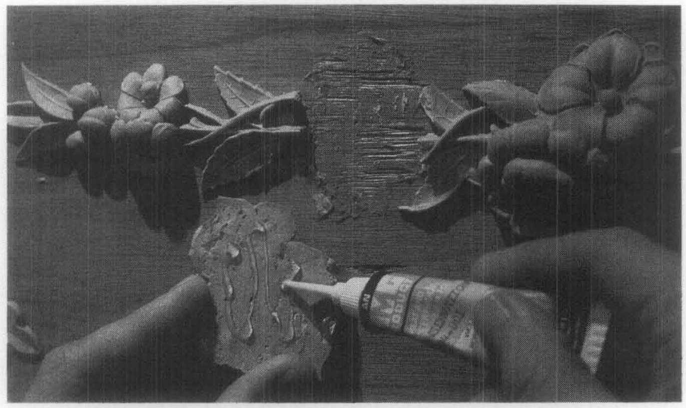


Figure 24. Treatment would be optional for the age cracking that has occurred in the egg-like portions of this composition ornament. Photo: William Adair.



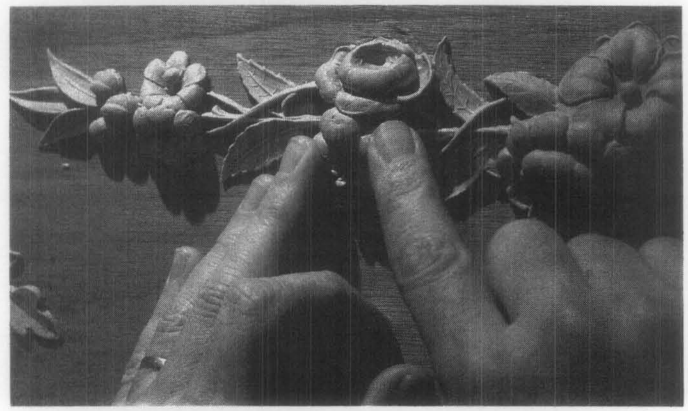


Figure 25. (a) Adhesive is being applied to this 19th century composition ornament that has de-laminated from its wood substrate; and (b) The compo fragment is held in place until the quick-setting adhesive takes hold. Photos: Jonathan Thornton .

Professional conservators often formulate their own adhesives based on stable synthetic polymers (plastics) dissolved in solvent that will be more reversible, should the need arise, and also offer better long-term stability than many commercial adhesives.

Repairs to broken or damaged compo. When some original compo has been lost, additional work is required to make a repair. One particularly easy and inexpensive method of repairing broken ornamentation is to use non-hardening clay ("plastilina") or polymer-based modeling materials as an impression material to make a mold. After a mold is made from existing ornament, missing or deteriorated portions of the historic design can be duplicated with a durable gypsum plaster (see Fig. 26). Especially in cases where economic considerations dictate procedure, use of this substitute material may be helpful because it is cheaper. Alternatively, an existing studio mold may sometimes be used to make small replacement pieces in a repair project (see Fig. 27).

In another scenario, a repetitive design on a mantelpiece may be damaged or portions missing. Especially if the compo design is complex and several portions of ornament need to be replaced, rigid polymer molds with traditional compo are recommended for the repair work. The mold is created using a section of the original ornament as a model. After replacement pieces are fabricated, they are attached using brads, or finish nails (see Fig. 28). The pointed end of the nail is clipped blunt with snips to avoid possible splitting of the wood substrate. The nail is first hammered into the surface, then countersunk, and the resulting hole filled with gesso putty or additional compo.

Finally, a ready-made replacement piece can be ordered from the catalog of a compo manufacturer, but it is unlikely to be a perfect match to an extant historic decoration

Replacement of missing compo ornamentation. Once-attractive compo may become damaged to such a degree that the remaining fragments are removed by an owner and the entire surface painted over. Thus, if there is some existing composition ornament in a room, such as an overdoor or chair railing, the conservator would most likely look for evidence of other ornament that is now missing.

For example, a mantel may appear as a flat, unornamented surface to the untrained eye, but after many layers of paint are removed by the conservator, shadow images are revealed (see Fig. 29). These images or "ghost marks" are left by the hide glue component of the original mix. Although the glue is water soluble, it will not be completely removed by an organic stripper such as methylene chloride. (But if earlier inappropriate paint removal methods were used, such as water-based strippers, caustic strippers, or mechanical sanding, ghost marks from the glue would be destroyed.)

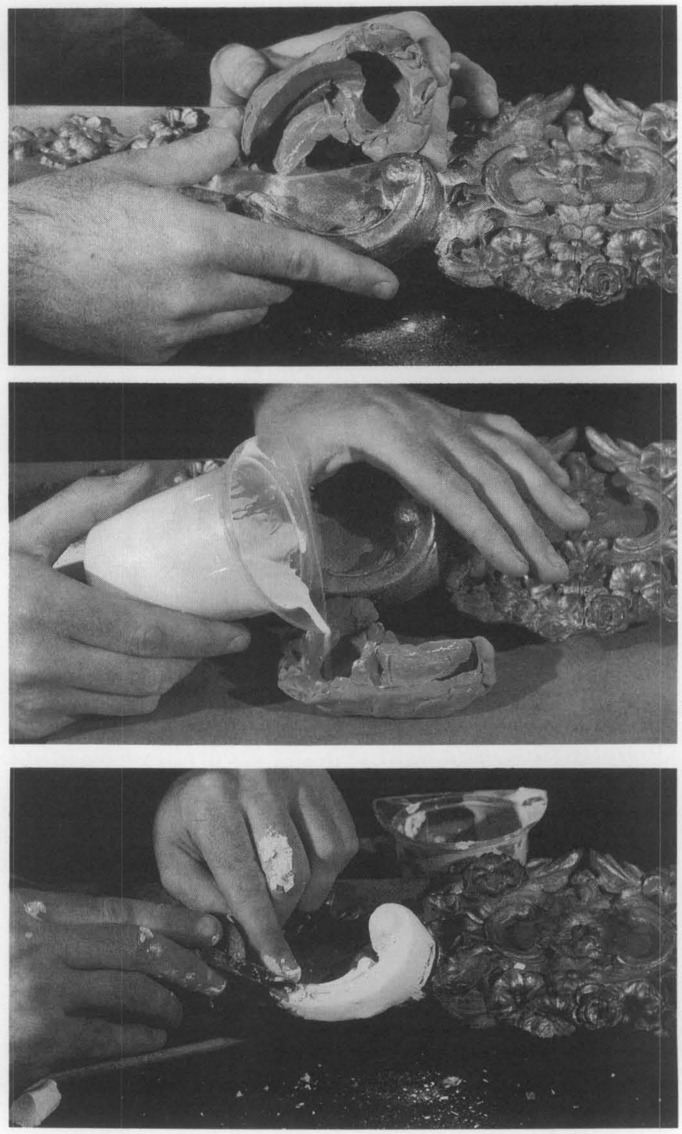
When the paint stripper dries, a ghost mark left by composition ornament appears slightly darker than the surrounding area where no compo had been attached. In addition, small, square-headed, 1/4" brads used to reinforce the original compo may be embedded in the wood.

In summary, detailed physical evidence, as well as written and pictorial documentation, can provide a valid framework for replacement at a particular site. With careful detective work, missing historic ornamentation may be successfully identified and replaced with matching ornament (see Fig. 30; see also Fig. 19).

Restoration of a "period" interior. When ornamentation is extensively deteriorated and missing, owners often want to re-create the historic appearance through restoration. Physical evidence and other documentation may be used as a basis for the restoration; it should be remembered, however, that as the amount of surviving material diminishes, the greater the chance for inaccuracy when attempting to depict the historic appearance. Choosing restoration as a treatment thus requires exacting documentation prior to work and meticulous attention to detail in the work itself.

Conclusion

Despite its popularity and widespread use as a decorative material, the history of composition ornament has yet to be thoroughly studied. Individual craftsmen have acquired fragmentary knowledge about some designs and historic methods; historians and students of interior decorative design have accumulated knowledge about patterns, artisans, and methods of manufacture and distribution; and curators of historic collections that include compo are knowledgeable about the objects under their care. The combined knowledge of these individuals, together with examples and images of compo ornament from a variety of sources, needs to be synthesized to address the complex issues involving compo repair and preservation. The future of the study of composition ornament, as well as many other facets of architectural, decorative, and fine art history, lies in this sort of cooperative effort.



a.

b.

c.

Figure 26. When a small amount of ornamentation needs to be replaced, (a) plastilina clay is recommended as an impression material. Next (b), a plaster-like, liquid material is used to cast the replacement piece. Finally, (c) the new piece is smoothed and fixed in place. Photos: Roland White.

Figure 27. When a compo frieze depicting The Triumph of Mars was found to be damaged, improperly restored, and its intricate design clogged with paint, the first step was to replace a missing wheel on the chariot. Because molds depicting classical themes are part of many professional studio collections, it was possible to fabricate a new wheel from the rubber mold shown here. Photo: William Adair.

Figure 28. A conservator is replacing broken pieces of compo ornamentation on a mantel during restoration of the Nightingale-Brown House in Providence, Rhode Island. Photo: Courtesy, Irving Haynes and Associates.

a.

Whether applied interior ornamentation such as composition ornament is being repaired or restored, treatment should always be preceded by careful documentation and planning.

Figure 30. Based on documentary and physical evidence, missing composition ornament was accurately re-created for the Miles-Brewton House, Charleston, South Carolina. First (a) the conservator used molds to fabricate ornament in small pieces and lengths; and (b) the new ornament was attached to thin birch plywood backing with glue and brads to create larger sections. These sections were then fastened to the original paneling with stainless steel screws. Photos: Jonathan Thornton

b.

Figure 29. The ghost marks of compo past—floral swags or festoons—are in clear evidence on a mantelpiece in the back bedroom of the George Read II House, New Castle, Delaware. This physical evidence will be used to assure their accurate re-creation in a restoration project. Photo: Courtesy, Gold Leaf Studios, Inc.

Composition and Other Applied Interior Ornamentation

As explained below, compo is a polymer-based material; however, several related materials used to create sculptural relief were sometimes referred to as "compositions" because they combined various ingredients to achieve new and hybrid properties. These related decorative materials can be polymer-based, plaster-based, paper-based, or wood-based. The following terms and definitions are important to know because they provide a background for identifying compo and other applied interior ornamentation *prior* to treatment.

Polymer-based Materials

Polymers are organic, i.e., carbon-based materials comprised of repeated units linked together into long chain-like molecules. Most polymers are soft and pliable (plastic) or can be made so by the application of heat (thermoplastic). In addition to compo and modern synthetic plastics, defined below, polymers include animal glue, horn, natural resins such as shellac, latex rubber, and rosin.

Compo. This thermoplastic mixture based on natural polymers—typically glue, linseed oil, and resin bulked with chalk—has been used extensively to create sculptural relief.

Modern Synthetic Plastics. Starting with cellulose nitrates such as celluloid (1840s), a vast array of man-made polymers has been created. Plastics received their popular name because, like composition, they are generally shaped while soft and pliable, but, due to cost, composition is the only polymer material to be used extensively in architectural decoration until quite recently.

Plaster and Plaster-based Materials

Plaster: This term describes two distinct calcium-based mixes. First, *lime plaster* is made by heating calcium carbonate to produce calçium oxide and slaking it with water to produce calcium hydroxide (lime putty). This material, mixed with fillers and aggregates and applied to surfaces gradually reconverts to calcium carbonate over a period of years. Second, *gypsum plaster* ("Plaster of Paris") is made by heating hydrated calcium sulfate to remove part of the chemically bound water. When water is added, it reconverts to fully hydrated calcium sulfate, setting and hardening in the process. Wet plaster was "run" in cornices; or made in piece-molds and flexible gelatin molds, then applied to interior surfaces.

Stucco: In its earliest use in Europe and America, stucco was a lime putty-based mix for fine interior ornamental plasterwork; historically, "stucco" referred to ornamental (particularly sculptural) plaster work. In the United States by the 19th century, however, stucco was primarily used to describe exterior plastering, usually done with Portland cement-based mixtures.

***Fibrous Plaster*:** This is the term for molded architectural plasterwork which is heavily reinforced with coarse weave cloth as it is built up in the molds. Fibrous plaster is lightweight, strong, and somewhat flexible and was used to manufacture large architectural units such as balcony fronts, columns, and pilasters.

***Pate Coulante** (flowing paste).* This is a mixture mentioned in one 19th century text that consisted of gypsum plaster, whiting, glue, alum, and sometimes paper pulp. If encountered in an historic interior, it is likely to be indistinguishable from plaster.

Paper-Based Materials

***Papier-mâché*:** This material became popular for interior decoration during the mid-18th century in England and its colonies. *Papier-mâché* was made from soaked rag paper layered into molds with small quantities of glue or starch paste as additional binders. It was usually covered with whiting and glue (gesso) and sometimes gilded. *Papier-mâché* is always hollow and can be distinguished from compo or plaster by gentle tapping.

Anaglypta: This is a trade name for a wallpaper embossed with relief decoration.

Carton-Pierre: This material was based on fully pulped paper fiber extended and hardened with substantial amounts of glue, whiting, and gypsum plaster, and sometimes alum and flour. Carton-pierre was pressed into molds as a plastic mass and allowed to harden. It is mid-way between plaster and papier-mache in weight and density.

Fibrous Slab: This was the name given to layered papier-mache panels heavily impregnated with linseed oil by inventor, C.F. Bielefeld, in the mid-19th century. The composite of paper fiber and hardened linseed oil made a thermoplastic panel that could be shaped and embossed by heating and pressing.

***Lincrusta*:** This material, composed of fiber and dried linseed oil and press molded onto paper backing, was introduced by the linoleum manufacturer, F. Walton, in 1877 and is still made. Typical use is in continuous low-relief friezes at the top of a room.

Wood and Wood-Fiber Based Materials

***Wood*:** Natural wood can also be press molded to a limited extent after it is made plastic by either steam or ammonia. *Pressed wood* architectural elements have been extensively marketed, but would be difficult to mistake for the deeper and sharper relief of most of the other materials described above.

***Wood-fiber*:** Also called saw dust, this cheap and readily available product has been used as a bulking agent in moldable mixtures since before the Renaissance. Numerous recipes consisting of wood fiber and various binders were published in 19th century formulas, and some of these proprietary mixtures or *patent woods* were used to produce small architectural decorations and moldings. Modern particle boards are non-sculptural variations of the material.

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Organizations

For information on conservators, contact the following organizations:

Association for Preservation Technology
904 Princess Anne St.
Fredericksburg, VA 22404

National Institute for the Conservation
of Cultural Property
3299 K St., NW, Ste. 403
Washington, D.C. 20007

American Institute for the Conservation
of Historic & Artistic Works
1400 16th St.
Washington, D.C. 20036

Cover photograph: The process of making composition ornament has changed little over the years. In the J.P. Weaver Company, located in Glendale, California, freshly made compo is being kneaded prior to pressing it in a mold.

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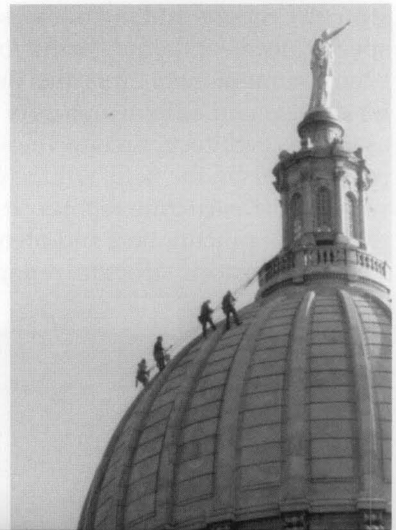
The Preparation and Use of Historic Structure Reports

Deborah Slaton

National Park Service
U.S. Department of the Interior

Heritage Preservation Services



A historic structure report provides documentary, graphic, and physical information about a property's history and existing condition. Broadly recognized as an effective part of preservation planning, a historic structure report also addresses management or owner goals for the use or re-use of the property. It provides a thoughtfully considered argument for selecting the most appropriate approach to treatment, *prior* to the commencement of work, and outlines a scope of recommended work. The report serves as an important guide for *all* changes made to a historic property during a project—repair, rehabilitation, or restoration—and can also provide information for maintenance procedures. Finally, it records the findings of research and investigation, as well as the processes of physical work, for future researchers.

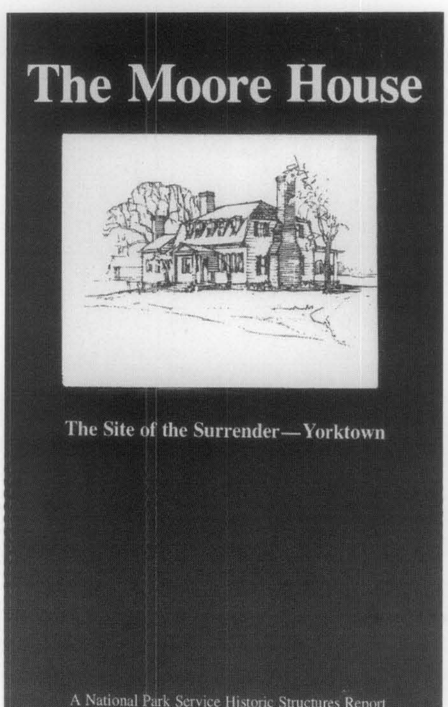


Figure 1. In the introduction to the first historic structure report in this country, Charles E. Peterson of the National Park Service wrote in 1935 "any architect who undertakes the responsibility of working over a fine old building should feel obligated to prepare a detailed report of his findings for the information of those who will come to study the structure in future years." Since then, thousands of historic structure reports (HSRs) have been prepared to help guide work on historic properties. Photo: National Parks and Conservation Association.

A historical "first." The first historic structure report prepared in the United States, *The Moore House: The Site of the Surrender—Yorktown*, was written by Charles E. Peterson of the National Park Service in the early 1930s (Fig. 1). In the decades since the Moore House report was completed, preservation specialists commissioned by owners and managers of historic properties have prepared thousands of reports of this type. Similar studies have also been used for many years as planning tools in France, Canada, Australia, and other countries, as well as in the United States. Although historic structure reports may differ in format depending upon the client, the producer of the report, the significance of the structure, treatment requirements, and budgetary and time restrictions, the essential historic preservation goal is the same.

> *Just as an art conservator would not intervene in the life of an artistic artifact before obtaining a thorough knowledge of its history, significance, and composition, so those engaged in the preservation of buildings . . . should proceed only from a basis of knowledge. Too often in the past, the cultural integrity of countless buildings . . . has been compromised by approaches to restorations grounded on personal whim, willful romanticism, and expedient notions of repair . . . . The preparation of a historic structure report is the first step in adopting a disciplined approach to the care of a historic building.*[1]

In response to the many inquires received on the subject, this Preservation Brief will explain the purpose of historic structure reports, describe their value to the preservation of significant historic properties, outline how reports are commissioned and prepared, and recommend an organizational format. The National Park Service acknowledges the variations that exist in historic structure reports and in how these reports address the specific needs of the properties for which they have been commissioned. Thus, this Brief is written primarily for owners and administrators of historic properties, as well as architects, architectural historians, and other practitioners in the field, who have limited experience with historic structure reports. It also responds to the requests of practitioners and owners to help define the scope of a historic structure report study.

Guiding the Treatment of Significant Historic Properties

A historic structure report is generally commissioned by a property owner for an individual building and its site that has been designated as historically or architecturally significant, particularly buildings open to the public, such as state capitols, city halls, courthouses, libraries, hotels, theaters, churches, and house museums (Fig. 2). It is certainly possible, but is less common, to prepare a historic structure report for a privately owned residence.

Besides the building itself, a historic structure report may address immediate site or landscape features, as well as items that are attached to the building, such as murals, bas reliefs, decorative metalwork, wood paneling, and attached floor coverings. Non-attached items, including furniture or artwork, may be discussed in the historic structure report, but usually receive in-depth coverage in a separate report or inventory. One significant property may include multiple buildings, for example, a house, barn, and outbuildings; thus, a single historic structure report may be prepared for several related buildings and their site.

Historic structure reports can be prepared for other historic resource types as well, including bridges, canals, ships, mines, and locomotives, which are categorized as structures by the National Register of Historic Places; sculpture and monuments, which are categorized as objects; and college campuses and industrial complexes, which are categorized as districts (Fig. 3). For battlefields, gardens, designed landscapes, and cemeteries, which are categorized as sites, parallel evaluation and investigation is usually undertaken through a separate document called a cultural landscape report.

Figure 2. Historic structure reports are prepared for many types of structures with various intended uses. Examples include courthouses and state capitols still serving their historic function (upper left, Wisconsin State Capitol, Madison); significant properties that are to be rehabilitated and adaptively reused (center left, New York Merchants' Exhange, from former bank headquarters to hotel); and properties that are to be restored as house museums (lower left, Willa Cather Childhood Home, Red Cloud, Nebraska). The scope of such studies includes the interior as well as exterior of the historic structure (lower right, Stanley Field Hall, Field Museum, Chicago). Photos: upper and lower left, Wiss, Janney, Elstner Associates, Inc.; center left, Jan Hird Pokorny Associates, Inc.; lower right, McGuire Igleski & Associates, Inc.

Figure 3. The University of Vermont has more than thirty contributing buildings in four historic districts listed in the National Register of Historic Places. The Campus Master Plan recognizes a commitment to respect and maintain the historic integrity of these facilities. Historic structure reports are available for many of the University's historic structures. Photo: University of Vermont Historic Preservation Program.

A team approach. With such an array of subject matter, it is not surprising that preparation of a historic structure report is almost always a multi-disciplinary task. For a small or simple project, the project team may include only one or two specialists. For a complex project, a team may involve historians, architectural historians, archeologists, architects, structural engineers, mechanical engineers, electrical engineers, landscape architects, conservators, curators, materials scientists, building code consultants, photographers, and other specialists. The disciplines involved in a specific historic structure report reflect the key areas or issues to be addressed for the particular property. The project leader or designated principal author for the report is responsible for coordinating and integrating the information generated by the various disciplines. Designation of a principal author may depend on the goals of the historic structure report and on which disciplines are emphasized in the study.

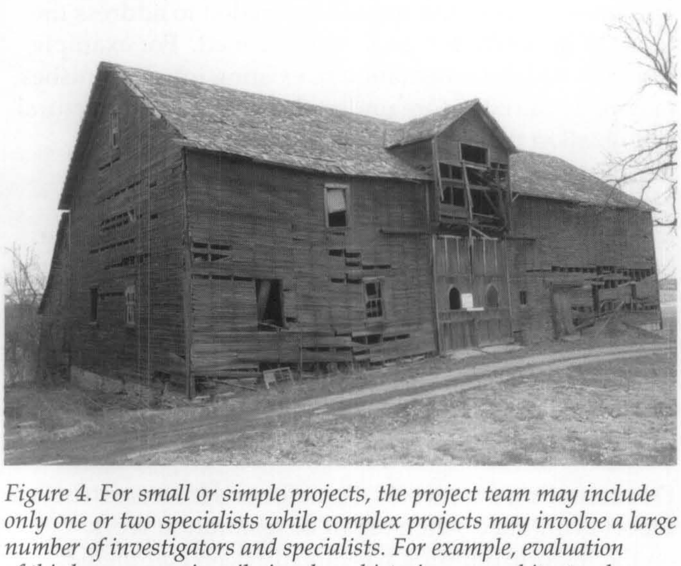


Figure 4. For small or simple projects, the project team may include only one or two specialists while complex projects may involve a large number of investigators and specialists. For example, evaluation of this barn may primarily involve a historian, an architectural conservator, and a structural engineer. Photo: Wiss, Janney, Elstner Associates, Inc.

Value of the Historic Structure Report

The completed historic structure report is of value in many ways. It provides:

- A primary planning document for decision-making about preservation, rehabilitation, restoration, or reconstruction treatments
- Documentation to help establish significant dates or periods of construction
- A guide for budget and schedule planning for work on the historic structure
- A basis for design of recommended work
- A compilation of key information on the history, significance, and existing condition of the historic structure
- A summary of information known and conditions observed at the time of the survey
- A readily accessible reference document for owners, managers, staff, committees, and professionals working on or using the historic structure
- A tool for use in interpretation of the structure based on historical and physical evidence
- A bibliography of archival documentation relevant to the structure
- A resource for further research and investigation
- A record of completed work

Benefits for large-scale and long-term projects. In the development of any historic structure report, the scope of work and level of detail are necessarily adjusted to meet the requirements of a particular project, taking into account the property's significance, condition, intended use, and available funding. This does not mean that every significant historic property requires—or receives—a comprehensive investigation and detailed report. Some historic structure reports are of very limited scope. It may be necessary for a project to proceed without a historic structure report, either because of the cost of the report or a perceived need to expedite the work.

Most large-scale or long-term work projects would benefit greatly from the preparation of such a report—and not only from the value of the report as an efficient planning tool. (See box above.) If work proceeds without a historic structure report to guide it, it is possible that physical evidence important to understanding the history and construction of the structure may be destroyed or that inappropriate changes may be made. The preparation of a report prior to initiation of work preserves such information for future researchers. Even more importantly, prior

Figure 5. At the Hudson Opera House, a multi-arts center in Hudson, New York, the historic structure report was prepared incrementally. The first phase of the report focused on assessment and recommendations for repair of the roofing, the most critical issue in preservation of the building. Photo: Gary Schiro.

Determining the Scope of Work

The following questions should be answered to determine the scope of work required for the study:

- Is the building's history well understood?
- Has the period of significance been established?
- Does the building represent a variety of periods of construction, additions, and modifications, not all of which may be significant?
- What archival documentation is available?
- Does the building have physical problems that require repair? What construction materials and systems are known to exhibit distress or deterioration?
- Does the building have code or functional problems that interfere with its use?
- Is the building in use? Is a new or more intensive use planned?
- Is funding available to commission the report needed to address these requirements? If not, can the scope of the report be reduced to answer critical questions in a limited report?
- Has the time frame for the overall project been established?

preparation of a report helps ensure that the history, significance, and condition of the property are thoroughly understood and taken into consideration in the selection of a treatment approach and development of work recommendations. One of the goals of a historic structure report is to reduce the loss of historic fabric or significance and to ensure the preservation of the historic character of the resource.

When to Prepare the Report

Optimal first phase. The historic structure report is an optimal first phase of historic preservation efforts for a significant building or structure, preceding design and implementation of preservation, rehabilitation, restoration, or reconstruction work. Information contained in the report documents existing conditions and serves as a basis for proposing physical changes. As additional information is learned relevant to the history of the building, and as work on the historic structure is implemented, the report can be amended and supplemented.

The length of time required to prepare a historic structure report and the budget established for its development will vary, depending on the complexity of the project, the extent and availability of archival documentation, and to what extent work has already been performed on the building. If the scope of a historic structure report for a simple building is limited to a brief overview of historic significance, a walk-through condition assessment, and general treatment, the study and report may be completed within a few months' time by an experienced investigator. On the other hand, a historic structure report for a larger building with numerous past alterations and substantive problems will require extensive research and on-site study by a multidisciplinary team. This type of report can often take up to two years to complete.

Incremental preparation. If budgetary constraints preclude completing the historic structure report as one project, it can be prepared incrementally (Fig. 5). The work recommendations should not be developed or implemented prior to completion of research and investigation, except for emergency stabilization to prevent immediate failure or damage, or temporary measures to address critical health and safety issues. A partial historic structure report can be completed in preparation for anticipated work that must be initiated to preserve or protect the building. This type of report includes analysis of only those building elements and systems that may be affected by the proposed work, and involves only the specialists needed to address the types of investigation and work planned. For example, research and documentation of existing interior finishes may be required before undertaking localized structural stabilization that will require removal of interior materials.

In undertaking such work prior to the completion of a historic structure report, caution should be taken not to alter or unnecessarily remove changes to the building that had occurred over time. The completed report may conclude that such changes to the building may have acquired significance in their own right and therefore merit preservation.

Documenting past work. Sometimes a historic structure report is initiated when repair or restoration work on the historic building has already been completed. Although it is always recommended that the study be done prior to new work, in this case, the report needs to document—as fully as possible—the condition and appearance of materials, elements, and spaces as they existed *prior* to the work performed. The extent to which this can be achieved depends on the quality of archival documentation available and physical recording undertaken prior to the completed work. The report should describe the nature and extent of the past repair or restoration work, and, if possible, should also document research performed, reasons for design decisions made, and the construction process for the work already completed on the structures.

Commissioning a Report

Commissioning a historic structure report requires answering a series of questions to establish the scope of work. (See sidebar.) The goals of the report need to be defined and the report should be designed to support planning for the future of the historic structure. This effort may involve gathering information to answer questions about what is significant about the building and site; what uses are appropriate for the building, or whether existing uses need to be modified; what known conditions require repair and whether those repairs are urgent; and what short-term and long-term goals need to be addressed. Finally the available budget for the historic structure report project should be established before a request for proposals is issued.

The procedures for preparing a historic structure report and the outline of report content and organization can serve as the basis to develop a scope of work for the study and also to solicit proposals for a report that reflects the requirements of the specific structure, and, of course, the available budget. Although the request for proposals should always establish such a scope of work, firms may be invited to suggest adjustments to the scope of work based on their past experience. The request for proposals should require a qualifications submittal from each proposer. This submittal should include resumes for the principal investigators and a description of experience in preparing historic structure reports or similar studies, as well as experience with buildings of similar type, age, and construction to the subject of the study. References and samples of work may be requested from the proposer as part of this submittal. An interview with one or more candidates is highly recommended, both so that the proposers can present their project approach and qualifications, and so that the client can ask questions in response to the submitted proposal.

How Much Will It Cost?

The cost of undertaking a historic structure report is determined by numerous factors, some of which may be unique to a particular property. Common to most projects, however, are seven factors that help determine the cost of a report:

1. The *level of significance* of the property will certainly influence the cost. That is, a property that is nationally significant would likely require a greater effort than a property that is only locally significant.

Figure 6. Historical photographs are an invaluable aid and time saver in establishing a building's original construction and evolution; in guiding the replication of missing features; and even in understanding existing material deterioration. The availability of information, such as archival photographs, surviving original architectural drawings, or HABS documentation, has a direct bearing on the cost of preparing a historic structure report. In this circa 1890 photo of the Rancho San Andrés Castro Adobe, the "lumbering up" on the south end is a character-defining feature of adobe construction, rarely seen today. Photo: Historic photograph from the Historic Structure Report for Rancho San Andrés Adobe by Edna Kimbro, State Historian, California State Parks, Monterey District.

2. The *treatment and use* for which the historic structure report information provides a basis is an important cost consideration. If the decision is reached to maintain a building in its current form, the level of effort required in preparing a historic structure report would be less than where the intended treatment is a comprehensive restoration. A change in building use likewise may increase the level of effort; for example, the additional work involved in addressing different building code provisions.

3. The *availability of information* about the historic resource has a direct bearing on costs. Some historic structures are well researched, and drawings may have been prepared to exacting standards, while others may require considerable original research and investigation to establish the evolution of the structure (Fig. 6). On occasion, a property owner's in-house staff or volunteers may undertake further research in advance of a contracted study as a way to reduce the cost of the report.

4. The *location of and access to a historic building* is a cost factor for some studies. A property in a remote mountain location can involve high travel costs relative to properties in or near an urban area. A structure requiring special techniques for exterior physical inspection would involve higher access costs than a small residential structure (Fig. 7).

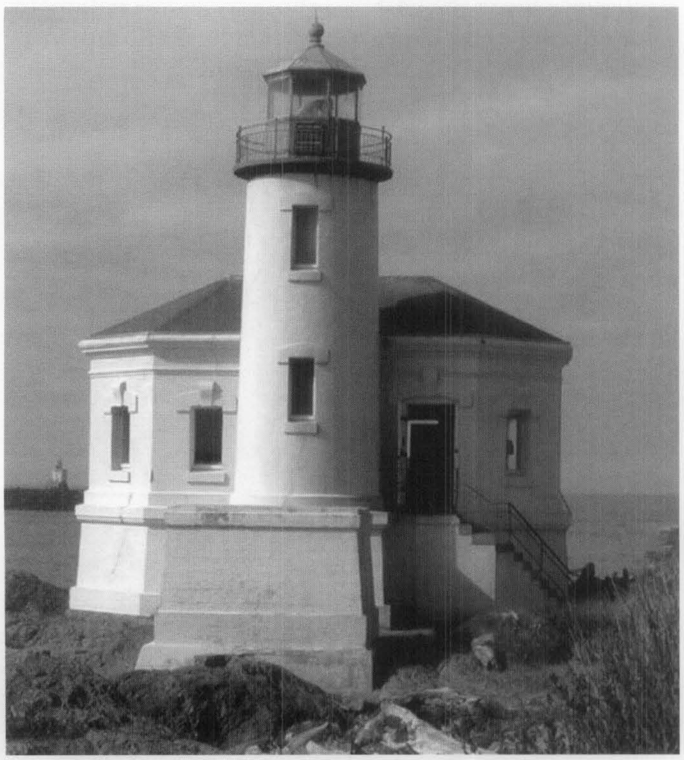


Figure 7. Numerous factors influence the cost of preparing a historic structure report including the level of significance, size, and complexity of the property; required treatment and use; existing condition; and the location and access to the structure. Historic structure reports were prepared for several small lighthouses along the Oregon coast, including the Coquille River Lighthouse, shown here. Photo: Wiss, Janney, Elstner Associates, Inc.

Collecting Information for the Report

A typical study involves:

- Preliminary walk through
- Research and review of archival documentation
- Oral histories
- An existing condition survey (including exterior and interior architectural elements, structural systems, mechanical and electrical systems, etc.)
- Measured drawings following the *Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation*
- Record photography
- Selected materials studies (e.g., mortar analysis, finishes analysis, etc.)
- Evaluation of significance
- Discussion with the owner and users about current and future intended uses for the structure
- Selection and rationale for the most appropriate treatment approach (preservation, rehabilitation, restoration, or reconstruction)
- Development of specific work recommendations

5. The *size and architectural character* of a property affect the time required to prepare a historic structure report. A simple four-room vernacular structure would usually involve less effort than a complicated high-style courthouse with many significant spaces.

6. The *physical condition of the structure* and also the *extent of physical fabric that is accessible for study* will be cost determinants as well. Obviously, a property in good condition is usually less problematic than one in a deteriorated state. For a structure that was continuously occupied and where alterations cover earlier fabric, the opportunity to extract information from physical fabric dating to early periods may be limited without extensive removals that are usually beyond the scope of the historic structure report study. Even where buildings are vacant, there are instances where certain physical investigations may need to be limited because of the destructive impact that will occur to historic fabric.

7. The *type of final report* that is required can significantly affect the cost of the project, but is an area where costs can readily be controlled. Historic structure reports do not necessarily need to be professionally bound and printed. In-house desktop publishing has become commonplace, and a formal work product can often be obtained without excessive costs. Overly sophisticated printing and binding efforts represent a misplaced funding allocation for most historic

properties. There are distinct advantages to having a report prepared in an appropriate electronic form, thus reducing the number of hard copies and facilitating future updates and additions to the report. For most properties where historic structure reports are prepared, ten or so hard copies should suffice. Providing one copy of the report in a three-ring binder is a helpful and inexpensive way to furnish the owner with a "working" copy of the document.

Suggested steps for collecting information prior to configuring the data into the actual report are as follows:

Preliminary walk through. A preliminary walk through of the building and its site with the owner or site manager, appropriate building staff representatives, and key members of the historic structure report team is important to review the project scope of work. During the walk through, a brief review of existing conditions can be performed to highlight user concerns and gather information about distress and deterioration observed. Building staff may also be able to provide information on recent repairs, current maintenance procedures, and specific areas of active deterioration. A brief review of existing documentation available on site is also useful. Site personnel may be able to recommend additional archival resources.

Historical research. Archival research should be directed toward gathering information on the building's history, original construction and later modifications, occupancies, and uses over time (Fig. 8). Research for the report is not intended to produce a large compendium of historical and genealogical material, but rather selected information necessary to understand the evolution of the structure, its significance, and justification for the treatment selected. For significant sites where other types of studies such as archeological investigations or a cultural landscape report have been completed or are underway, coordination is required to ensure that research information is shared and that the research effort is not duplicated.

If a National Register nomination or other inventory has already been completed for the building and its site, the bibliography of that document may suggest possible sources for further research. In addition, a completed National Register nomination can serve as a starting point for development of the historic structure report sections on history and significance, and can be included in the appendix of the report.

Public and university libraries, and state and local historical societies, are likely sources of relevant materials. Municipal records collections often contain deed and building permit information that is useful in developing a chronology of ownership and construction. Architectural, engineering, and construction documents, shop drawings, repair documents, and maintenance records are valuable sources of information. The original

Figure 8. Historical research is directed toward gathering information on a structure's history, original construction and later modifications, occupancies, and uses over time. Research may range from national repositories such as the Library of Congress to local collections or private family records. Old newspapers, architectural journals, and even manufacturing trade catalogs can be surprising sources of historical accounts and illustrations. This circa 1902 photograph of New York's Flatiron Building is of the construction in progress; such photographs are useful in understanding building chronology as well as concealed conditions of as-built construction such as building framing. Photo: Library of Congress, LC-D401-14278. The interior photograph of the former Bemir Drug Store in Rochester, New York, showcases a rubber tile floor as illustrated in a 1925 publication by the United States Rubber Company.

drawings and specifications, if extant, may be kept at the archives of the historic building but may also have been retained by the firm that designed the building or successor firms. Building records and other archival documentation may have remained with the structure or site, with previous owners, or with related properties.

Historic photographs are invaluable in developing a chronology of building changes and in determining the character and detailing of missing elements (Fig 9). Photographs in private collections, not intended as formal documentation, can often be useful. For example, family photographs taken outdoors can document a building that appears in the background. Renderings and paintings can also be useful, but these images must be carefully analyzed and compared with other information to ensure accurate interpretation. Correspondence and oral histories can be important additions to the overall information, but may be unreliable and should be confirmed, when possible, by comparison with photographic documentation and physical evidence.

Fire insurance maps, such as Sanborn maps, can provide information on type of construction materials. When maps from different years are available, these can be useful in developing a chronology of additions and other changes to the structure.

Existing condition survey. A survey is performed to document physical spaces and elements, and to assess the current condition of building materials and systems. In conjunction with historical research, the condition survey helps determine the historic integrity of a structure. The survey and inspection should address the building's exterior and interior materials, features and finishes; structural systems; interior spaces; mechanical, electrical, and plumbing systems; and fire detection and security systems. Further study may be required such as non-intrusive or intrusive investigation, field testing, sample removal, and laboratory testing and analysis of materials.

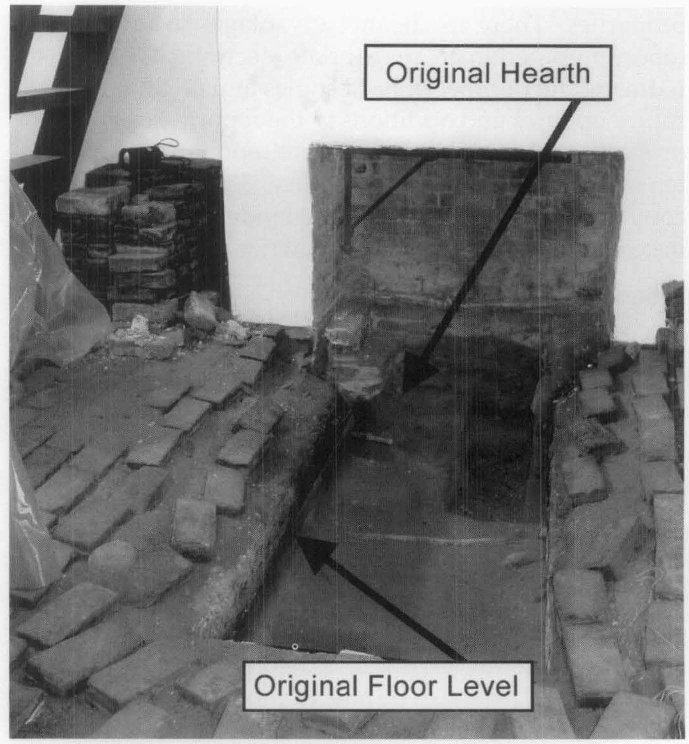


Figure 10. Archeological studies may be valuable in uncovering important evidence of changes to a historic structure. Following historical research and after several archeological soil probes, a decision was made to excavate an area in front of a mid-nineteenth century fireplace, revealing the original dirt floor and hearth undetected by earlier restoration efforts. Photo: Kaaren Staveteig, National Park Service.

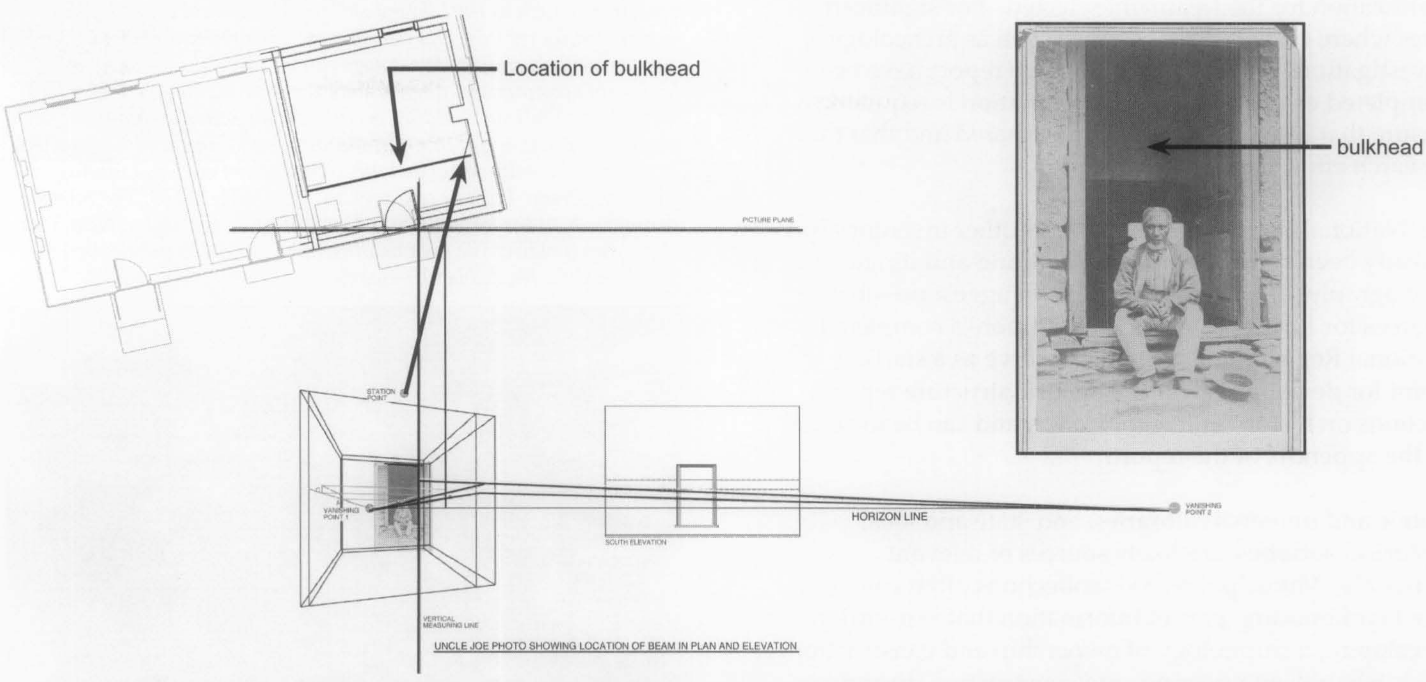


Figure 9. A CADD perspective analysis facilitated study of the location of a long removed interior bulkhead wall. The bulkhead appears in a historic exterior photograph of a man seated in the door entrance to a mid-nineteenth century plantation dependency. Drawing: John Volz & Associates, Inc.; historic photo: National Park Service files.

Archeological investigations can provide information on the locations of building foundations and other sub-grade building elements, and can also assist in developing information on the function of adjacent site areas, building elements, and previously unfinished floor spaces (Fig. 10). The survey may also address the immediate site landscape, if this is not covered in a separate cultural landscape report.

Information gathered during the survey can be documented with field notes on baseline drawings consisting of field sketches or measured drawings. In addition, documentation can include photographs (35-mm, large format, digital, perspective-corrected, and scale-rectified photographs; photogrammetry; and laser techniques), sketches and measured drawings, computer-aided design and drafting (CADD), video records, and written notes and field measurements. Depending upon project requirements, documentation may need to be prepared to archival standards regarding paper, photographs and negatives, electronic records, and backup data.

Measured drawings and record photography. The collection of the Historic American Building Survey/ Historic American Engineering Record (HABS/HAER) archive at the Library of Congress should be searched in case the property has been previously documented through drawings and photographs. While many historic properties have been documented since the start of this invaluable collection in the 1930s, it is still more likely that this type of documentation does not exist for a property for which a historic structure report is being undertaken. Preparation of such documentation to portray the current condition of a property can be an invaluable addition to the historic structure report. Besides serving as a documentary record of a structure, the recording documents can serve another purpose such as an easement document, information for catastrophic loss protection, interpretive drawings, or baseline drawings for proposed work. If undertaken as part of the current building study, the measured drawings and record photography should follow the *Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation.*

Materials investigation and testing. Field examination and testing of building material may include non-destructive (non-intrusive) or, where necessary, destructive (intrusive) examination and/or testing of materials, components, and systems (Fig. 11). Examples of non-destructive methods of field examination and testing include field microscopy, the use of a metal detector to locate concealed metal elements, and X-ray techniques to assess concealed conditions. Some examples of destructive methods of field examination and testing include structural testing, strain relief testing, and inspection openings (probes). Instruments such as a borescope, through which concealed conditions can be viewed through a small hole, permit enhanced examination while limiting damage to the existing building fabric.

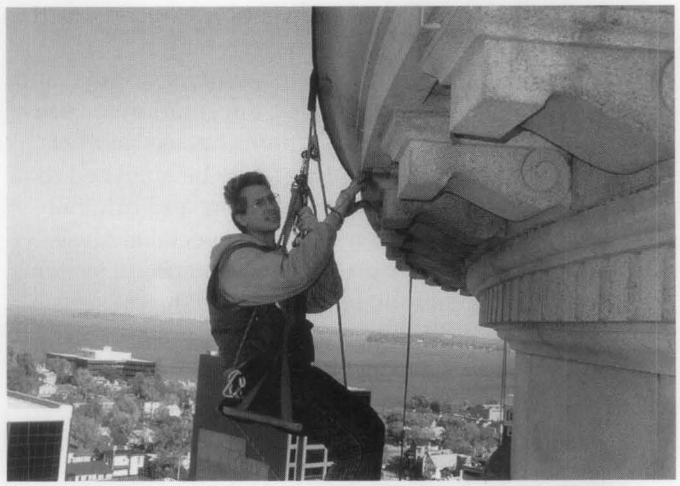
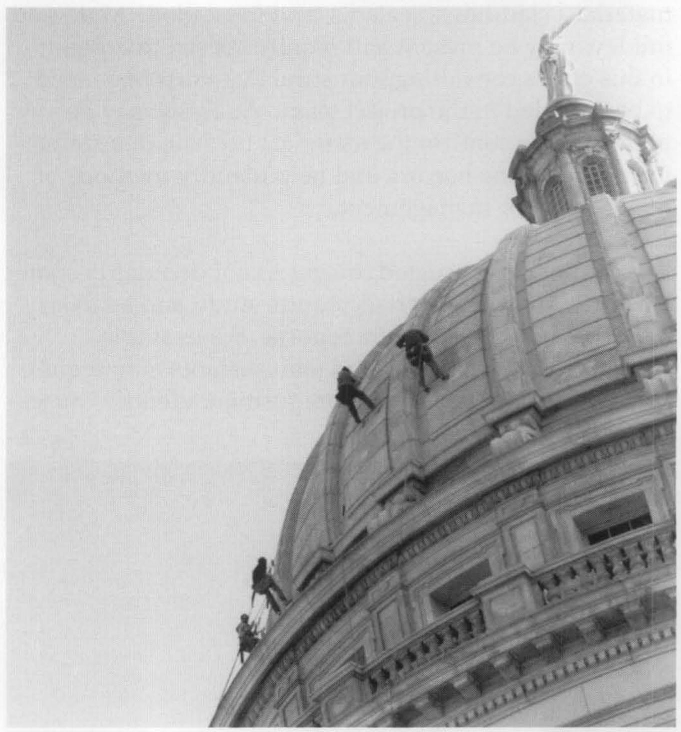


Figure 11. The use of special access methods may be necessary for close-up investigation of building elements. At the Wisconsin State Capitol, project architects and engineers used rappelling techniques. Photo: Wiss, Janney, Elstner Associates, Inc.



Depending upon existing conditions and the results of the site inspection, field monitoring may be required. Field monitoring can include humidity and temperature monitoring, documentation of structural movement and vibrations, light level monitoring, and other environmental monitoring.

In addition, materials samples may be removed for laboratory studies. A wide range of laboratory testing may be appropriate to establish the composition of various construction materials, determine causes of deterioration, and identify and assess appropriate conservation and repair measures (Fig. 12). Materials analysis may also be helpful in dating changes to the structure and in developing a chronology of construction (Fig. 13). For example, mortar analysis may be performed to determine the composition of original and repointing mortars and to provide information for use in designing a mortar mix for repointing. As another example, paint and other coatings may be analyzed to determine finish types and composition, and original and subsequent color schemes, using special analysis techniques and comparison with color standard systems. Samples should generally be returned to the owner and retained in case future testing is required. In some cases, it may be appropriate to reinstall the samples after materials studies have been completed.

Sample removal and analysis may also be required to identify hazardous materials, which are present in many historic buildings. For example, lead and other heavy metals are components of many older paints and coatings, and asbestos is a constituent of some roofing materials, claddings, sealants, and insulation. Mold and mildew may be present and require special treatment; in this case a consulting industrial hygienist may need to be included in the project team. Analysis may be performed to confirm the materials present, determine the nature of the hazard, and help identify methods of remediation or management.

As buildings constructed during recent decades become "historic," newer materials require study and analysis as part of historic structure reports. For example, curtain wall components and joint sealants may require analysis to determine their composition, identify causes of deterioration, and select appropriate replacement sealants. Composite materials and plastics, present in post-World War II buildings, may also require special effort to determine repair techniques or appropriate materials for replacement.

Figure 13. Paint studies may not only help establish the chronology of paints and paint colors used on a building but also may aid in the dating of existing architectural features. Examination of the paint layers on these modillions utilizing a hand-held microscope enabled an investigating team to confirm in the field which modillions were original and which were later replacements. Photo: Charles Fisher, National Park Service.

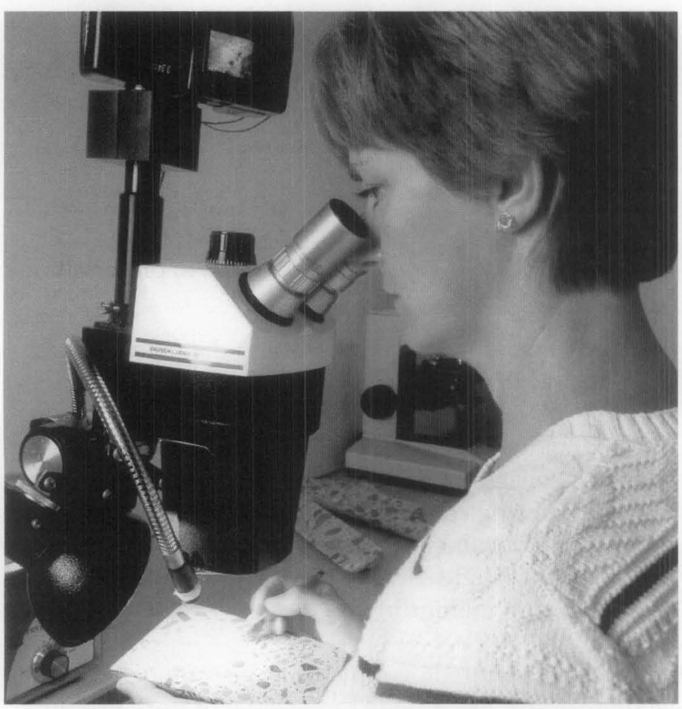


Figure 12. Field and laboratory studies of construction materials may be performed as part of a historic structure report. Laboratory studies of samples removed from the building may include a range of chemical and physical testing and evaluation. Here, a petrographer uses a stereomicroscope to examine concrete specimens. Photo: Wiss, Janney, Elstner Associates, Inc.

All of the information gathered during the physical investigation, and through field testing and laboratory analysis, should be documented in field notes, sketches, photographs, and test reports. This information is incorporated in the historic structure report and provides a basis for the development of treatment recommendations.

Evaluation of significance. The process of evaluation occurs throughout the study of the historic structure as information is gathered, compared, and reviewed. Historical data and physical evidence are reviewed to help evaluate the historical, architectural, engineering, and cultural significance of the property, its construction and use, and occupants or other persons associated with its history and development. This evaluation includes determination of the period(s) of primary significance. An overview of the building's history and an assessment of its significance are included in the report.

Depending on the historical significance of the property, and whether a detailed history has already been written,

The Secretary of the Interior provides four distinct but interrelated approaches to the treatment of historic properties.

Preservation focuses on the maintenance and repair of existing historic materials and retention of a property's form as it has evolved over time.

Rehabilitation acknowledges the need to alter or add to a historic property to meet continuing or changing uses while retaining the property's historic character.

Restoration is undertaken to depict a property at a particular period of time in its history, while removing evidence of other periods.

Reconstruction re-creates vanished or non-surviving portions of a property for interpretive purposes.

a brief or more detailed history may be appropriate. A chronology of construction and changes to the building, developed through historic and physical research, is an effective approach to identifying original building elements, as well as modifications that have occurred over time. If a comprehensive National Register nomination or other inventory has been prepared, the significance may already be defined. In other cases, the significance of a building and even its treatment may have been established through authorizing legislation or through the charter of an organization or foundation that owns the historic property. Where appropriate, however, the building's significance should be re-evaluated in light of research performed for the historic structure report.

The results of the research, investigation, and field and laboratory testing are reviewed as a basis for developing specific work recommendations. The history and significance of the building and its site are evaluated to understand what spaces, elements, and finishes are of architectural or historical importance, and to confirm the overall project goals and treatment direction. The physical condition of the building and its systems is evaluated with regard to existing deterioration and distress, and needed repairs, as well as changes required to meet treatment goals. Attention is given to identification of life safety issues and code considerations. Conditions are also identified that could lead to future safety risks, loss of historic fabric, or loss of performance.

Selection of a treatment approach. Once the building's history, significance, and physical condition have been researched and investigated, an appropriate treatment is usually selected (Fig. 14). Depending upon the intended use of a property, funding prospects, and the findings of the investigation, it may be necessary in some cases to identify and discuss an alternate treatment as well. For example, a building currently occupied by caretakers that is a candidate for restoration and use as a museum may require such ambitious funding support that, for the foreseeable future, a more practical treatment could be to preserve the building and retain the caretakers. In this case, the treatment recommendation would be to restore the property and project work relevant to the restoration would be described. However, the alternate treatment (in this instance an interim one) of preserving the building in its current form would also be described, including discussion of work appropriate to preservation such as repairing the existing roof and installing a monitored fire detection system.

Figure 14. The treatment approach selected for a building usually is determined by the intended use of a property, funding prospects, and the findings of an investigation. The Wolf Creek Inn, operated by the Oregon Parks and Recreation Department, is among the most intact and oldest active travelers' inns in Oregon. The historic structure report outlined a rehabilitation treatment which included such work recommendations as repairs to specific historic fabric, landscape restoration and site improvements, and upgrading of the building's mechanical and electrical systems. Photo: Historic American Building Survey, 1934.

In selecting an appropriate treatment, the Secretary of the Interior's Standards for the Treatment of Historic Properties can be particularly helpful. (See sidebar.) In use for more than twenty-five years, the Standards are a widely accepted means of planning for and undertaking project work in a manner that preserves historic materials and elements. The Secretary's Standards have been adopted by many state and local review entities for review of work proposals on historic structures.

The Standards and their accompanying Guidelines describe four different options for treatment and list recommended techniques for exterior and interior work consistent with each option. One treatment (preservation, rehabilitation, restoration, or reconstruction) is usually selected and followed throughout the course of a project involving a particular building. Application of a single treatment approach helps to avoid inappropriate combinations of work, such as restoring a building's appearance to an earlier time in history while simultaneously constructing a new addition.

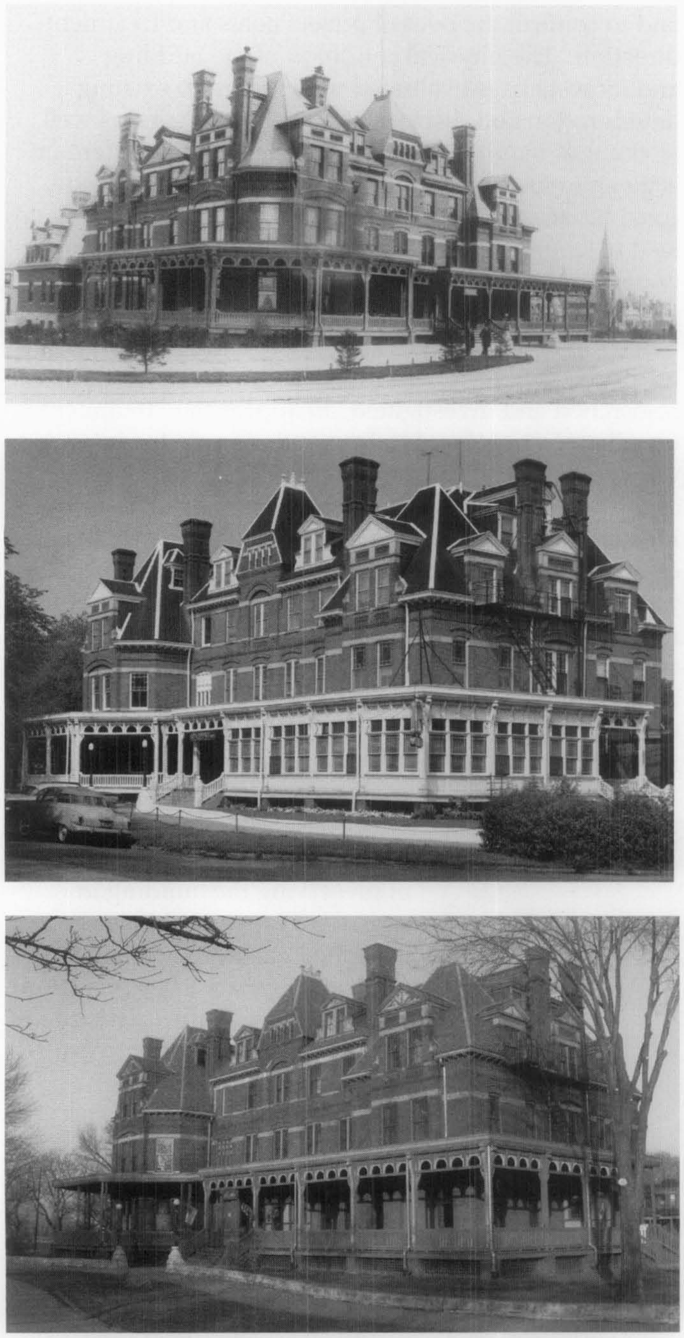


Figure 15. The historic structure report for the Hotel Florence, shown here in 1886 (upper), 1963 (center), and 2004 (lower) views, provided a basis for stabilization and repair work which has been completed. Initial phases of work addressed preservation of the building envelope, structural repairs, and limited mechanical and electrical improvements. The report also provided recommendations for future rehabilitation work that will be implemented in phases as funding becomes available. Photos: upper and center, Historic American Building Survey; lower, Wiss, Janney, Elstner Associates, Inc.

Development of work recommendations. The work recommendations are a central feature of the report. They are developed only after the research and investigation has been completed and the overall project goal established as to whether a particular building should be preserved, rehabilitated, restored, or reconstructed. The specific work recommendations need to be consistent with the selected treatment. If analysis performed during the study suggests that the approach or use initially proposed would adversely affect the materials, character, and significance of the historic building, then an alternate approach with a different scope of work or different use may need to be developed. The process of developing work recommendations also needs to take into account applicable laws, regulations, codes, and functional requirements with specific attention to life safety, fire protection, energy conservation, abatement of hazardous materials, and accessibility for persons with disabilities.

In addition to project goals, the proposed work is also guided by the building's condition. The scope of recommended work may range from minor repairs to structural stabilization to extensive restoration. In addition, the scope of work may be very narrow (e.g., priming and painting of woodwork and repair of deteriorated roof flashings), or very extensive (e.g., stabilization of timber framing or major repair and repointing of exterior masonry walls). The result of implementing (or not implementing) the recommended work needs to be considered as the recommendations are developed.

Of course, the available project budget is also a factor in determining the extent of recommended work and whether it must be accomplished in several phases or projects. Whether or not available budget is the primary factor in determining the extent of work that can be performed, it is often useful to prioritize recommended work items. The recommended tasks can be examined in terms of relative importance and the time required for implementation. Prioritizing repairs can be critical where immediate or short-term work is needed to stabilize a building or structure, eliminate safety hazards, make the building weather tight, and protect it against further deterioration (Fig. 15).

Appropriate procedures for undertaking the recommended work items are described in the historic structure report and are intended to serve as a basis for planning the repair, rehabilitation, or restoration design. The level of detail to which the work items are defined should be limited in the historic structure report, as these recommendations serve as the foundation for, rather than in place of, design and construction documents for the work. For example, baseline drawings annotated with existing condition notes can later serve as a starting place for development of construction drawings. Outline procedures provided in the report for recommended work items can be used later to develop specifications for the work. Finally, a general opinion of probable costs associated with the recommended work is often prepared. A cost estimate is useful to building owners and managers in budget planning and also assists in prioritizing the work. For large or complex projects, the services of a professional cost estimator may be helpful in this effort.

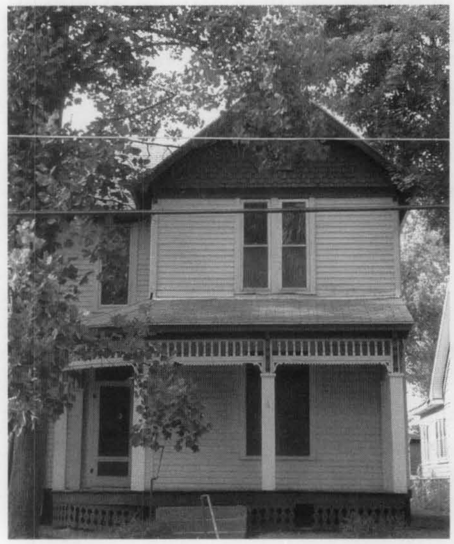
Report Preparation. Upon completion of the research, physical investigation, evaluation, and work recommendations, the historic structure report is compiled. The principal investigator may submit an outline of the report for owner review at the beginning of the report preparation. A draft report may also be submitted for review when the report is partially complete, especially if there are many new research findings, significant physical distress conditions to be addressed, or complicated choices to be made in determining the treatment.

The report should be prepared in a style and format that is readily accessible and user-friendly; however, it is not essential that a standardized method or format be followed for all historic structure reports. The report can be primarily narrative or graphic, but is most typically a combination of these formats. Ease and economy of report preparation should be considered but should not take precedence over clarity and thoroughness of documentation.

Meetings and presentations. In addition to meetings with site personnel early in the study process, it is helpful for the project team to meet at key points during the research, investigation, and development of the historic structure report. For example, it is useful for the project team members performing archival research to meet with site personnel to review documents and findings, and to help ensure that important archival sources have not been overlooked. Project team members may also walk through the building with site personnel during the investigation phase to review and discuss existing conditions and possible recommendation approaches. When the report is in draft form, a meeting of the project team with those personnel who will be reviewing and using the report is useful to discuss overall goals, treatments, and recommendations as these are being developed. Finally, when the study is complete, a presentation of the completed study by the project team helps to familiarize the owner and building personnel with the report, highlight key issues, answer questions, and provide a transition to the use of the report as a working document by the building's caretakers.

Report Organization

The scope of the study—historical research, condition survey, investigation and testing, evaluation, selection of appropriate treatment, and development of specific work recommendations—generates a wealth of information about the history and condition of the building and the specific work needed to preserve, rehabilitate, restore, or reconstruct it. This information is typically a combination of historical and technical data obtained by different members of the project team and presented as an integrated report in text, photographs, drawings, and tables (Fig.16). The project leader or principal author must guide the development of the report so that key issues are addressed, information is



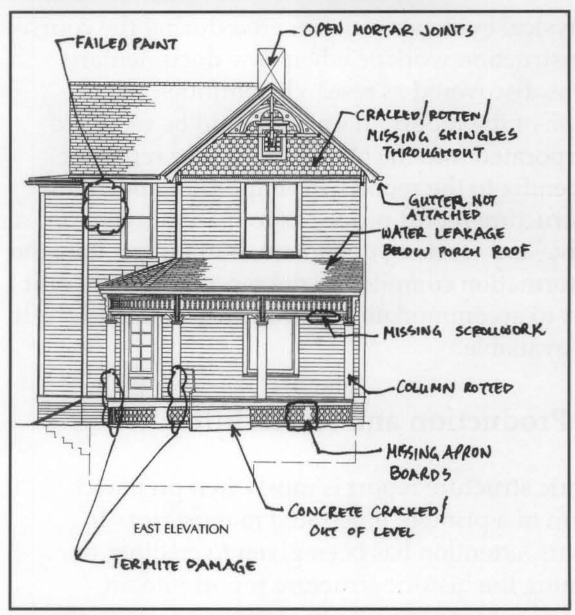


Figure 16. The historic structure report for the Noland House in Independence, Missouri, a vernacular house that is significant as part of the context of Harry S Truman's life and family in Independence, Missouri, includes photographs and measured drawings to record existing features and conditions of the building. The measured drawings will also provide a basis for construction documents for future preservation work. This photograph and drawing illustrate the front elevation of the house. Photo and drawing: Bahr Vermeer Haecker Architects.

documented and assimilated in the report findings and discussion, recommendations are clearly presented, and no information is lost or misinterpreted in the compilation process.

In order to integrate the many pieces of information into a coherent and comprehensive whole, the historic structure report is generally organized into two principal sections preceded by a brief introduction that summarizes overall findings and recommendations and provides project administrative data. The main sections of the report consist of (1) a narrative that documents the evolution of the building, its physical description, existing condition, and an evaluation of significance; and (2) a discussion of historic preservation objectives, together with recommendations for an overall treatment approach and for specific work. The report is usually supplemented with footnotes or endnotes, bibliography, and appendices of historical documentation and technical data.

It is highly recommended that a post project record of all work performed later be added as a supplement to the historic structure report. This record may consist of annotated drawings, photographs, and other documentation of the work performed. Site personnel may help coordinate this supplement or record if the principal author of the report is not involved in the later construction phase. Some organizations and government agencies consider the post project record to be a third part of a historic structure report and not just a supplement.

When physical evidence is discovered during the course of the construction work or when new documentary evidence is discovered as research continues after completion of the report, this also should be recorded and incorporated into the historic structure report or in an appendix to the report. An important goal of the historic structure report process is to maintain the report as an active and working document, both to facilitate the use of information compiled in the report and to permit the report to accommodate new information readily as it becomes available.

Report Production and Availability

The historic structure report is most often prepared in the form of a printed, illustrated manuscript. In recent years, attention has been given to creating or transforming the historic structure report into an electronic document as well. In electronic format, the report can easily be shared with interested parties and is readily updated.

However, because historic structure reports are still mostly produced in printed format (although sometimes concurrently with an electronic document), it is important that, after production, one or more copies be provided to the property owner and also made available to the project team. As the basis for design and construction documents, the historic structure report needs to be readily available and extensively used during implementation of the work. At least one site copy should be maintained in a physical format that can be readily updated, such as a three-ring notebook to which additional documentation can easily be added. Field documentation materials, including photographs and negatives, measured field drawings, condition reports and surveys, materials test reports, and other information gathered during the study can be stored in an archive by the building owner for future reference.

An archival copy should also be provided to the owner, and a minimum of one archival copy kept at the project site and at an appropriate local or regional archive, such as a state historical library. Copies of the historic structure report may also be provided to a local historical organization or university and the state historic preservation agency or historical society. In addition, a copy may be given to the National Trust for Historic Preservation Library at the University of Maryland at College Park, which has established a reference collection of historic structure reports.

Summary

Various agencies and organizations have employed historic structure reports as planning tools for many years, for example, the National Park Service, General Services Administration, New York State Office of Parks, Recreation and Historic Preservation, and the Society for the Preservation of New England Antiquities. These and other agencies and organizations may have specific requirements and procedures for reports prepared for properties under their stewardship that differ from those described in this Preservation Brief. All historic structure reports, however, share a common goal—the careful documentation and appropriate treatment of significant historic structures.

The historic structure report is an optimal first phase of historic preservation efforts for a significant building, preceding design and implementation of its preservation, rehabilitation, restoration, or reconstruction. If work proceeds without a historic structure report as a guide, physical evidence important to understanding the history and construction of the building may be destroyed. The preparation of a report prior to initiation of work provides documentation for future researchers. Even more importantly, prior preparation of a report helps ensure that the history, significance, and condition of the property are thoroughly understood and taken into consideration in the selection of an appropriate treatment and in the development of work recommendations. A well prepared historic structure report is an invaluable preservation guide.

Content and Organization of Report

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- Work Recommendations and Alternatives

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Appendices
Supplemental Record of Work Performed (section often added later)
- Completion Report
- Technical Data (on work completed)

Introduction. This section includes a concise account of research and investigation findings and recommendations for treatment and use, and a record of project administrative data.

- *Study Summary* - a brief statement of the purpose, findings, and recommendations of the study, including major research findings, key issues addressed by the study, and a summary of recommendations for treatment and use.
- *Project Data* - a summary of project administrative data (e.g., location, ownership, and landmark status of property) and the methodology and project participants.

Part 1 Developmental History. This section consists of a narrative report based on historical research and physical examination documenting the evolution of the building, its current condition and causes of deterioration, and its significance.

- *Historical Background and Context* - a brief history of the building and its context, its designers and builders, and persons associated with its history and development.
- *Chronology of Development and Use* - a description of original construction, modifications, and uses, based on historical documentation and physical evidence.
- *Physical Description* - a description of elements, materials, and spaces of the building, including significant and non-significant features of the building.
- *Evaluation of Significance* - a discussion of significant features, original and non-original materials and elements, and identification of the period(s) of significance (if appropriate).
- *Condition Assessment* - a description of the condition of building materials, elements, and systems and causes of deterioration, and discussion of materials testing and analysis (if performed as part of this study).

Part 2 Treatment and Work Recommendations. This section presents the historic preservation objective and selected treatment (preservation, rehabilitation, restoration, or reconstruction), requirements for work, and recommended work that corresponds with the defined treatment goal.

- *Historic Preservation Objectives* - a description and rationale for the recommended treatment and how it meets the project goals for use of the building, e.g., rehabilitation for a new use, restoration for interpretive purposes, etc.
- *Requirements for Work* - an outline of the laws, regulations, and functional requirements that are applicable to the recommended work areas (e.g., life safety, fire protection, energy conservation, hazardous materials abatement, and handicapped accessibility).
- *Work Recommendations and Alternatives* - a presentation of tasks recommended to realize the proposed treatment approach; evaluation of proposed solutions; and description of specific recommendations for work, including alternate solutions, if appropriate.

Notes, Bibliography and Appendices

- Footnotes or endnotes
- Bibliography, annotated if possible
- List of sources of information (e.g., archives, photograph collections)
- Appendices (e.g., figures, tables, drawings, historic and current photographs, reference documents, materials analysis reports, etc.)
- Index (if the report is particularly long or complex)

Supplemental Record of Work Performed. This section documents work performed, which may include planning studies, technical studies such as laboratory testing or structural analysis, or other investigation work that was not part of the scope of the original historic structure report, and records physical work on the building (construction documents, annotated drawings, photographs). The section is usually added later to update the report, as most historic structure reports are issued prior to implementation of the recommended treatment approach and specific work. It is sometimes referred to as Part 3 of the report.

- *Completion Report* - a record of the work accomplished, physical evidence discovered during construction, and how findings affect interpretation of the building.
- *Technical Data* - a collection of field reports, material data sheets, field notes, correspondence, and construction documents.

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[1] From the introduction to the *University of Virginia, Pavilion 1, Historic Structure Report*, Mesick Cohen Waite Hall Architects, 1988.

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48 PRESERVATION BRIEFS

Preserving Grave Markers in Historic Cemeteries

Mary F. Striegel, Frances Gale, Jason Church, &
Debbie Dietrich-Smith

National Park Service
U.S. Department of the Interior

Technical Preservation Services

Cemeteries found across the country are not only places of burial, but they also provide a vivid record of community history. Whether large or small, well maintained or neglected, historic cemeteries are an important part of our cultural landscape. The vast richness of expression through form, decoration and materials informs our understanding of the individuals buried in historic cemeteries and their cultural significance.

While cemeteries are often considered to be perpetual, their most prominent feature—the grave markers—are not. They weather, naturally decay, often are poorly maintained and repaired and, on occasion, are vandalized (Fig. 1). Grave markers are usually noteworthy not only for their inscriptions but also for their craftsmanship. Exceptional markers are considered works of art.

This Preservation Brief focuses on a single aspect of historic cemetery preservation—providing guidance for owners, property managers, administrators, in-house maintenance staff, volunteers, and others who are responsible for or are interested in preserving and protecting grave markers. Besides describing grave marker materials and the risk factors that contribute to their decay, the Brief provides guidance for assessing their conditions and discusses maintenance programs and various preservation treatments.

Figure 1. Sandstone and slate grave markers in the Ancient Burying Ground in New London, CT, display a variety of weathering conditions. Markers in the cemetery date from the mid-17th to the early 19th centuries. Photo: Jason Church.

Also identified are a number of excellent references that address materials used in all grave markers, including several other Preservation Briefs (listed in Additional Reading). This Brief highlights particular issues that should be considered with historic grave markers.

Types of Traditional Grave Markers

The great variety in the types of grave markers is a fascinating aspect of the study and appreciation of historic cemeteries. Three broad categories can be used to describe grave markers—(1) single-element, (2) multiple-element, and (3) structures. Single-element grave markers are stone, cast iron, or wood elements that are set in a vertical position or placed as a horizontal slab on the ground (Fig. 2). Early examples of this simplest type of grave markers are field stone and basic wooden or wrought iron crosses, with the name of the deceased person scratched into or engraved on the marker. Often, these rudimentary grave markers are overlooked, significantly deteriorated, or lost. Vertical stone slabs and large stone ledgers laid horizontally over the gravesite are more sophisticated examples of this type.

Multiple-element grave markers are found in a number of different forms (Fig. 3). In the most typical form, a grave marker would consist of two stones—an upper headstone placed on top of a base stone. The upper headstone may be secured in a number of different ways to the base. In the simplest of forms, the upper stone was placed on the base, set in a bed of mortar on top of the base, or joined with pins and mortar. With a "tab-and-

Figure 2. These mid-19th century, single-element stone grave markers in the Grove Cemetery in Bath, NY, are set in a vertical position. Photo: Jason Church.

slot" grave marker, the tabbed upper stone was set in a slotted base. More common today, the upper headstone is secured with a technique that uses small spacers set on the base and a setting compound. This technique or one that uses an epoxy adhesive may be found on older markers where the stones have been reset.

Figure 3. A multi-element grave marker from the early 19th century in the St. Michael's Cemetery, Pensacola, FL, consists of a vertical element with tabs (left image) into a slotted base (right image). Photo: Fran Gale.

Stacked-base grave markers use multiple bases to increase the height of the monument and provide a stable foundation for upper elements. Tall, four-sided tapered monuments, known as obelisks, are typically placed on stacked bases. Columns or upright pillars have three main parts – a base, shaft, and capital. Multiple-element grave markers may also include figurative or sculptural components. Traditionally, stacked base grave markers were set on lead shims with mortar joints or with lead ribbon along the outer edges.

Grave markers can also be engineered structures. Examples of grave marker structures include masonry arches, box tombs, table tombs, grave shelters, and mausoleums (Fig. 4). The box tomb is a rectangular structure built over the gravesite. The human remains are not located in the box itself as some believe, but rather in the ground beneath the box structure. The table tomb is constructed of a horizontal stone tablet

Figure 4. This sandstone table tomb, located in Cedar Grove Cemetery, New London, CT, is an engineered grave marker structure consisting of a horizontal stone tablet supported by four vertical table "legs" with and a central column,. Photo: Jason Church.

supported by small corner supports or columns. Grave shelters, also called grave houses, can be simple or elaborate wooden structures built over the gravesite. Mausoleums are above-ground buildings with compartments for multiple burials. Engineered structures also include hillside and underground tombs.

Guidelines for Evaluating and Registering Cemeteries and Burial Places, National Register Bulletin 41, provides a concise review of grave marker types.

Materials

Stone, brick, concrete, metal, and wood are the most common materials used for grave markers and for fences and gravesite enclosures in historic cemeteries. This section briefly describes the composition and properties of these diverse materials

Masonry materials

There is a wide variety of masonry materials used in historic cemeteries; some are naturally occurring and others man-made. Although there are notable exceptions, most masonry materials are durable, have high compressive strength, and are resistant to weathering. As grave markers, they typically represent the work of masons and stone carvers.

Stone is a naturally occurring material with a wide range of properties and is available in a variety of colors (Fig. 5). Geologists classify stone according to the way in which it was formed with the three categories being igneous, sedimentary and metamorphic rock. Stone found in cemeteries is predominantly quarried, though the use of field stones is not uncommon. The mineralogy and chemical composition of stones vary. Some are composed primarily of silicate minerals; granites, sandstones, slate, and schist are examples. Other stones contain calcium carbonate with marble and limestone in this group. Mineralogy, chemical composition, and physical structure of the stone influence weathering and

Figure 5. A variety of colors of natural stone are found in historic cemeteries, such as this pink granite marker in the Cedar Grove Cemetery, New London, CT. Photo: Jason Church.

the selection of materials and procedures for its cleaning and protection.

Man-made masonry materials are manufactured from naturally occurring raw materials. For example, the raw materials used to make brick include clay, sand, and shale. During firing, clay minerals and sand melt and come together forming silicates, aluminates, and metallic oxides. The resulting brick material has a hard-fired outer surface with a softer interior.

Concrete is a man-made material composed of cement, sand, gravel, and water. Most concrete produced after 1870 contains Portland cement, another manufactured product. In its plastic or wet state, concrete can be cast or poured. It hardens by hydration, a chemical-curing process. The resulting product has excellent compressive strength, but much lower tensile strength. Reinforcing concrete with steel helps compensate for this limitation.

All masonry materials are porous with an interior network of pores. The porosity of sedimentary rocks such as limestone and sandstone can be as high as 20 percent while the pore volume of granite is very low. Because moisture is a key factor in many deterioration processes, porous masonry materials are more vulnerable to weathering.

Metals

Metals are solid materials that are typically hard, malleable, fusible, ductile, and often shiny when new (Fig. 6). A metal alloy is a mixture or solid solution of two or more metals. Metals are easily worked and can be melted or fused, hammered into thin sheets, or drawn into wires. Different metals have varying physical

Figure 6. Decorative cast-iron grave markers like this late-19th century one in Oakland Cemetery in Shreveport, LA, are produced by heating the iron alloy and casting the liquid metal into a mold. Photo: Jason Church.

and mechanical properties, aesthetics, and weathering characteristics.

Ferrous metals and alloys, including cast iron, wrought iron, and steel, all contain iron. Cast iron also contains carbon and silicon and has a relatively low melting point. When heated to a liquid state, it can be molded into a variety of shapes. Wrought iron is an alloy with low carbon content. Its fibrous inclusions (called slag) are sometimes visible to the naked eye. Unlike cast iron, wrought iron is heated to the point where it becomes soft and then is hammered or "worked" into desired shapes. Most of the wrought and cast iron in historic cemeteries is ornamental rather than structural. While cast iron, steel, and wrought iron all contain iron, steel and wrought iron are more resistant to corrosion. Paint was often applied to ferrous metals to help protect them from corrosion and for decorative purposes. Metal elements were painted in a variety of colors including black, white, and green, among others.

Nonferrous metals and alloys, such as bronze, zinc, and lead, do not contain iron. Bronze contains about 85% copper, 10-15% tin, and sometimes lead. Historic bronze cemetery markers were created by casting processes that involves pouring liquid bronze into a mold. The completed casting is hollow. Bronze work may comprise a single molded component, such as a plaque, or multiple molded components welded or fitted together as with large statuary. Chemical patinas were applied to enhance color, and clear coatings for protection. Cast zinc monuments were popular from 1870 through the early 20th century. Most cast zinc is bluish-gray in color. Although cast zinc is resistant to corrosion, it is a brittle material with a tendency to "creep" or deform, especially when exposed to high outdoor temperatures.

Wood

Wood is a porous organic material composed of tubular cells in a parallel arrangement. The structure and characteristics of these cells determine the wood's

Figure 7. As shown by this 1877 marker in Silver Terrace Cemetery, Virginia City, NV, exposure to sunlight can damage wood grave markers, making the wood more susceptible to water damage and cracking. Photo: Jason Church.

appearance and influence wood properties. Wood-cell walls and cavities contain moisture. Oven drying reduces the moisture content of wood. After the drying process, the wood continues to expand and contract with changes in moisture content. The loss of water from cell walls causes wood to shrink, sometimes distorting its original shape (Fig. 7).

Hardwoods come from deciduous trees such as oak, maple, and walnut; softwoods from conifers such as pine, cedar, and fir. In general, hardwoods have higher density than softwoods, which makes them more durable materials, and are darker in color. Wood cut at different orientations affects its strength and weathering. As an organic material, wood is also particularly vulnerable to termites, carpenter ants, and other wood-destroying insects and fungi. Paints, coatings, and fungicides such as borates are used to help protect wood from various insect damage and fungal rot.

Other materials

Old cemeteries often include a wide variety of other materials not normally associated with contemporary grave markers, such as ceramics, stained glass, shells, and plastics (Fig. 8). As with masonry, metals, and wood, each has its own chemical and physical properties which affect durability and weathering. These materials

Figure 8. A fired ceramic, this cameo is set in a marble grave marker, located in Elmwood Cemetery, Memphis, TN. Different materials may require different conservation approaches. Photo: Mary Striegel.

present unique challenges and their properties must be understood before establishing appropriate maintenance and repair. Documentation of unusual materials is critical when repair is not possible.

Weathering

All grave marker materials deteriorate when they are exposed to weathering such as sunlight, wind, rain, high and low temperatures, and atmospheric pollutants (Fig. 9). If a marker is composed of several materials, each may have a different weathering rate. Some weathering processes occur very quickly, and others gradually affect the condition of materials. Weathering results in deterioration in a variety of ways. For example, when exposed to rainwater some stones lose surface material while others form harder outer crusts that may detach from the surface.

Figure 9. The limestone and sandstone grave markers in this historic cemetery have different weathering processes. On the left, the limestone shows surface loss in areas exposed to rainwater and gypsum crust formation below. The sandstone marker on the right displays uniform soiling, but surface hardening may be occurring. Photo: Fran Gale.

Granite is a durable grave marker material considered resistant to weathering. It is a compact, hard rock with low porosity, and granite deterioration can be imperceptible for many years. Slate also has low porosity, but its layered structure can result in delamination. Some stones used to make grave markers, like sandstone, limestone and marble, are softer than granite and more porous. These materials are more vulnerable to weathering with deterioration noticeable during the initial years of exposure. With slate and other stones with layered structures, weathering sometimes results in delamination, defined as the separation of layers along bedding planes. Different rates of weathering are related to the chemical composition and physical structure of the material.

Deterioration affects other grave marker materials in different ways. With brick, durability is related to its firing temperature, which influences the brick's compressive strength and absorption. Brick fired at high temperatures has a protective fire skin. The weathering of concrete also is variable, and largely depends on the materials used in its manufacture. For example, Portland cement concrete is generally more resistant to weathering than lime concrete. With wood, grave markers fashioned from heartwood (the dead inner wood) are more durable than those of sapwood (the living exterior wood), and some wood species such as cedar, Osage orange and black locust contain extractives that provide decay resistance.

The term "inherent vice" is used to describe a material with a naturally occurring problem that leads to premature deterioration (Fig. 10). An example of this problem is marble that has cracked due to natural locked-in stresses. Inherent vice also describes grave markers that are composed of incompatible materials, where decay is accelerated in one or both materials because of chemical interactions caused by their close proximity. An example is the galvanic corrosion that occurs when dissimilar metals, such as copper and iron, are in contact and exposed to moisture.

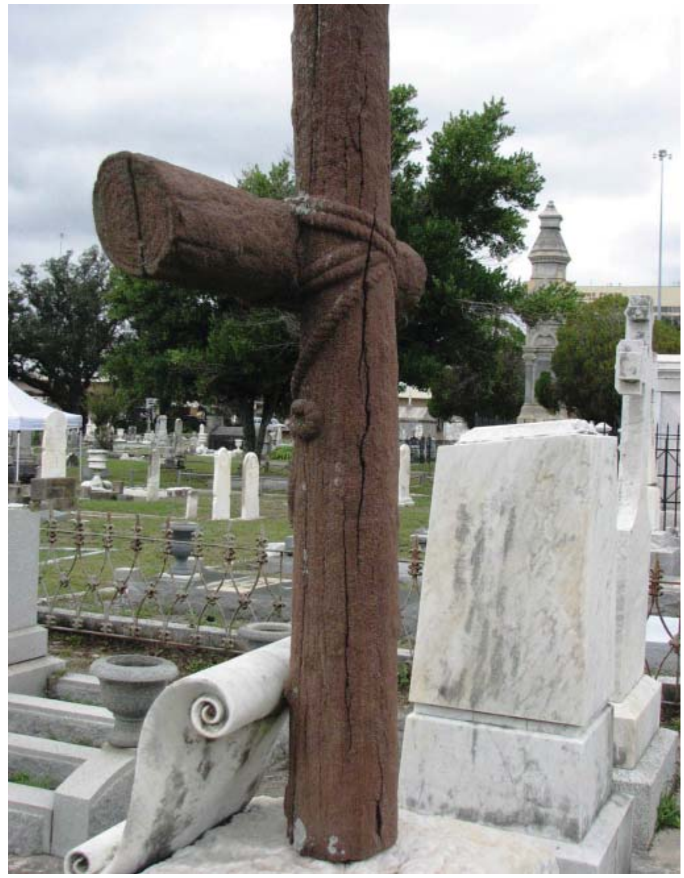

Figure 10. The sandstone cross (carved to look like wood) in this grave marker in St. Michael's Cemetery in Pensacola, FL, provides an example of inherent vice – the severe delamination affecting the sandstone has occurred along its natural bedding planes. Photo: Fran Gale.

Risk Factors

There are two major categories of risk factors that can impact historic grave markers. The first comprises naturally-occurring deterioration phenomena known as the forces of nature, including weathering. The list of natural risk factors includes climate, biological issues, and natural hazards such as fire and floods. The other category includes the many degradation phenomena that are related to human activities. The results of humans and their actions include pollution, lack of maintenance, inappropriate repairs, arson, and vandalism. While some of the factors related to human activities, such as improper repair, may not be intentional, the results can be just as damaging to grave markers.

Often, it is not possible to separate natural risk factors from those related to human activities. For example, pollution is deposited on grave markers by rain and other forms of precipitation, resulting in discoloration and often material degradation. Whether due to natural risk factors, human activities or both, "synergism" occurs when the result of two or more risk factors is greater than the sum of the individual effects. An example is the damage that occurs to salt-laden masonry materials during freeze/thaw cycles. The combined effect of these two deterioration factors is severe.

Natural Risk Factors

Climate plays an important role in weathering processes. Depending upon the climate, cemetery grave markers are exposed to rain, snow, sleet, ultraviolet (UV) light, humidity, high and low temperatures, and wind. All of these forces can damage masonry, metals, and wood. For example, with wood, the UV rays present in sunlight accelerate the weathering process.

Exposure to repeated changes in temperature can have an adverse effect on materials such as stone and other porous masonry. High temperatures deteriorate and weaken many materials while low temperatures cause materials to become brittle. In some climates there are rapid changes during spring and fall that

Figure A. Cemeteries are cultural landscapes made up of a variety of features. Grave markers are but one component of cemeteries that also include walkways, drives, fences, coping, trees, shrubs, and other vegetation. Each component adds to the understanding of the cemetery landscape. Photo: Debbie Dietrich Smith.

Vegetation Management

Carefully monitoring and managing of trees and other vegetation is an integral part of a cemetery preventive conservation program. Mature trees and ornamental shrubs can add character, shade, and seasonal color to historic cemeteries (Fig. A). However, if not properly maintained, they can damage grave markers, fencing, and other historic features. Mature trees may fall during storms and drop large limbs that topple grave markers and mangle fencing. Overgrown vegetation creates wet, shaded areas and fosters biological growth than can accelerate deterioration of stone, iron, and wood objects.

A treatment plan for cemetery vegetation should address trees, shrubs, vines, and "volunteer" growth. For the assessment and treatment of trees that pose hazards, consult an International Society of Arboriculture (ISA) certified arborist. Prune trees and shrubs adjacent to grave markers to allow air circulation and light penetration. Certified arborists and master gardeners should carry out this work or direct others in pruning trees and shrubs, as many may be historic features integral to the cultural landscape and worthy of preservation.

Regarding lawn care, historic cemeteries were not designed for today's large riding lawnmowers, yet this is the mower of choice for many cemeteries, as mowing is one of the most time-consuming and costly maintenance tasks generally undertaken. Mowing between tight spots with a large riding mower deck is destined to cause damage. Best practices include using a smaller, push mower between particularly sensitive features, and outfitting riding mower decks with protective bumpers. Low-cost options include using fire hose padding or a foam swimming 'noodle' (Fig. B). Additional damage is caused by riding over low stones or coping, especially when the blade height is set low. If rolling over these features is unavoidable, many riding mowers have a hand-control adjustment to temporarily raise and lower the blade height.

Improper use of a string-trimmer is also potentially destructive, especially when it comes into contact with soft materials such as marble, limestone, and wood. Using the lightest trim line and angling the trimmer head towards the ground will help reduce damage if the trimmer hits unintended targets. Consider hand trimming around the most significant, fragile features.

As a time-saving measure, herbicides are sometimes used around the base of features to remove unwanted grass and weeds. In most cases, use of herbicides for this purpose is not recommended, as salts within the herbicide can wick into the stone (especially soft stones) and cause spalling and deterioration. The removal of vegetation also exposes soil around the base of the grave marker, which, in a heavy rain, can cause soil splashing that may result in staining.

If fertilizer is applied, choose a natural organic fertilizer to minimize salt content for the reasons stated above. For any chemical application, be sure to rinse away residue from grave markers, etc., with water using a low pressure hose or spray bottle, to minimize continued contact.

Ongoing maintenance of cemetery vegetation is essential to conserve grave markers and fencing. Periodic inspections may warrant removing trees; trimming tree limbs, shrubs, and vines; and removing volunteer vegetation. All trees should be inspected at least every five years. Annual inspections are necessary to assess the condition of shrubs and vines, and to identify volunteer growth for removal. Mowing and trimming around the hundreds of stone, brick, iron, and wood features found in many cemeteries is a weekly or bi-weekly chore. Lawn care is the most time-consuming, and, if not done carefully, potentially destructive maintenance activity in historic cemeteries.

Figure B. A pool 'noodle' can be fitted to the deck of a lawnmower to prevent damage to grave markers. Photo: Debbie Dietrich Smith.

cause damaging cycles of expansion and contraction. Adjacent dissimilar materials may respond differently to temperature changes, resulting in distortion. High winds can carry water and abrasive particles causing abrasion and erosion, especially to soft materials. Wind may also drive rain water into masonry joints and permeable elements and materials.

Water, in liquid, solid or vapor form, plays a critical role in the deterioration process. Most grave marker materials are porous, and moisture from precipitation, ground water, or frequent landscape watering can enter the pore system. If temperatures drop below the freezing point, water in interior pores, joints and cracks freezes, and its increased volume often applies internal pressure, resulting in damage to the grave marker such as cracks or spalling.

Ferrous metals are particularly vulnerable to water-related deterioration. Iron increases in size when it corrodes, sometimes as much as 20 percent. As the corrosion process proceeds, the ferrous metal eventually weakens. When embedded within concrete or masonry materials, the corroding iron often causes cracks and spalls in the masonry.

Woody vegetation can damage grave markers in a variety of ways (Fig. 11). Trees, bushes, and vines can shade grave markers, extending the time that the markers are exposed to moisture. Tendrils and roots may burrow into mortar joints and openings, causing mechanical damage and large plants may lift up or shift markers. Even leaves and twigs, when allowed to collect on the ground near grave markers, can affect water drainage and evaporation (Fig. 12).

Microorganisms such as algae, fungi, and lichens may affect grave markers. Microorganisms hold in moisture and some produce acids. With acid-sensitive materials such as limestone and marble, the result is surface erosion. Sometimes the organisms use the material as a food source, dissolving minerals in the stone and attacking the cellular structure of wood. Wood is especially vulnerable to fungi, algae, and other microorganisms when its moisture content is above 25%.

Infestation by termites, carpenter bees and ants, and other insects can affect the appearance and structural integrity of wood. Unsightly bird droppings can also affect paint and other surface finishes.

Human Activities

Aside from vandalism and purposeful neglect, most risk factors attributable to human activity are unintentional. Sometimes damage to grave markers is the result of cleaning or repair done with the best of intentions. These unfortunate mistakes can be the result of insufficient training and funding, misuse of tools and equipment, and poor planning. With proper training and supervision, human risk factors can be lessened.

Figure 11. Woody vegetation can damage grave markers and pose a risk to visitors unless well managed and maintained. Photo: Jason Church.

Deferred maintenance usually accelerates the deterioration of grave markers and can be a safety hazard. All materials have a service life with mortar, paints, and other coatings requiring periodic upkeep to be effective. For example, unless ferrous metal has a sound protective coating, exposure to weathering can result in corrosion. Loose, misaligned or detached grave markers may lead to further damage or deterioration if not corrected in a timely manner. When nearby trees and shrubs are overgrown and invasive vegetation is present, needless risks to historic grave markers may also occur.

Inappropriate maintenance activities can be devastating. One of the most common threats stems from improper lawn care, particularly the misuse of mowing equipment and string trimmers (weed whackers). The use of large mowers or mishandling them can lead to displacement of markers. Scrapes, gouges and even breakage also can occur. Improper use of string trimmers in areas immediately adjacent to grave markers can result in

Figure 12. A cemetery professional undertakes a tree inventory in American Cemetery, Natchitoches, LA, to determine the health of trees in the cemetery. Management decisions for trimming or removal are based on the inventory. Photo: Debbie Dietrich Smith.

Avoiding 10 Common Maintenance Mistakes

1. *Maintain records on conditions and treatments of historic markers.*

2. *Seek advice from persons experienced with preserving historic markers when initiating a major maintenance or repair program.*

3. *Discourage visitor use of chalk, shaving cream, and other materials to highlight carvings and lettering.*

4. *Train grounds crews in methods to avoid damage to historic markers, including flat grave markers which can be easily damaged by machinery, fertilizers and weed killers.*

5. *Remove graffiti as quickly as possible, using appropriate methods, so as not to encourage further marker disfiguration and vandalism.*

6. *Maintain ground cover around cemetery markers to avoid surrounding dirt from splashing back and staining grave markers.*

7. *Never use rotary grinders to resurface or "clean" historic markers.*

8. *Avoid the use of coatings on masonry without proper investigation.*

9. *Avoid high pressure water washing to clean historic markers.*

10. *Repair rather than replace damaged and deteriorated grave markers. For markers encased in cement, leave any repair work to trained conservators.*

scratching and even cutting into softer stone and wood. Generally, the use of chemical weed killers at the base of grave markers should be avoided, especially if there is a risk that the marker would absorb the chemicals.

Repointing masonry grave markers using Portland cement mortars that are harder than historic mortars often results in accelerated deterioration of the masonry material. Mortar should be softer than the adjacent masonry, enabling trapped moisture to migrate out, and serve as the sacrificial material when cracking occurs to relieve excessive stress. Problems also result when using impervious "protective" coatings that can trap moisture within the masonry, resulting in damage during wet/dry and freeze/thaw cycles (Fig. 13).

Figure 13. The impervious coating used to "protect" this sandstone grave marker trapped moisture within the stone, eventually resulting in deterioration and surface loss. Photo: Fran Gale.

Figure 14. High-pressure water washing can damage grave markers. The photograph shows "wand marks" on the headstones produced by inappropriate pressure washing. Photo: Jason Church.

Harsh cleaning products and techniques can have a detrimental effect on grave markers. Acidic cleaners such as muriatic acid can dissolve minerals in many masonry materials and can attack metals. Alkaline cleaners, such as bleach, are notorious for leaving residual salts that are deposited on the surface (a process called efflorescence). Both acidic and alkaline cleaning can result in staining, especially if rinsing is inadequate. Using high-pressure water, above 500 to 1,000 psi, can needlessly damage materials as well, increasing their vulnerability to weathering (Fig. 14). If the marker is fragile, even low pressure water can be damaging. Techniques to avoid include aggregate blasting with sand or other harsh media and the use of power tools with abrasive wire or NyloxTM brushes.

Pollution

Grave markers can be both visually and materially affected by pollution. Most readily apparent is the discoloration that takes place when airborne pollutants are deposited on markers. Depending on the exposure, how water is shed, and the marker material and intricacies, discoloration on markers will usually appear uneven and in streaks.

While the visual effect of pollution is often discoloration, less apparent is the potential damage caused by pollution to the grave marker materials themselves. Most rain is slightly acidic, and its pH (a measurement of acidity) becomes more acidic when pollutant gases, such as sulfur dioxide and nitrous oxides, are present. Acid rain damages materials containing calcium carbonate, such as limestone and marble, resulting in surface loss or erosion. When erosion is severe, the grave marker inscription, carvings and sculptural elements may become discernable. Recarving the inscription is not recommended. Instead, a small stand-alone interpretative sign could be placed nearby.

Acid rain also damages bronze grave markers. Pollutant gases alter the composition of exposed bronze, often producing water-soluble minerals. These minerals are washed away during subsequent rains, resulting in surface erosion. If the bronze element is positioned on a masonry pedestal or plinth, the minerals are deposited on the masonry below. These effects of acid rain are disfiguring to the bronze element and associated masonry.

Condition Assessments

Condition assessments help identify potential safety hazards, required preservation work, and any additional conservation that is needed for stabilization and protection of grave markers. Assessments also provide important baseline information about deterioration affecting grave markers. The collected information is helpful in determining and prioritizing maintenance tasks, identifying unstable conditions that pose an immediate threat, and for developing a plan for any needed repair or conservation work. Assessments should be recurring, preferably every spring. Condition assessments also help determine the extent and severity of damage following a disaster.

Depending upon the size of the cemetery and funding available, the initial assessment may be carried out by a team consisting of cemetery staff, a materials conservator, and, where necessary, an architect or structural engineer for cases involving large monuments and mausoleums (Figs. 15a and 15b). For smaller cemeteries without large monuments and mausoleums, and where funding is problematic, volunteers can be trained to prepare a condition assessment under the guidance of an experienced individual.

The first step in any condition assessment is to gather background information, including cemetery records and documents, historical photographs, records of previous repair and maintenance work, and current practices. The next step is to conduct an on-site survey. Following the survey, recommended maintenance procedures should be provided. If the team or individual conducting the survey is experienced in repairing historic grave markers, their assessment should include information about appropriate materials and techniques for restoration and stabilization.

Survey forms facilitate both recording of field conditions and needed maintenance or repair work. Most forms include sections for marker type (headstone, obelisk, etc.), construction materials, orientation, dimensions, soil type, and grave marker deterioration. There are a number of excellent examples of survey forms available for download, including the National Park Service Condition Survey Form at www.ncptt.nps.gov However, because each cemetery is unique, it may be necessary to modify an existing form.

A tool kit for the condition assessment may include binoculars, digital camera, magnifying glass, measuring tape, clipboard, carpenter's rule, level, magnet, and flashlight. For large monuments, a ladder or aerial lift may be required. Photographs of each marker, including overall shots and close-up details, are an essential part of the documentation process. Photo logs are helpful for

Figure 15a. Condition surveys are undertaken to document current conditions, determine safety issues, and plan both emergency stabilization and future treatment plans. There are a variety of survey forms available that can be tailored to the specific cemetery. Photo: Mary Striegel.

Figure 15b. Photographs are used to document the condition of the grave marker as part of a condition assessment. Photo: Fran Gale.

recording the date, direction, and photographer. Digital photographs should be captured in a standardized size and format (.tif, .jpg, .raw).

Defining conditions can be challenging, especially for cemetery staff and volunteers who are new to the process. There are a number of illustrated glossaries that can assist with determining accurate terminology for describing conditions. The ICOMOS Illustrated Glossary on Stone Deterioration Patterns http://www.international.icomos.org/ and the NACE International Resource Center Corrosion 101 http://nace.org/ are excellent resources.

Where deterioration is apparent, the assessment should address questions such as:

- What are the physical characteristics of the defects? Has deterioration obscured ornamental work or made the inscription difficult to read?

- What is the extent of the affected area? Are all areas of the marker affected by deterioration or is there a pattern?

- Do the conditions appear to be stable or getting worse.

- Are the defects affecting other materials or impacting the safety of visitors?

- Is deterioration contributing to loss or theft?

- Is further investigation required?

Maintenance

The old axiom that an ounce of prevention is worth a pound of cure certainly applies to the preservation of historic cemeteries. Maintenance is essential to the long-term preservation of historic grave markers. The principal components of a maintenance program include regular inspections, cyclical and prioritized maintenance work, and annual reports and budgeting. An important first step is the development of a support team, including staff, conservators, engineers, skilled masons, and other professionals. In most cases, the cemetery manager should initiate this process.

The cemetery manager can use the information from the condition assessment report to develop a maintenance plan with a list of cyclical maintenance work. Many tasks can be carried out by in-house staff. For example, maintenance cleaning of metal and stonework can often be accomplished by rinsing with a garden hose. Applications of wax coatings can be used to protect bronze elements. Trained staff can undertake these tasks. Teaching graffiti removal techniques to cemetery staff may also be necessary if vandalism is an on-going problem. Staff should have access to written procedures

Figure 16. A professional mason works to insert a new piece of stone. Often referred to as a "dutchman", this repair technique requires replacing the deteriorated stone section with a new finished piece of the same size and material. Photo: Jason Church.

that include lists of appropriate materials and forms for recording the work completed.

Some work is best done by specialists (Fig. 16). For example, unless there is a trained mason on staff, replacing deteriorated or missing mortar will require a skilled masonry contractor. Services of a conservator or trained cemetery specialist should be used for removing severe soiling and staining from grave markers and for carrying out adhesive repair work such as selectively replacing a piece of stone when a marker is damaged by mechanical equipment. Care should be taken to clearly define the scope of work when hiring a contractor. It is useful to reference guidelines and preservation standards, such as those provided by the Secretary of the Interior or the American Institute for Conservation, whenever possible.

Treatments

In historic cemeteries, preservation treatments are used to preserve grave markers and protect them from future deterioration. Tasks such as cleaning, where appropriate, painting, or lime washing may be undertaken both as an initial treatment and on a cyclical basis as part of the maintenance program for the site. Other treatments, including repointing, patching and filling, and resetting, should be undertaken on an as-needed basis.

It is important to note that the Secretary of the Interior's Standards for Treatment of Historic Properties provide concepts and guidelines for maintaining, repairing, and replacing historic materials. The Standards promote best practices that will help to protect grave markers in historic cemeteries and other irreplaceable cultural resources. If replacement is required, the new material should match the old in composition, design, color, and texture. With chemical and physical treatments, the Standards recommend using the gentlest means possible.

Cleaning

Cleaning is carried out to remove soiling, staining, and contamination from grave markers (Fig. 17). Cleaning improves the visual appearance of the marker and sometimes reveals existing problems such as erosion and cracks. For various protective treatments, cleaning may be a necessary step in surface preparation. Although cleaning often is desirable and beneficial, the use of improper materials and techniques can cause great damage; when cleaning historic grave markers is undertaken, one should keep in mind the principle, "first do no harm."

To avoid a heavy build-up of soiling that might require aggressive cleaning procedures, regularly scheduled cleaning should be carried out by cemetery staff. The frequency of cleaning depends on a number of factors, including climate, location and vegetation. Before cleaning, an on-site inspection should be conducted to identify monument materials, including those not designated for cleaning since they may inadvertently come in contact with cleaning products and could be harmed. Temporary protective measure may be needed to safeguard nearby grave markers. Identifying the types of soiling present, including pollutants and contaminants, is important in deciding what cleaning procedures to use.

For some monuments, existing conditions may preclude cleaning. Even gentle cleaning may not be recommended for conditions such as severe erosion, advanced deterioration, or fragile areas. Additionally, open joints, unstable repairs, and large cracks may require alternate cleaning procedures.

General maintenance may involve low-pressure water washing. In most cases, surface soiling can be removed with a garden hose using municipal water or domestic water supply from a well. To avoid risks due to freezing, air temperature above 40° F is recommended for the time of treatment and subsequent 24 hours. To help remove stubborn soiling and dirt, soft, natural bristle scrub brushes are best. Avoid metal bristle brushes or firm nylon brushes and wrap metal elements with masking tape to avoid scratching grave markers.

Figure 17. Volunteers can undertake cleaning of grave markers once they have received initial training. Cleaning methods may include wetting the stone, using a mild chemical cleaner, gently agitating the surface with a soft bristle brush, and thoroughly rinsing the marker with clean water. Photo: Jason Church.

Selecting A Conservator or Preservation Professional

A conservator or preservation professional can provide valuable assistance in preserving historic cemeteries by documenting and surveying cemetery conditions, assisting with work plans and prioritizing work, and recommending specific maintenance and repair procedures. More commonly, they recommend more specialized preservation treatments for historic markers and carry out the actual work.

Specialized skills are required for undertaking certain treatments on historic grave markers or where markers are highly significant or are in more advanced states of disrepair. When contracting for grave marker conservation, it is important to interview conservators who have worked in cemeteries. They should be experienced with the historic materials and nature of the conditions where the work is to be undertaken. Prior to selecting a conservator, details about their previous work and training should be obtained and confirmed. Most conservators will provide sample reports and photographs of previous work.

The American Institute for Conservation of Historic and Artistic Works (AIC) offers information about selecting a conservator and what to expect once you have contracted with a conservator. Searching the "Find a Conservator" database provides a list of local and regional AIC members who have attained Professional Associate or Fellow status in the organization. More information can be found on the AIC website at http://www.conservation-us.org/

A conservator will inspect grave markers before designing appropriate treatments and submit a written plan for their proposed conservation work that includes materials to be used, a cost estimate, and a schedule for the project. As part of the contract, the conservator should be required to submit a written completion report that clearly describes their treatment of the marker/s and includes maintenance and care recommendations.

Soaking and/or spraying water in a fine mist are effective methods to remove natural growth. Water also has a "swelling action" for some soiling, making it easier to remove with gentle scrubbing. With cyclic spraying, a fine mist of water is directed at the targeted area for a short time (e.g., 20 minutes or less), followed by a short "off" period. This on/off process is repeated several times. Because high-pressure water can abrade the surface, this treatment is not recommended for masonry monuments.

For stains that are not water soluble or where organic solvents are ineffective, it is sometimes necessary to use chemical cleaning. Chemical cleaners include acids, alkalis, detergents and organic solvents. Each has advantages and disadvantages. Acids dissolve the interface between the stain and substrate while alkalis allow for longer dwell periods but must be neutralized. Some detergents are near-neutral in pH (neither acidic nor alkaline) and easier to rinse.

Before selecting or using a chemical cleaning agent, the manufacturer's Safety Data Sheet (SDS), available with the product and online, should be reviewed. The SDS provides information about the product's composition, including identified hazards, proper handling and storage, disposal, and required personal protective equipment. Once a chemical cleaning product has been selected, the manufacturer's instructions should be followed. Before undertaking large-scale cleaning, it is always advisable to undertake small-scale tests (approximately 6" x 6"areas in discrete locations), and then waiting several days before assessing the results.

Chemical cleaning is used to remove metallic stains and other contaminants such as old coatings and graffiti. For severe staining, poultice cleaning is useful as it extends contact time with the cleaner. A poultice is a mixture of clay or other inert material, such as paper pulp, and a cleaning agent. The mixture is applied to the surface and allowed an extended dwell period. The chemical cleaner dissolves the stain and the clay draws the stain out to the surface. When using a poultice, it should be applied just beyond the stained area and covered with polyethylene. The best practice is to leave the treatment on the surface for 24 hours and then remove the polyethylene cover and allow the poultice to continue drying. Once the poultice is dry, the mixture is then collected and the surface is thoroughly rinsed. For some stubborn stains, the application may need to be repeated.

Chemical cleaning also may be required if biological growth (algae, fungi and lichen) is severe. A study conducted by the National Park Service provides guidelines for cleaning government-issued marble headstones and recommends biocidal cleaners that contain quaternary ammonium compounds. Like all cleaning methods, chemical cleaning can accelerate deterioration. Adverse effects include efflorescence, stains, and etching.

Graffiti Removal

Markers with graffiti tend to be targets for further vandalism (Fig. 18). Timely removal helps deter future vandalism and improves the marker's appearance.

If the graffiti is water soluble, it can be removed using water and a soft cloth or towel. Rinsing the cloth frequently helps to avoid smearing graffiti on unaffected areas. If the graffiti is not water soluble, organic solvents or commercial graffiti removal products suitable for the grave marker material are recommended. Products should be tested prior to use. General cleaning of the entire marker is a good follow-up for a more even appearance. For deep-seated graffiti, poultice cleaning (previously described) may be required to extract staining materials.

Figure 18. Graffiti is carefully removed using a low-pressure dry-ice misting instrument. Photo: Jason Church.

Repointing

Missing and deteriorated mortar in old cemetery grave markers is a common condition, and the mortar should be replaced to prevent water intrusion and potential damage (Fig. 19). Several questions should be considered when selecting materials for repointing.

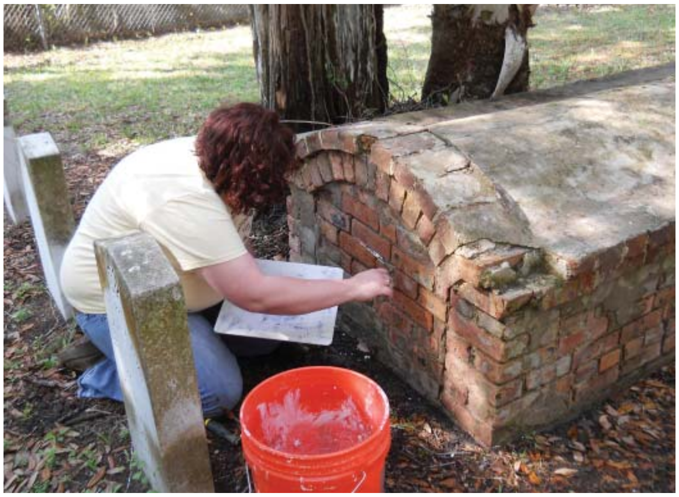

Figure 19. Masonry markers like this box tomb may require the repointing of mortar joints. It is important to use a mortar that is softer than the historic brick. In this case a conservator uses a lime putty-based mortar to repoint. Photo: Jason Church.

Most importantly, what is the masonry substrate that requires repointing? What mortar mix is suitable for the historic masonry? How quickly will mortar need to cure? Soft mortars contain traditional lime putty or modern hydrated lime. Harder mortars contain natural or Portland cement. If necessary, mortars can be tinted with alkali-stable pigments to match historic mortar colors. The selection of the mortar to be used is critically important to the success of the project. An inappropriate mortar can result in unattractive work and accelerate the deterioration of the historic grave marker. Always avoid the use of bathtub caulk and silicone sealants for repointing mortar joints.

Prior to repointing, any loose and deteriorated mortar needs to be removed from the joint, preferably using hand tools. Following joint preparation, the mortar materials (lime, cement, and sand) are mixed, and then water added to form a stiff paste. The repointing mortar is applied using a tuck pointing trowel, typically with a narrow 1/8"- 1/2" flat blade. Mortar is compacted into the joint, and then excess mortar is removed and the original joint profile replicated. Good repointing requires skill. Generally, a mason or person with masonry training should repoint mortar joints.

Resetting

Resetting is recommended for grave markers when their foundations are unstable or out of plumb (Figs. 20a through 20c). This often complex activity involves lifting the grave marker, leveling its foundation, and returning the marker to its original upright position. Workers can be injured and the grave marker damaged if resetting is not carried out properly and safely.

Inexperienced staff or volunteers should not attempt resetting without training from a conservator, engineer, or other preservation professional. When dealing with fragile or significant grave markers, or those with large

Figure 20a. This slate grave marker in the Ancient Burying Ground in Hartford, CT, is a ground-support stone. Resetting requires digging a hole that will hold the base of the stone and then compacting the soil at the bottom of the hole by hand. Photo: Fran Gale.

Figure 20b. To facilitate drainage, crushed stone, gravel, and sharp sand line the hole and are hand-tamped around the stone after placement. Photo: Fran Gale.

Figure 20c. The reset ground-supported grave marker should be level and plumb. Photo: Fran Gale.

Safety

Encouraging the public to visit and explore public burial grounds and cemeteries increases awareness of the value of these sacred sites. If visitation is promoted, owners and property managers must be responsible for ensuring that their sites are safe for staff and visitors. This responsibility includes monitoring the condition of grave markers.

Historic cemeteries can be hazardous workplaces for staff members, consultants, contractors, and volunteers. Awareness of potential hazards in a historic cemetery and careful planning are essential to avoiding injury. Maintain an appropriate first aid kit on site for minor injuries and have an emergency plan in place that includes contact information for medical assistance.

Creating a safe work environment in historic cemeteries requires appropriate planning for each project, starting with personal protective equipment. Suitable clothing and personal protective equipment should be fundamental safety requirements. Supportive shoes such as steel toe work boots or sturdy lace-up shoes help protect ankles and feet from injury, just as good work gloves help protect hands from cuts, scrapes, and splinters. Whether using a chipper, drill and other power tools or equipment, safety glasses or goggles are essential. A back brace often is recommended for heavier lifting tasks. Do not work alone or, if you must, tell someone where you are and when you expect to return.

During hot weather, heat stress is a present risk. Besides knowing the signs of heat stress, preventive measures should be taken by each worker:

- Wear light, loose-fitting, breathable clothing and a broad-brimmed hat.
- Use sunscreen, reapplying as needed.
- Take frequent breaks in the shade.
- Make sure fresh water is available and drink to stay hydrated.
- Eat small meals before and during work.
- Avoid caffeine, alcohol, and large amounts of sugar.

Trip and falling hazards include uneven ground, holes, open graves, toppled grave markers, fallen tree limbs, and other debris (Fig. C). Sitting, climbing, or standing on a grave marker should be avoided since the additional weight may cause

Figure C. Gophers and other burrowing animals produce uneven ground and holes that are trip and falling hazards to visitors and staff of historic cemeteries. Photo: Jason Church.

deteriorated and structurally unstable monuments to break or collapse with serious injury potentially occurring to the worker and damage to the marker. To help prevent injuries that can result from unstable grave markers, it is important to routinely identify and flag severely damaged and unstable grave markers for corrective work and to rope off any marker considered to be in immediate danger of collapse. Prior to beginning work, the immediate area around the job site should be rechecked for safety hazards.

Snakes, wasps, and burrowing animals inhabit historic cemeteries (Fig. D). Snakes sun on warm stones and hide in holes and ledges, so it is important to be able to identify local venomous snakes. An appropriate venomous snake management plan should be in place, and

Figure D. Yellow jackets that are nesting below the projecting molding of this grave marker pose a hazard to visitors and staff because, if disturbed, they will vigorously defend their nest. Yellow jacket, paper wasp and hornet nests should be removed from grave markers by trained staff or specialists. Photo: Jason Church.

all workers should be familiar with it. Workers and volunteers should be instructed as to safety measures to be taken in regards to snakes, including proper clothing where there is an identified risk.

The imported red fire ant is an invasive pest, prevalent in the southern United States. They attack en masse, resulting in painful bites that can be potentially life threatening to people with allergic reactions. It is important to be able to identify the presence of red imported fire ants; be informed as to safety measures to take when working in areas known to be infested with them; and take steps to control them as necessary. A rescue medicine is available for those with serious allergic reactions.

Paper wasps, yellow jackets, and hornets are another concern, building nests around and on ledges and lips of box tombs, mausoleums, and other grave markers. They are very territorial around their nests and will vigorously defend them. There are non-toxic sprays that can be used in and around the work area. Nests should be safely removed.

Burrowing animals like armadillos, groundhogs, gophers, and moles disrupt the ground with their digging and tunnels and can create tripping hazards or undermine grave markers. Prairie dogs have been known to dig up bones and destroy gravesites. Sinkholes created by these animals can also be perfect places for other creatures like snakes to inhabit.

Proper work practices and lifting techniques need to be used whenever lifting or resetting grave markers. Many markers are surprisingly heavy. For example, a common upright marble headstone measuring 42" long, 13" wide, and 4" deep weighs over 200 pounds. Volunteers and workers should work in pairs, be able bodied, and have training in safe lifting techniques. Lift equipment and ergonomically correct tools should be routinely used to lift heavy markers (for most people this includes markers that weight more than 50 pounds). For smaller grave markers, a simple wooden clamp system can be constructed for a two-person lift (Figs. E1 and E2).

Figure E1. The simple wooden clamp system allows two people to safety lift a marble grave marker. Photo: Sarah Jackson.

Figure E2. The clamp system is constructed from off-the-shelf wooden boards. Photo: Sarah Jackson.

stacked bases, a specialist should be contracted for resetting.

It is important to check state and local regulations to make sure that digging around the grave marker is authorized before starting any resetting effort. Also, grave markers should be documented and cleaned before resetting. It is also a good time to measure and record the overall size of the marker and note any stone carver's marks or inscription of the company that made the marker. The company name is often found on buried portions of the base and revealed during the resetting process.

Typical materials required for resetting include a hoist, shovels, plumb lines, levels, tamping devices, wooden stakes, and boards. To improve drainage, sand and small gravel or small stones are commonly used when resetting.

Prior to resetting, it is important to establish the type of base. Most grave markers have one of three main base types: (1) ground supported, (2) slotted base, or (3) stacked base. Similar tasks are undertaken for each base type.

Ground-supported stones are a common type of historic grave marker. This type includes the traditional New England slate and brownstone markers and government-issued marble headstones. The primary goal with any ground-supported marker is to have it level and plumb. To reset the marker, a few inches or more of soil is first removed from around the stone. This is usually sufficient to enable a stone marker to be straightened. The enlarged hole is then filled and compacted around the marker.

If a grave marker has fallen over and has been covered with soil or turf, it must first be inspected for attached concrete or other anchoring system. If this system is still attached, the grave marker may break during lifting. After removing the stone, it can be cleaned and then temporarily set on wood supports.

The hole left from removal of the marker will need to be enlarged to hold the base of the stone. Soil at the bottom of the hole should be compacted by hand, not with a power tamper. In most cemeteries, crushed stone or sharp pea-size gravel mixed with angular sand can be used to line the hole and then hand-tamped around the stone after it is placed in the hole. The gravel helps facilitate drainage and keeps the stone from settling. A bubble level can be used to ensure that the stone is plumb. Markers should not be set in concrete.

The second type of monument base is the slotted base where the upright element is secured to the base using mortise-and-tenon style construction. The upright element in the slotted base may be leaning or loose. In any case, the upright element should be removed from the base, the base leveled, then the element returned to the base. It is important to keep in mind the depth that the base was intended to be set into the ground. This may be indicated by the style of the base or the observed soil- line staining. Many bases were intended to sit flush on grade while some were set a few inches below ground.

Prior to resetting, the upright element should be disengaged from the base and carefully set aside. In most cases, the base will need to be removed to properly prepare the hole before resetting the grave marker. After doing so, four to six inches of soil should be removed from the hole and the soil then tamped by hand to make a proper bed or foundation. The foundation area can be filled with crushed stone or sharp pea-sized gravel and sand, checking to make sure that the base is plumb and level as resetting proceeds. Clean the headstone prior to resetting. Old mortar, concrete or epoxy should be removed from the slot and the bottom of the upright element using a hammer and small chisel. Once the stone elements are cleaned and the base is level and plumb, the next step is placing the upright element into the slot. A lime mortar can be used to fill any gaps in the slot. This prevents water intrusion that may cause marker movement related to freeze-thaw cycles.

A third common base type is the stacked base. This style includes at least one element placed on a base or a series of bases of varying sizes. Resetting a stacked-base grave marker usually requires special skills and lifting equipment. Depending upon the complexity of the marker, a conservator, experienced masonry contractor, or preservation professional with engineering skills is usually needed.

The sections of a stacked-base grave marker often are pinned together for support. If deteriorated, the pins should be replaced. Using a hammer and chisel, a conservator or person experienced in working with historic grave markers should remove any corroded iron, copper, or bronze pins, as well as the old mortar or adhesive adhered to each section. Replacement pins should be stainless steel all-thread, and sized slightly shorter and smaller than the existing hole. The replacement pins then can be set with epoxy, lime mortar, or packed in lead. Once the pins are in place, the sections of the stacked base can be individually reset using traditional or contemporary materials. These include lead, shims, mortars, and setting compounds. Finally, each gap or seam between sections should be pointed with a setting compound or appropriate mortar to prevent water intrusion.

Filling and Patching

Hairline masonry cracks may be the result of natural weathering and require no immediate treatment except to be photographed and recorded. However, larger cracks often merit further attention. Repairing masonry cracks involves several steps and typically a skilled hand (Fig. 21). The repair begins with the removal of loose material and cleaning. Materials that are used for crack repair include grouts for small cracks and epoxy for large cracks affecting the structural integrity of the monument. Gravity or pressure injection is used to apply grout or epoxy. Crack repair can be messy, so careful planning and experience are helpful. If the crack is active, a change in size of the crack will be noted over time. Active cracks require further investigation to ascertain the cause of the changes, such as differential settlement, and to correct, if possible, the cause prior to repairing the crack.

Figure 21. Cracks in a stone marker should be filled to keep water and debris out and prevent the crack from becoming larger. A patching mortar is designed to be used, in this case, with historic marble. Photo: Mary Striegel.

Repairing masonry markers with severely damaged or missing pieces requires a skilled mason or conservator. The materials used for patching are similar to those used for repointing mortar joints. With patching, it is critical that the physical and mechanical properties of the patching material be appropriate for the masonry material. Work includes designing a durable patch compatible with the substrate. Proper curing is especially critical for large patches and often involves procedures to protect the patch from premature drying. Repairs to stucco-covered surface should be carried out by a skilled plasterer using a stucco mix that is compatible with the original material.

Repairing delaminated slate and brownstone grave markers also requires a skilled mason or conservator. With this condition, there are openings along bedding planes which expose the stone grave marker to moisture intrusion. Treatments are design to eliminate or reduce moisture intrusion that would accelerate deterioration. The selection of appropriate repair materials and procedures depends on the severity of the condition. Traditionally, delaminated slate or brownstone grave markers were "capped" with a strip of lead or other metal. Today, this repair technique is seldom used, in part because the drilling procedure used to attach the cap can be damaging, if the stone is brittle. Also, there are toxicity issues associated with the use of lead. An alternative approach is to fill the openings exposed by delamination with grout or patching material that is compatible with the stone. Adhesion of the repair material to the delaminated surfaces is particularly important.

The decision whether to use patching material or undertake a dutchman repair with matching materialdepends on the grave marker material, location of the damaged area, size, and other factors. A successfully executed dutchman usually results in a repair that has long durability and maintains a similar weathering pattern to the adjacent historic material. When working with stone grave markers, repairs using dutchman techniques are best done by a skilled stone craftsman.

Detached fragments should be collected, documented and stored in a suitable facility. Reattachment of these fragments should be undertaken by a conservator or mason. This work often requires pins to reinforce the joints and patching to compensate for losses.

Protective treatments

Protective treatments for metal, stone, and wood grave markers stabilize corrosion and protect the monument from rainwater, pollutants, and other contaminants. Treatments may vary not only due to material differences, but also to specific site conditions.

Wax coatings are often used for bronze markers (Fig. 22). Wax provides a protective barrier against moisture, soiling, and graffiti. There are several steps in the wax application process. Where there is little corrosion, gentle cleaning of the marker is undertaken prior to applying the wax coating. Apply a thin layer of wax to the marker using a stencil brush or chip brush. Mineral spirits can be added to the wax to facilitate

Figure 22. A protective coating must be maintained on metal elements. Wax or lacquer coatings help preserve the bronze patina and slow corrosion. Conservators apply a microcrystalline wax to this bust at St. Mark's Church in-the-Bowery, New York, NY. Photo: John Scott.

brush application. A soft, clean cloth is used to remove excess wax and buff the surface. A second coat of wax is sometimes needed.

In most climates, iron objects require coatings to protect them from corrosion. Clear coatings are sometimes used to protect wrought iron objects. A corrosion inhibitive primer and topcoat are used for cast iron and steel objects. Direct-to-Metal (DTM) coatings combine the two. Because of their durability, acrylic enamels, urethane, and fluoropolymer coatings are preferred. Proper surface preparation is important, including the removal of surface soiling, flaking paint, and loose rust. This can be accomplished with compressed air, wire brushing, solvent rinsing, or other cleaning method. Next the surface is cleaned with a damp cloth, repeatedly rinsing the cloth as needed. While the surface needs to be thoroughly dried before painting, it is important to repaint as soon as possible since even overnight condensation deposits are not desirable.

Another approach for iron objects is using a rust converter to stabilize corrosion that involves less surface preparation. Commercially available rust converters contain tannin or phosphoric acid and react with rust to form more stable iron compounds. The surface must be painted following surface preparation with the rust converter.

Limewash is a traditional coating that brightens stucco-covered grave markers (Fig. 23). Like paint coatings, it needs to be periodically applied. Limewash is prepared with lime putty or hydrated lime and water. Curing begins following application. The lime putty or hydrated lime reacts with carbon dioxide in the air in a process called carbonation. This reaction eventually forms calcium carbonate, a stable hard coating. Limewash is a "green" coating with no volatile organic compound content and is "breathable," i.e., it allows for water vapor transmission. Although commonly white, limewash can be colored or tinted with alkali-stable pigments such as iron oxide.

Figure 23. Limewash is a breathable coating sometimes used to protect the surface of the grave marker and provide a decorative finish. Limewash is applied by brush in five to eight thin coats (with each coat about the consistency of skim milk). The surface is allowed to slowly dry between coats. Sometimes the surface is covered by damp burlap to slow the drying process. Photo: Sarah Jackson.

Before applying the limewash, the masonry surfaces should be inspected for coating residues that need to be removed and any required repair work undertaken. Stucco-covered surfaces should be repaired and allowed to fully cure before applying limewash. If the original color has been determined, the renewal coating can be formulated to match. In preparing the wash, enough water is added to lime putty or hydrated lime to produce slurry with the consistency of skim milk. A mixture of four parts water and one part lime usually works well. A Zahn or Ford cup can be found at a hardware store and used to measure the thickness of the limewash and ensure consistency with each batch. Although many traditional recipes include additives, a simple mixture of lime and water performs best. Using a power drill with a paddle attachment to stir the limewash will help ensure that the lime particles are fully suspended in the mixture. Any pigment for coloration is added during the final mixing.

The surface must be cleaned of old coating residues, soiling, and other contaminants. After dampening the surface, the limewash is applied in 5-8 thin coats, allowing each coat to dry between applications. Limewash is translucent immediately after application and then becomes opaque when dry.

Proper curing of limewash is critical to its durability. To prevent premature drying, the treated surface may need to be covered with damp burlap. Limewash must not be applied when frost or freeze conditions are predicted or in temperatures above 90° F. Ideally, limewash should be applied during spring or fall when temperatures are around 70° F, avoiding direct sunlight where possible.

Clear water repellents and consolidation treatments are sometimes considered for severely deteriorated grave markers, including unpainted wood markers and masonry. For wood markers, epoxy consolidants are used to patch and repair. For masonry materials, it is important to remember that they are porous, and water vapor and liquid water can travel through their internal network. Protective treatments must allow for water vapor transmission to prevent trapping moisture inside the marker. Although a wide variety of water repellents have been employed on masonry (wax, acrylic, epoxy resins, etc.), silane and siloxane treatments have been the most successful. These organosilicon compounds are "breathable," penetrate below the surface, and form chemical bonds with silicate minerals.

When erosion is severe, consolidation treatments (e.g., ethyl silicate) have been used to replace mineral binders lost to weathering (Fig. 24). Because these treatments are not reversible, laboratory and on-site testing are essential. Application by a conservator or other experienced preservation professional is advised.

Figure 24. A severely deteriorating monument or grave marker can be treated with a stone consolidant. The treatment is usually applied using a spray system. The consolidant soaks into the stone and replaces mineral binders that hold the stone together. On-site and laboratory testing and evaluation are performed prior to using this non-reversible type of treatment. Photo: Lucas Flickinger.

Conclusion

Maintenance is the key to extending the life of historic cemetery grave markers. From ensuring that markers are not damaged by mowing equipment and excessive lawn watering, to proper cleaning and resetting, good cemetery maintenance is the key to extending the life of grave markers. Whether rescuing a long-neglected small cemetery using volunteers or operating a large active cemetery with paid staff, the cemetery's documentation, maintenance and treatment plans should include periodic inspections. Only appropriate repair materials and techniques that do not damage historic markers should be used and records should be kept on specific repair materials used on individual grave markers. A well-maintained cemetery provides an attractive setting that can be appreciated by visitors, serves as a deterrent to vandalism, and provides a respectful place for the dead. A community history recorded in stone, wood and metal markers, cemeteries are an important part of our heritage, and are deserving of preservation efforts (Fig. 25).

Figure 25. Involving the community in activities helps to develop an appreciation for the cemetery and serves to deter vandalism. Events may include children through school or scouting organizations and can help teach across the curriculum. Photo: Debbie Dietrich Smith.

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About the Authors

Dr. Mary Striegel directs the Material Conservation Program at the National Park Service's National Center for Technology and Training (NCPTT) in Natchitoches, Louisiana. Frances Gale is the former Training Chief (NCPTT) and currently is a Senior Lecturer and Director of the Architectural Conservation Laboratory, University of Texas at Austin. Jason Church is a Materials Conservator with NCPTT. Debbie Dietrich-Smith is the Chief, Historic Landscape Program, NCPTT.

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Whether large or small, well maintained or neglected, historic cemeteries are an important part of our cultural landscape. This historic cemetery at Cape Lookout National Seashore, NC, provides a record of the families who lived in Portsmouth Village during the 19th and early 20th centuries. Photo: Fran Gale.

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Appendix E
Electronic Appendices