If **CLASS III** conditions have necessitated total paint removal, there are two options, both of which assure protection of the exterior wood: (1) an oil primer may be applied followed by an oil-type top coat, preferably by the same manufacturer; or (2) an oil primer may be applied followed by a latex top coat, again using the same brand of paint. It should also be noted that primers were never intended to withstand the effects of weathering; therefore, the top coat should be applied as soon as possible after the primer has dried.

Conclusion

The recommendations outlined in this Brief are cautious because at present there is no completely safe and effective method of removing old paint from exterior woodwork. This has necessarily eliminated descriptions of several methods still in a developmental or experimental stage, which can therefore neither be recommended nor precluded from future recommendation. With the ever-increasing number of buildings being rehabilitated, however, paint removal technology should be stimulated and, in consequence, existing methods refined and new methods developed which will respect both the historic wood and the health and safety of the operator.

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This publication has been prepared pursuant to The Economic Recovery Tax Act of 1981, which directs the Secretary of the Interior to certify rehabilitations of historic buildings that are consistent with their historic character; the advice and guidance in this brief will assist property owners in complying with the requirements of this law.

Preservation Briefs 10 has been developed under the technical editorship of Lee H. Nelson, AIA, Chief, Preservation Assistance Division, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. Comments on the usefulness of this information are welcomed and can be sent to Mr. Nelson at the above address.

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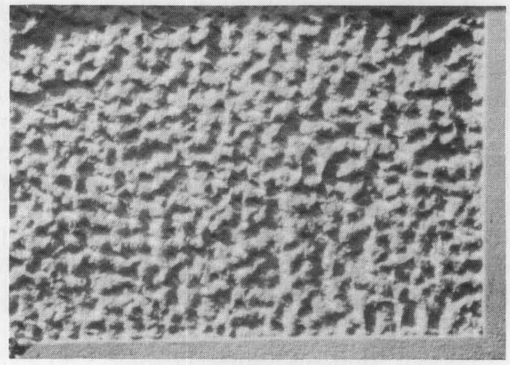
17 PRESERVATION BRIEFS



Architectural Character: Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character

Lee H. Nelson, FAIA

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

Heritage Preservation Services

The Secretary of the Interior's "Standards for Historic Preservation Projects" embody two important goals: 1) the preservation of historic materials and, 2) the preservation of a building's distinguishing character. Every old building is unique, with its own identity and its own distinctive character. Character refers to all those visual aspects and physical features that comprise the appearance of every historic building. Character-defining elements include the overall shape of the building, its materials, craftsmanship, decorative details, interior spaces and features, as well as the various aspects of its site and environment.

The purpose of this Brief is to help the owner or the architect identify those features or elements that give the building its *visual character* and that should be taken into account in order to preserve them to the maximum extent possible.

There are different ways of understanding old buildings. They can be seen as examples of specific building types, which are usually related to a building's function, such as schools, courthouses or churches. Buildings can be studied as examples of using specific materials such as concrete, wood, steel, or limestone. They can also be considered as examples of an historical period, which is often related to a specific architectural style, such as Gothic Revival farmhouses, one-story bungalows, or Art Deco apartment buildings.

There are many other facets of an historic building besides its functional type, its materials or construction or style that contribute to its historic qualities or significance. Some of these qualities are feelings conveyed by the sense of time and place or in buildings associated with events or people. A complete understanding of any property may require documentary research about its style, construction, function, its furnishings or contents; knowledge about the original builder, owners, and later occupants; and knowledge about the evolutionary history of the building. Even though buildings may be of historic, rather than architectural significance, it is their tangible elements that embody its significance for association with specific events or persons and it is those *tangible elements* both on the exterior and interior that should be preserved.

Therefore, the approach taken in this Brief is limited to identifying those visual and tangible aspects of the historic building. While this may aid in the planning process for carrying out any ongoing or new use or restoration of the building, this approach is not a substitute for developing an understanding about the significance of an historic building and the district in which it is located.

If the various materials, features and spaces that give a building its visual character are not recognized and preserved, then essential aspects of its character may be damaged in the process of change.

A building's character can be irreversibly damaged or changed in many ways, for example, by inappropriate repointing of the brickwork, by removal of a distinctive side porch, by changes to the window sash, by changes to the setting around the building, by changes to the major room arrangements, by the introduction of an atrium, by painting previously unpainted woodwork, etc.

A Three-Step Process to Identify A Building's Visual Character

This Brief outlines a three-step approach that can be used by anyone to identify those materials, features and spaces that contribute to the visual character of a building. This approach involves first examining the building from afar to understand its overall setting and architectural context; then moving up very close to appreciate its materials and the craftsmanship and surface finishes evident in these materials; and then going into and through the building to perceive those spaces, rooms and details that comprise its interior visual character.

Step 1: Identify the Overall Visual Aspects

Identifying the overall visual character of a building is nothing more than looking at its distinguishing physical aspects without focusing on its details. The major contributors to a building's overall character are embodied in the general aspects of its *setting;* the *shape* of the building; its *roof* and roof features, such as chimneys or cupolas; the various *projections* on the building, such as porches or bay windows; the *recesses* or voids in a building, such as open galleries, arcades, or recessed balconies; the *openings* for windows and doorways; and finally the various exterior *materials* that contribute to the building's character. Step one involves looking at the building from a distance to understand the character of its site and setting, and it involves walking around the building where that is possible. Some buildings will have one or more sides that are more important than the others because they are more highly visible. This does not mean that the rear of the building is of no value whatever but it simply means that it is less important to the overall character. On the other hand, the rear may have an interesting back porch or offer a private garden space or some other aspect that may contribute to the visual character. Such a general approach to looking at the building and site will provide a better understanding of its overall character without having to resort to an infinitely long checklist of its possible features and details. Regardless of whether a building is complicated or relatively plain, it is these broad categories that contribute to an understanding of the overall character rather than the specifics of architectural features such as moldings and their profiles.

Step 2: Identify the Visual Character at Close Range

Step two involves looking at the building at close range or arm's length, where it is possible to see all the surface qualities of the materials, such as their *color* and *texture,* or surface evidence of craftsmanship or age. In some instances, the visual character is the result of the juxtaposition of materials that are contrastingly different in their color and texture. The surface qualities of the materials may be important because they impart the very sense of craftsmanship and age that distinguishes historic buildings from other buildings. Furthermore, many of these close up qualities can be easily damaged or obscured by work that affects those surfaces. Examples of this could include painting previously unpainted masonry, rotary disk sanding of smooth wood siding to remove paint, abrasive cleaning of tooled stonework, or repointing reddish mortar joints with gray portland cement.

There is an almost infinite variety of surface materials, textures and finishes that are part of a building's character which are fragile and easily lost.

Step 3: Identify the Visual Character of the Interior Spaces, Features and Finishes

Perceiving the character of interior spaces can be somewhat more difficult than dealing with the exterior. In part, this is because so much of the exterior can be seen at one time and it is possible to grasp its essential character rather quickly. To understand the interior character, it is necessary to move through the spaces one at a time. While it is not difficult to perceive the character of one individual room, it becomes more difficult to deal with spaces that are interconnected and interrelated. Sometimes, as in office buildings, it is the vestibules or lobbies or corridors that are important to the interior character of the building. With other groups of buildings the visual qualities of the interior are related to the plan of the building, as in a church with its axial plan creating a narrow tunnel-like space which obviously has a different character than an open space like a sports pavilion. Thus the shape of the space may be an essential part of its character. With some buildings it is possible to perceive that there is a visual linkage in a sequence of spaces, as in a hotel, from the lobby to the grand staircase to the ballroom. Closing off the openings between those spaces would change the character from visually linked spaces to a series of closed spaces. For example, in a house that has a front and back parlor linked with an open archway, the two rooms are perceived together, and this visual relationship is part of the character of the building. To close off the open archway would change the character of such a residence.

The importance of interior features and finishes to the character of the building should not be overlooked. In relatively simple rooms, the primary visual aspects may be in features such as fireplace mantels, lighting fixtures or wooden floors. In some rooms, the absolute plainness is the character-defining aspect of the interior. So-called secondary spaces also may be important in their own way, from the standpoint of history or because of the family activities that occurred in those rooms. Such secondary spaces, while perhaps historically significant, are not usually perceived as important to the *visual* character of the building. Thus we do not take them into account in the visual understanding of the building.

Conclusion

Using this three-step approach, it is possible to conduct a walk through and identify all those elements and features that help define the visual character of the building. In most cases, there are a number of aspects about the exterior and interior that are important to the character of an historic building. The visual emphasis of this brief will make it possible to ascertain those things that should be preserved because their loss or alteration would diminish or destroy aspects of the historic character whether on the outside, or on the inside of the building.

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Overall Visual Character: Shape

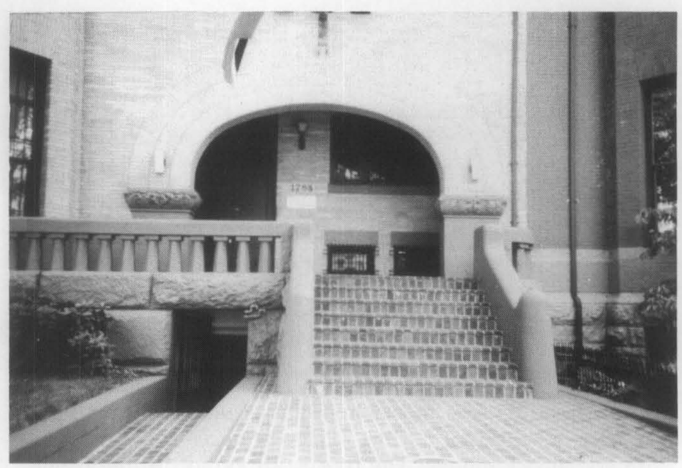
The shape of a building can be an important aspect of its overall visual character. The building illustrated here, for example, has a distinctive horizontal box-like shape with the middle portion of the box projecting up an extra story. This building has other visual aspects that help define its overall character, including the pattern of vertical bands of windows, the decorative horizontal bands which separate the base of the building from the upper floors, the dark brown color of the brick, the large arched entranceway, and the castle-like tower behind the building.

Overall Visual Character: Openings

Window and door openings can be important to the overall visual character of historic buildings. This view shows only part of a much larger building, but the windows clearly help define its character, partly because of their shape and rhythm: the upper floor windows are grouped in a 4,3,4,1,4 rhythm, and the lower floor windows are arranged in a regular 1,1,1,... rhythm. The individual windows are tall, narrow and arched, and they are accented by the different colored arched heads, which are connected where there are multiple windows so that the color contrast is a part of its character. If additional windows were inserted in the gap of the upper floors, the character would be much changed, as it would if the window heads were painted to match the color of the brick walls. Photo by Susan I. Dynes

Overall Visual Character: Shape

It should not be assumed that only large or unusual buildings have a shape that is distinctive or identifiable. The front wall of this modest commercial building has a simple three-part shape that is the controlling aspect of its overall visual character. It consists of a large center bay with a two story opening that combines the storefront and the windows above. The upward projecting parapet and the decorative stonework also relate to and emphasize its shape. The flanking narrow bays enframe the side windows and the small iron balconies, and the main entrance doorway into the store. Any changes to the center portion of this three-part shape, could drastically affect the visual character of this building. Photo by Emogene A. Bevitt



Overall Visual Character: Openings

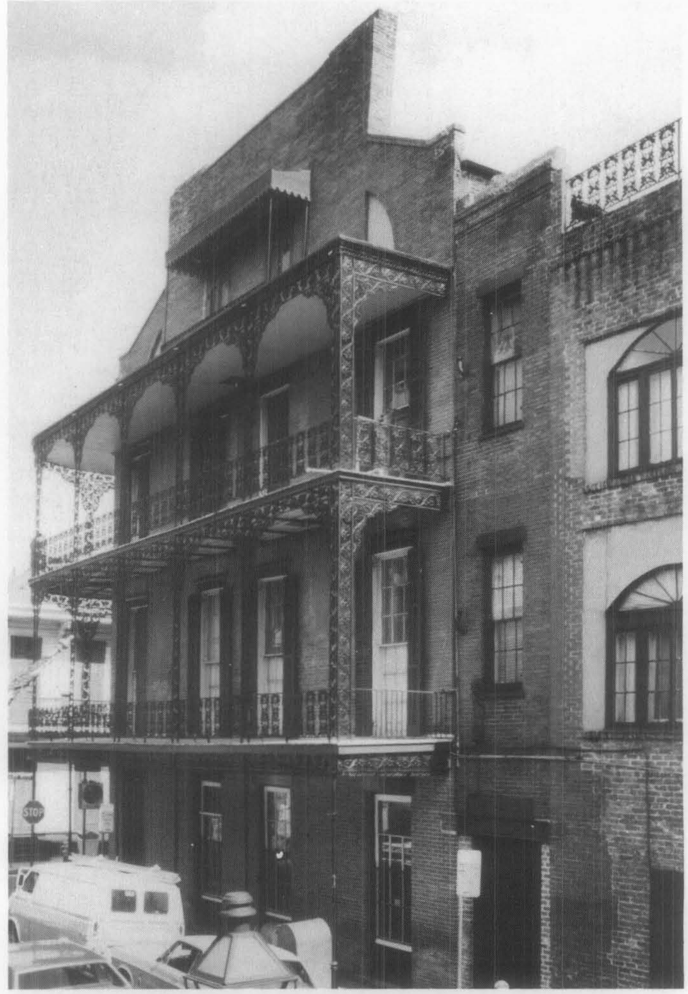
The opening illustrated here dominates the visual character of this building because of its size, shape, location, materials, and craftsmanship. Because of its relation to the generous staircase, this opening places a strong emphasis on the principal entry to the building. Enclosing this arcade-like entry with glass, for example, would materially and visually change the character of the building. Photo by Lee H. Nelson.

Overall Visual Character: Roof and Related Features

This building has a number of character-defining aspects which include the windows and the decorative stonework, but certainly the roof and its related features are visually important to its overall visual character. The roof is not only highly visible, it has elaborate stone dormers, and it also has decorative metalwork and slatework. The red and black slates of differing sizes and shapes are laid in patterns that extend around the roof of this large and freestanding building. Any changes to this patterned slatework, or to the other roofing details would damage the visual character of the building. Photo by Laurie R. Hammel

Overall Visual Character: Roof and Related Features

On this building, the most important visual aspects of its character are the roof and its related features such as the dormers and chimneys. The roof is important to the visual character because its steepness makes it highly visible, and its prominence is reinforced by the patterned tinwork, the six dormers and the two chimneys. Changes to the roof or its features, such as removal or alterations to the dormers, for example, would certainly change the character of this building. This does not discount the importance of its other aspects, such as the porch, the windows, the brickwork, or its setting; but the roof is clearly crucial to understanding the overall visual character of this building as seen from a distance. Photo by Lee H. Nelson



Overall Visual Character: Projections

A projecting porch or balcony can be very important to the overall visual character of almost any building and to the district in which it is located. Despite the size of this building (3 1/2 stories), and its distinctive roofline profile, and despite the importance of the very large window openings, the lacy wrap-around iron balcony is singularly important to the visual character of this building. It would seriously affect the character to remove the balcony, to enclose it, or to replace it with a balcony lacking the same degree of detail of the original material. Photo by Baird M. Smith

Overall Visual Character: Projections

Since these are row houses, any evaluation of their visual exterior character is necessarily limited to the front and rear walls; and while there are a number of things competing for attention in the front, it is the half round projecting bays with their conical roofs that contribute most prominently to the visual character. Their removal would be a devastating loss to the overall character, but even if preserved, the character could be easily damaged by changes to their color (as seen in the left bay which has been painted a dark color), or changes to their windows, or changes to their tile roofs. Though these houses have other fine features that contribute to the visual character and are worthy of preservation, these half-round bays demonstrate the importance of projecting features on an already rich and complex facade. Because of the repetitive nature of these projecting bays on adjacent row houses, along with the buildings' size, scale, openings, and materials, they also contribute to the overall visual character of the streetscape in the historic district. Any evaluation of the visual character of such a building should take into account the context of this building within the district. Photo by Lee H. Nelson

Overall Visual Character: Projections

Many buildings have projecting features such as porches, bay windows, or overhanging roofs, that help define their overall visual character. This projecting porch because of its size and shape, and because it copies the pitch and material of the main roof, is an important contributor to the visual character of this simple farmhouse. The removal or alteration of this porch would drastically alter the character of this building. If the porch were enclosed with wood or glass, or if gingerbread brackets were added to the porch columns, if the tin roof was replaced with asphalt, or if the porch railing was opened to admit a center stairway, the overall visual character could be seriously damaged. Although this projecting porch is an important feature, almost any other change to this house, such as changes to the window pattern, or changes to the main roof, or changes to the setting, would also change its visual character. Photo by Hugh C. Miller

Overall Visual Character: Trim

If one were to analyze the overall shape or form of this building, it would be seen that it is a gable-roofed house with dormers and a wrap-around porch. It is similar to many other houses of the period. It is the wooden trim on the eaves and around the porch that gives this building its own identify and its special visual character. Although such wooden trim is vulnerable to the elements, and must be kept painted to prevent deterioration; the loss of this trim would seriously damage the overall visual character of this building, and its loss would obliterate much of the close-up visual character so dependent upon craftsmanship for the moldings, carvings, and the see-through jigsaw work. Photo by Hugh C. Miller

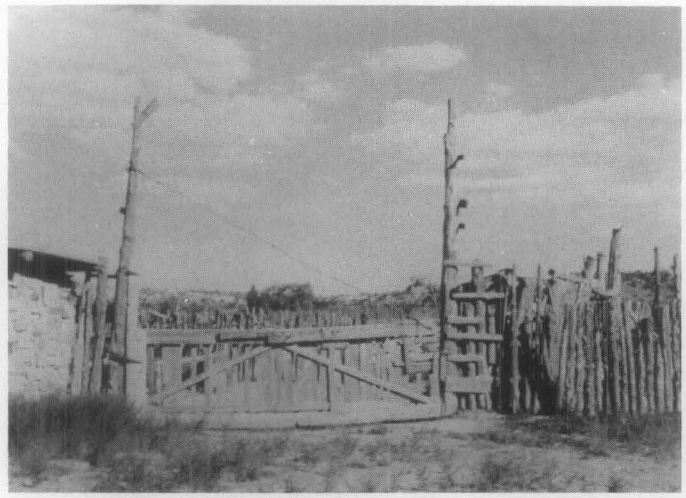
Overall Visual Character: Setting

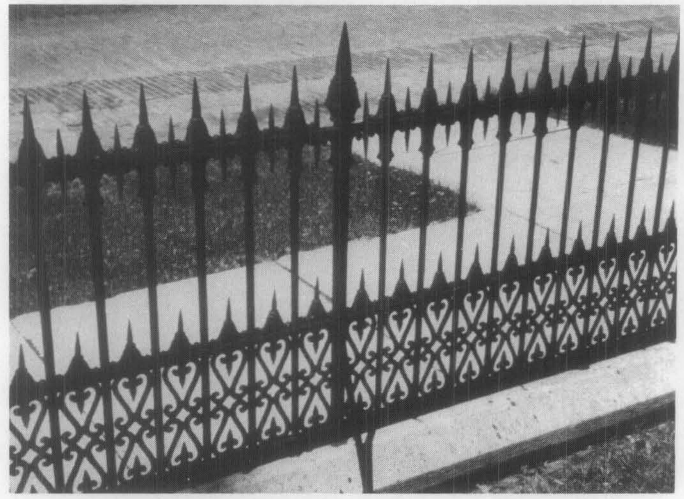
In the process of identifying the overall visual character, the aspect of setting should not be overlooked. Obviously, the setting of urban row houses differs from that of a mansion with a designed landscape. However, there are many instances where the relationship between the building and its place on the streetscape, or its place in the rural environment, in other words its setting, may be an important contributor to its overall character.

In this instance, the corner tower and the arched entryway are important contributors to the visual character of the building itself, but there is also a relationship between the building and the two converging streets that is also an important aspect of this historic building. The curb, sidewalk, fence, and the yard interrelate with each other to establish a setting that is essential to the overall visual character of the historic property. Removing these elements or replacing them with a driveway or parking court would destroy an important visual aspect. Photo by Lee H. Nelson

Overall Visual Character: Setting

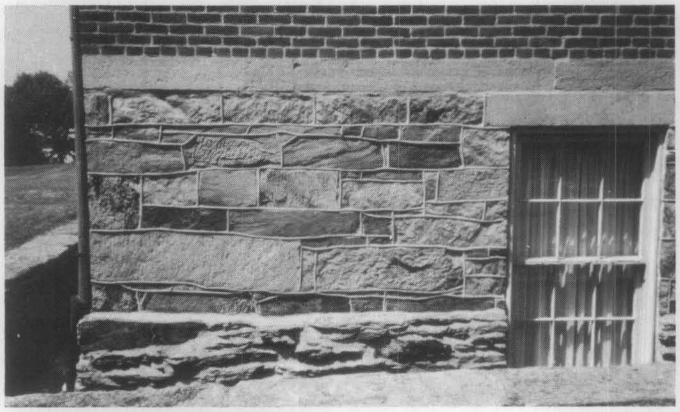
Even architecturally modest buildings frequently will have a setting that contributes to their overall character. In this very urban district, set-backs are the exception, so that the small front yard is something of a luxury, and it is important to the overall character because of its design and materials, which include the iron fence along the sidewalk, the curved walk leading to the porch, and the various plantings. In a district where parking spaces are in great demand, such front yards are sometimes converted to off-street parking, but in this instance, that would essentially destroy its setting and would drastically change the visual character of this historic property. Photo by Lee H. Nelson





Overall Visual Character: Setting

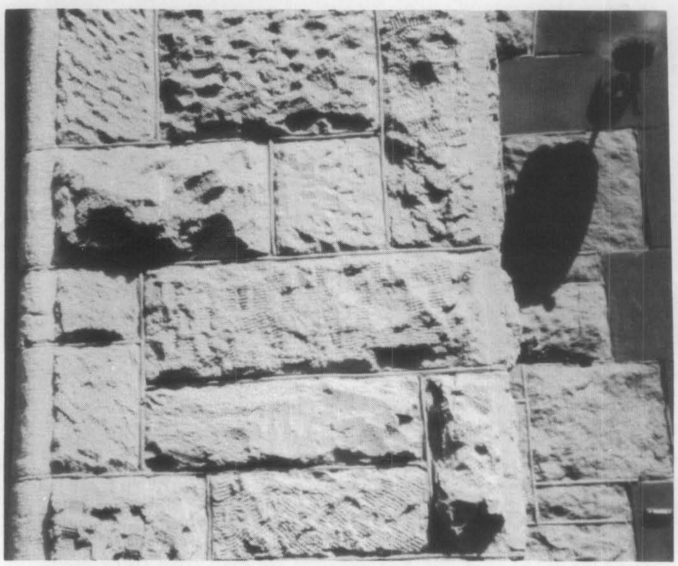
Among the various visual aspects relating to the setting of an historic property are such site features as gardens, walks, fences, etc. This can include their design and materials. There is a dramatic difference in the visual character between these two fence constructions—one utilizing found materials with no particular regard to their uniformity of size or placement, and the other being a product of the machine age utilizing cast iron components assembled into a pattern of precision and regularity. If the corral fence were to be repaired or replaced with lumberyard materials its character would be dramatically compromised. The rhythm and regularity of the cast iron fence is so important to its visual character that its character could be altered by accidental damage or vandalism, if some of the fence top spikes were broken off thus interrupting the rhythm or pattern. Photos by Lee H. Nelson



Arm's Length Visual Character: Materials

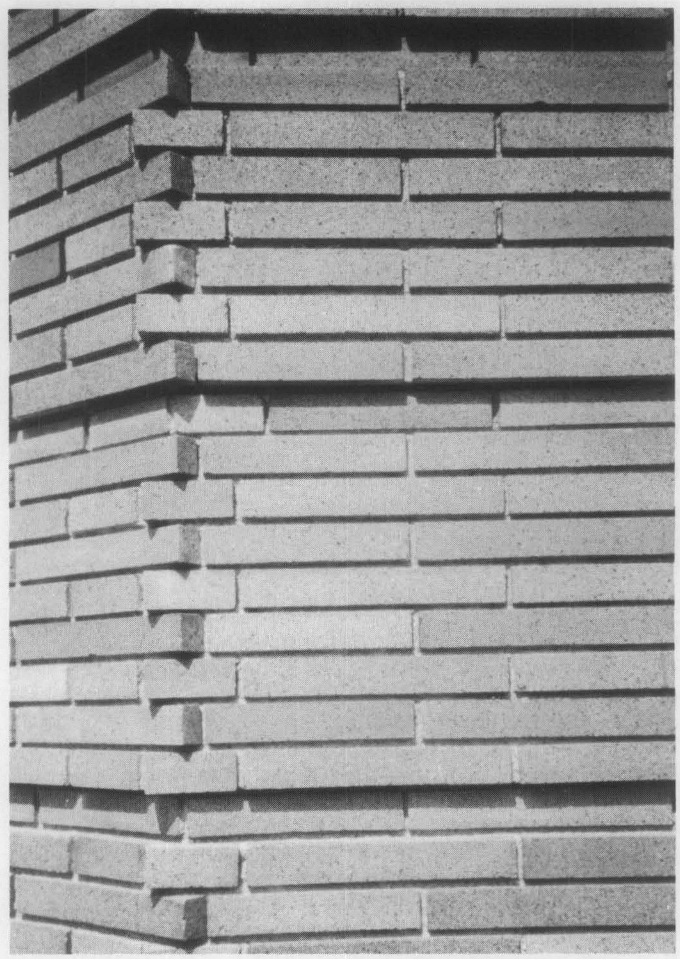
At arm's length, the visual character is most often determined by the surface qualities of the materials and craftsmanship; and while these aspects are often inextricably related, the original choice of materials often plays the dominant role in establishing the close-range character because of the color, texture, or shape of the materials.

In this instance, the variety and arrangement of the materials is important in defining the visual character, starting with the large pieces of broken stone which form the projecting base for the building walls, then changing to a wall of roughly rectangular stones which vary in size, color, and texture, all with accentuated, projecting beads of mortar, then there is a rather precise and narrow band of cut and dressed stones with minimal mortar joints, and finally, the main building walls are composed of bricks, rather uniform in color, with fairly generous mortar joints. It is the juxtaposition and variety of these materials (and of course, the craftsmanship) that is very important to the visual character. Changing the raised mortar joints, for example, would drastically alter the character at arm's length. Photo by Lee H. Nelson



Arm's Length Visual Character: Craft Details

There are many instances where craft details dominate the arm's length visual character. As seen here, the craft details are especially noticeable because the stones are all of a uniform color, and they are all squared off, but their surfaces were worked with differing tools and techniques to create a great variety of textures, resulting in a tour-de-force of craft details. This texture is very important at close range. It was a deliberately contrived surface that is an important contributor to the visual character of this building. Photo by Lee H. Nelson

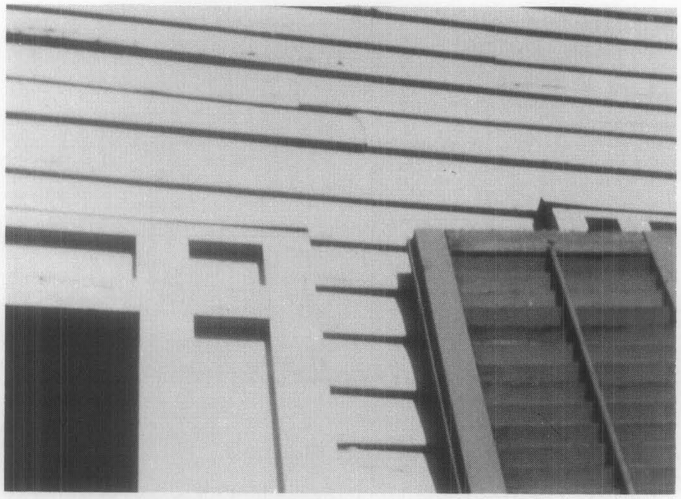


Arm's Length Visual Character: Craft Details

The arm's length visual character of this building is a combination of the materials and the craft details. Most of the exterior walls of this building consist of early 20th century Roman brick, precisely made, unusually long bricks, in varying shades of yellow-brown, with a noticeable surface spotting of dark iron pyrites. While this brick is an important contributor to the visual character, the related craft details are perhaps more important, and they consist of: unusually precise coursing of the bricks, almost as though they were laid up using a surveyor's level; a row of recessed bricks every ninth course, creating a shadow pattern on the wall; deeply recessed mortar joints, creating a secondary pattern of shadows; and a toothed effect where the bricks overlap each other at the corner of the building. The cumulative effect of this artisanry is important to the arm's length visual character, and it is evident that it would be difficult to match if it were damaged, and the effect could be easily damaged through insensitive treatments such as painting the brickwork or by careless repointing. Photo by Lee H. Nelson

Arm's Length Visual Character: Craft Details

On some buildings, there are subtle aspects of visual character that cannot be perceived from a distance. This is especially true of certain craft details that can be seen only at close range. On this building, it is easily understood that the narrow, unpainted, and weathered clapboards are an important aspect of its overall visual character; but at close range there are a number of subtle but very important craft details that contribute to the handmade quality of this building, and which clearly differentiate it from a building with machine sawn clapboards. The clapboards seen here were split by hand and the bottom edges were not dressed, so that the boards vary in width and thickness, and thus they give a very uneven shadow pattern. Because they were split from oak that is unpainted, there are occasional wavy rays in the wood that stand against the grain. Also noticeable is the fact that the boards are of relatively short lengths, and that they have feather-edged ends that overlap each other, a detail that is very different from butted joints. The occasional large nail heads and the differential silver-gray weathering add to the random quality of the clapboards. All of these qualities contribute to the arm's length visual character. Photo by Lee H. Nelson



Arm's Length Visual Character: Craft Details

While hand-split clapboards are distinctive visual elements in their own way, machine-sawn and painted wood siding is equally important to the overall visual character in most other instances. At arm's length, however, the machine sawn siding may not be so distinctive; but there might be other details that add visual character to the wooden building, such as the details of wooden trim and louvered shutters around the windows (as seen here), or similar surface textures on other buildings, such as the saw marks on wall shingles, the joints in leaded glass, decorative tinwork on a rain conductor box, the rough surface of pebble-dash stuccowork, or the pebbly surface of exposed aggregate concrete. Such surfaces can only be seen at arm's length and they add to the visual character of a historic building. Photo by Hugh C. Miller

Interior Visual Character: Individually Important Spaces

In assessing the interior visual character of any historic building, it is necessary to ask whether there are spaces that are important to the character of this particular building, whether the building is architecturally rich or modest, or even if it is a simple or utilitarian structure.

The character of the individually important space which is illustrated here is a combination of its size, the twin curving staircases, the massive columns and curving vaulted ceilings, in addition to the quality of the materials in the floor and in the stairs. If the ceiling were to be lowered to provide space for heating ducts, or if the stairways were to be enclosed for code reasons, the shape and character of this space would be damaged, even if there was no permanent physical damage. Such changes can easily destroy the visual character of an individually important interior space. Thus, it is important that the visual aspects of a building's interior character be recognized before planning any changes or alterations. Photo by National Portrait Gallery

Interior Visual Character: Related Spaces

Many buildings have interior spaces that are visually or physically related so that, as you move through them, they are perceived not as separate spaces, but as a sequence of related spaces that are important in defining the interior character of the building. The example which is illustrated here consists of three spaces that are visually linked to each other.

The first of these spaces is the vestibule which is of a generous size and unusual in its own right, but more important, it visually relates to the second space which is the main stairhall.

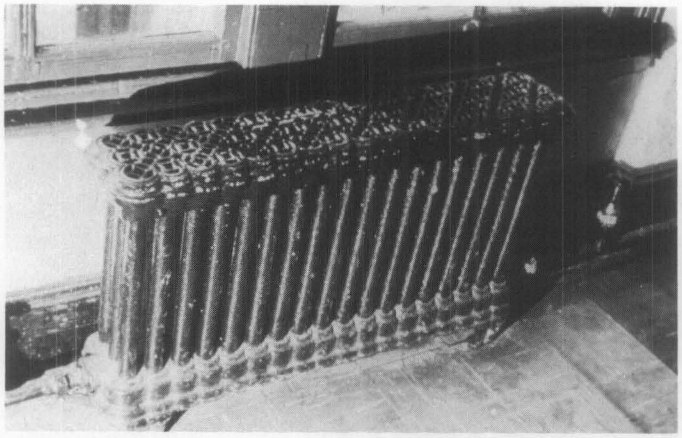
The hallway is the circulation artery for the building, and leads both horizontally and vertically to other rooms and spaces, but especially to the open and inviting stairway.

The stairway is the third part of this sequence of related spaces, and it provides continuing access to the upper floors.

These related spaces are very important in defining the interior character of this building. Almost any change to these spaces, such as installing doors between the vestibule and the hallway, or enclosing the stair would seriously impact their character and the way that character is perceived. Top photo by Mel Chamowitz, others by John Tennant

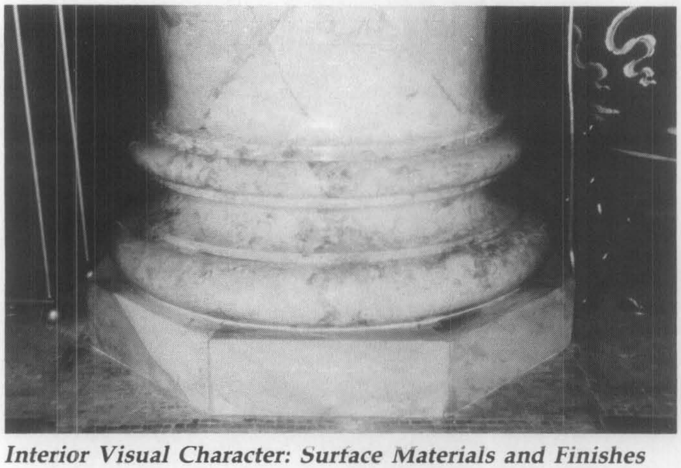
Interior Visual Character: Interior Features

Interior features are three-dimensional building elements or architectural details that are an integral part of the building as opposed to furniture. Interior features are often important in defining the character of an individual room or space. In some instances, an interior feature, like a large and ornamental open stairway may dominate the visual character of an entire building. In other instances, a modest iron stairway (like the one illustrated here) may be an important interior feature, and its preservation would be crucial to preserving the interior character of the building. Such features can also include the obvious things like fireplace mantles, plaster ceiling medallions, or panelling, but they also extend to features like hardware, lighting fixtures, bank tellers cages, decorative elevator doors, etc. Photo by David W. Look



Interior Visual Character: Interior Features

Modern heating or cooling devices usually add little to the interior character of a building; but historically, radiators, for instance, may have contributed to the interior character by virtue of their size or shape, or because of their specially designed bases, piping, and decorative grillage or enclosures. Sometimes they were painted with several colors to highlight their integral, cast-in details. In more recent times, it has been common to overpaint and conceal such distinctive aspects of earlier heating and plumbing devices, so that we seldom have the opportunity to realize how important they can be in defining the character of interior rooms and spaces. For that reason, it is important to identify their character-defining potential, and consider their preservation, retention, or restoration. Photo by David W. Look



Interior Visual Character: Surface Materials and Finishes

When identifying the visual character of historic interior spaces one should not overlook the importance of those materials and finishes that comprise the surfaces of walls, floors and ceilings. The surfaces may have evidence of either hand-craft or machine-made products that are important contributors to the visual character, including patterned or inlaid designs in the wood flooring, decorative painting practices such as stenciling, imitation marble or wood grain, wallpapering, tinwork, tile floors, etc.

The example illustrated here involves a combination of real marble at the base of the column, imitation marble patterns on the plaster surface of the column (a practice called scagliola), and a tile floor surface that uses small mosaic tiles arranged to form geometric designs in several different colors. While such decorative materials and finishes may be important in defining the interior visual character of this particular building, it should be remembered that in much more modest buildings, the plainness of surface materials and finishes may be an essential aspect of their historic character. Photo by Lee H. Nelson

Fragility of A Building's Visual Character

Some aspects of a building's visual character are fragile and are easily lost. This is true of brickwork, for example, which can be irreversibly damaged with inappropriate cleaning techniques or by insensitive repointing practices. At least two factors are important contributors to the visual character of brickwork, namely the brick itself and the craftsmanship. Between these, there are many more aspects worth noting, such as color range of bricks, size and shape variations, texture, bonding patterns, together with the many variable qualities of the mortar joints, such as color, width of joint and tooling. These qualities could be easily damaged by painting the brick, by raking out the joint with power tools, or repointing with a joint that is too wide. As seen here during the process of repointing, the visual character of this front wall is being dramatically changed from a wall where the bricks predominate, to a wall that is visually dominated by the mortar joints. Photo by Lee H. Nelson

The Architectural Character Checklist/Questionnaire

Lee H. Nelson, FAIA
National Park Service

This checklist can be taken to the building and used to identify those aspects that give the building and setting its essential visual qualities and character. This checklist consists of a series of questions that are designed to help in identifying those things that contribute to a building's character. The use of this checklist involves the three-step process of looking for: 1) the overall visual aspects, 2) the visual character at close range, and 3) the visual character of interior spaces, features and finishes.

Because this is a process to identify *architectural character,* it does not address those intangible qualities that give a property or building or its contents its historic significance, instead this checklist is organized on the assumption that historic significance is embodied in those *tangible* aspects that include the building's setting, its form and fabric.

Step One

1. Shape

What is there about the form or shape of the building that gives the building its identity? Is the shape distinctive in relation to the neighboring buildings? Is it simply a low, squat box, or is it a tall, narrow building with a corner tower? Is the shape highly consistent with its neighbors? Is the shape so complicated because of wings, or ells, or differences in height, that its complexity is important to its character? Conversely, is the shape so simple or plain that adding a feature like a porch would change that character? Does the shape convey its historic function as in smoke stacks or silos?

Notes on the Shape or Form of the Building:

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2. Roof and Roof Features

Does the roof shape or its steep (or shallow) slope contribute to the building's character? Does the fact that the roof is highly visible (or not visible at all) contribute to the architectural identity of the building? Are certain roof features important to the profile of the building against the sky or its background, such as cupolas, multiple chimneys, dormers, cresting, or weathervanes? Are the roofing materials or their colors or their patterns (such as patterned slates) more noticeable than the shape or slope of the roof?

Notes on the Roof and Roof Features:

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3. Openings

Is there a rhythm or pattern to the arrangement of windows or other openings in the walls; like the rhythm of windows in a factory building, or a three-part window in the front bay of a house; or is there a noticeable relationship between the width of the window openings and the wall space between the window openings? Are there distinctive openings, like a large arched entranceway, or decorative window lintels that accentuate the importance of the window openings, or unusually shaped windows, or patterned window sash, like small panes of glass in the windows or doors, that are important to the character? Is the plainness of the window openings such that adding shutters or gingerbread trim would radically change its character? Is there a hierarchy of facades that make the front windows more important than the side windows? What about those walls where the absence of windows establishes its own character?

Notes on the Openings:

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4. Projections

Are there parts of the building that are character-defining because they project from the walls of the building like porches, cornices, bay windows, or balconies? Are there turrets, or widely overhanging eaves, projecting pediments or chimneys?

Notes on the Projections:

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5. Trim and Secondary Features

Does the trim around the windows or doors contribute to the character of the building? Is there other trim on the walls or around the projections that, because of its decoration or color or patterning contributes to the character of the building? Are there secondary features such as shutters, decorative gables, railings, or exterior wall panels?

Notes on the Trim and Secondary Features:

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6. Materials

Do the materials or combination of materials contribute to the overall character of the building as seen from a distance because of their color or patterning, such as broken faced stone, scalloped wall shingling, rounded rock foundation walls, boards and battens, or textured stucco?

Notes on the Materials:

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7. Setting

What are the aspects of the setting that are important to the visual character? For example, is the alignment of buildings along a city street and their relationship to the sidewalk the essential aspect of its setting? Or, conversely, is the essential character dependent upon the tree plantings and out buildings which surround the farmhouse? Is the front yard important to the setting of the modest house? Is the specific site important to the setting such as being on a hilltop, along a river, or, is the building placed on the site in such a way to enhance its setting? Is there a special relationship to the adjoining streets and other buildings? Is there a view? Is there fencing, planting, terracing, walkways or any other landscape aspects that contribute to the setting?

Notes on the Setting:

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Step Two

8. Materials at Close Range

Are there one or more materials that have an inherent texture that contributes to the close range character, such as stucco, exposed aggregate concrete, or brick textured with vertical grooves? Or materials with inherent colors such as smooth orange-colored brick with dark spots of iron pyrites, or prominently veined stone, or green serpentine stone? Are there combinations of materials, used in juxtaposition, such as several different kinds of stone, combinations of stone and brick, dressed stones for window lintels used in conjunction with rough stones for the wall? Has the choice of materials or the combinations of materials contributed to the character?

Notes on the Materials at Close Range:

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9. Craft Details

Is there high quality brickwork with narrow mortar joints? Is there hand-tooled or patterned stonework? Do the walls exhibit carefully struck vertical mortar joints and recessed horizontal joints? Is the wall shinglework laid up in patterns or does it retain evidence of the circular saw marks or can the grain of the wood be seen through the semi-transparent stain? Are there hand split or hand-dressed clapboards, or machine smooth beveled siding, or wood rusticated to look like stone, or Art Deco zigzag designs executed in stucco?

Almost any evidence of craft details, whether handmade or machinemade, will contribute to the character of a building because it is a manifestation of the materials, of the times in which the work was done, and of the tools and processes that were used. It further reflects the effects of time, of maintenance (and/or neglect) that the building has received over the years. All of these aspects are a part of the surface qualities that are seen only at close range.

Notes on the Craft Details:

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Step Three

10. Individual Spaces

Are there individual rooms or spaces that are important to this building because of their size, height, proportion, configuration, or function, like the center hallway in a house, or the bank lobby, or the school auditorium, or the ballroom in a hotel, or a courtroom in a county courthouse?

Notes on the Individual Spaces:

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11. Related Spaces and Sequences of Spaces

Are there adjoining rooms that are visually and physically related with large doorways or open archways so that they are perceived as related rooms as opposed to separate rooms? Is there an important sequence of spaces that are related to each other, such as the sequence from the entry way to the lobby to the stairway and to the upper balcony as in a theatre; or the sequence in a residence from the entry vestibule to the hallway to the front parlor, and on through the sliding doors to the back parlor; or the sequence in an office building from the entry vestibule to the lobby to the bank of elevators?

Notes on the Related Spaces and Sequences of Spaces:

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12. Interior Features

Are there interior features that help define the character of the building, such as fireplace mantels, stairways and balustrades, arched openings, interior shutters, inglenooks, cornices, ceiling medallions, light fixtures, balconies, doors, windows, hardware, wainscotting, panelling, trim, church pews, courtroom bars, teller cages, waiting room benches?

Notes on the Interior Features:

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13. Surface Finishes and Materials

Are there surface finishes and materials that can affect the design, the color or the texture of the interior? Are there materials and finishes or craft practices that contribute to the interior character, such as wooden parquet floors, checkerboard marble floors, pressed metal ceilings, fine hardwoods, grained doors or marblized surfaces, or polychrome painted surfaces, or stencilling, or wallpaper that is important to the historic character? Are there surface finishes and materials that, because of their plainness, are imparting the essential character of the interior such as hard or bright, shiny wall surfaces of plaster or glass or metal?

Notes on the Surface Finishes and Materials:

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14. Exposed Structure

Are there spaces where the exposed structural elements define the interior character such as the exposed posts, beams, and trusses in a church or train shed or factory? Are there rooms with decorative ceiling beams (non-structural) in bungalows, or exposed vigas in adobe buildings?

Notes on the Exposed Structure:

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This concludes the three-step process of identifying the visual aspects of historic buildings and is intended as an aid in preserving their character and other distinguishing qualities. It is not intended as a means of understanding the significance of historical properties or districts, nor of the events or people associated with them. That can only be done through other kinds of research and investigation.

This Preservation Brief was originally developed as a slide talk/methodology in 1982 to discuss the use of the Secretary of the Interior's Standards for Rehabilitation in relation to preserving historic character; and it was amplified and modified in succeeding years to help guide preservation decisionmaking, initially for maintenance personnel in the National Park Service. A number of people contributed to the evolution of the ideas presented here. Special thanks go to Emogene Bevitt and Gary Hume, primarily for the many and frequent discussions relating to this approach in its evolutionary stages; to Mark Fram, Ontario Heritage Foundation, Toronto, for suggesting several additions to the Checklist; and more recently, to my co-workers, both in Washington and in our regional offices, especially Ward Jandl, Sara Blumenthal, Charles Fisher, Sharon Park, AIA, Jean Travers, Camille Martone, Susan Dynes, Michael Auer, Anne Grimmer, Kay Weeks, Betsy Chittenden, Patrick Andrus, Carol Shull, Hugh Miller, FAIA, Jerry Rogers, Paul Alley, David Look, AIA, Margaret Pepin-Donat, Bonnie Halda, Keith Everett, Thomas Keohan, the Preservation Services Division, Mid-Atlantic Region, and several reviewers in state preservation offices, especially Ann Haaker, Illinois; and Stan Graves, AIA, Texas; for providing very critical and constructive review of the manuscript.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended. Comments on the usefulness of this information are welcomed and can be sent to Mr. Nelson, Preservation Assistance Division, National Park Service, U.S. Department of the Interior, P.O. Box 37127, Washington, D.C. 20013-7127.

27 PRESERVATION BRIEFS

The Maintenance and Repair of Architectural Cast Iron

John G. Waite, AIA

Historical Overview by Margot Gayle

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

In Cooperation with the
New York Landmarks Conservancy

The preservation of cast-iron architectural elements, including entire facades, has gained increasing attention in recent years as commercial districts are recognized for their historic significance and revitalized. This Brief provides general guidance on approaches to the preservation and restoration of historic cast iron.

Cast iron played a preeminent role in the industrial development of our country during the 19th century. Cast-iron machinery filled America's factories and made possible the growth of railroad transportation. Cast iron was used extensively in our cities for water systems and street lighting. As an architectural metal, it made possible bold new advances in architectural designs and building technology, while providing a richness in ornamentation (Fig. 1).

This age-old metal, an iron alloy with a high carbon content, had been too costly to make in large quantities until the mid-18th century, when new furnace technology in England made it more economical for use in construction. Known for its great strength in compression, cast iron in the form of slender, non-flammable pillars, was introduced in the 1790s in English cotton mills, where fires were endemic. In the United States, similar thin columns were first employed in the 1820s in theaters and churches to support balconies.

By the mid-1820s, one-story iron storefronts were being advertised in New York City. Daniel Badger, the Boston foundryman who later moved to New York, asserted that in 1842 he fabricated and installed the first rolling iron shutters for iron storefronts, which provided protection against theft and external fire. In the years ahead, and into the 1920s, the practical cast-iron storefront would become a favorite in towns and cities from coast to coast. Not only did it help support the load of the upper floors, but it provided large show windows for the display of wares and allowed natural light to flood the interiors of the shops. Most importantly, cast-iron storefronts were inexpensive to assemble, requiring little on-site labor.

A tireless advocate for the use of cast iron in buildings was an inventive New Yorker, the self-taught architect/engineer James Bogardus. From 1840 on, Bogardus extolled its virtues of strength, structural stability, durability, relative lightness, ability to be cast in almost any shape and, above all, the fire-resistant qualities so sought after in an age of serious urban conflagrations. He also stressed that the foundry casting processes, by which cast iron was made into building elements, were thoroughly compatible with the new concepts of prefabrication, mass production, and use of identical interchangeable parts.

Fig. 1. The Haughwout Building in New York City is an excellent example of the quality and character of mass-produced cast-iron architecture. Once wood patterns were made, any number of elements could be cast, as was done with each of these repetitive bays. Photo: New York City Landmarks Preservation Commission.

In 1849 Bogardus created something uniquely American when he erected the first structure with self-supporting, multi-storied exterior walls of iron. Known as the Edgar Laing Stores, this corner row of small four-story warehouses that looked like one building was constructed in lower Manhattan in only two months. Its rear, side, and interior bearing walls were of brick; the floor framing consisted of timber joists and girders. One of the cast-iron walls was load-bearing, supporting the wood floor joists. The innovation was its two street facades of self-supporting cast iron, consisting of multiples of only a few pieces—Doric-style engaged columns, panels, sills, and plates, along with some applied ornaments (cover photo and Fig. 2). Each component of the facades had been cast individually in a sand mold in a foundry, machined smooth, tested for fit, and finally trundled on horse-drawn drays to the building site. There they were hoisted into position, then bolted together and fastened to the conventional structure of timber and brick with iron spikes and straps (Fig. 3).

The second iron-front building erected was a quantum leap beyond the Laing Stores in size and complexity. Begun in April 1850 by Bogardus, with architect Robert Hatfield, the five-story Sun newspaper building in Baltimore was both cast-iron-fronted and cast-iron-framed. In Philadelphia, several ironfronts were begun in 1850: The Inquirer Building, the Brock Stores, and the Penn Mutual Building (all three have been demolished). The St. Charles Hotel of 1851 at 60 N. Third Street is the oldest ironfront in America. Framing with cast-iron columns and wrought-iron beams and trusses was visible on a vast scale in the New York Crystal Palace of 1853.

In the second half of the 19th century, the United States was in an era of tremendous economic and territorial growth. The use of iron in commercial and public buildings spread rapidly, and hundreds of iron-fronted buildings were erected in cities across the country from 1849 to beyond the turn of the century. Outstanding examples of ironfronts exist in Baltimore, Galveston, Louisville, Milwaukee, New Orleans, Philadelphia, Richmond, Rochester (N.Y.), and especially New York City where the SoHo Cast Iron Historic District alone has 139 iron-fronted buildings (Fig. 1). Regrettably, a large proportion of ironfronts nationwide have been demolished in downtown redevelopment projects, especially since World War II.

Fig. 2. The Edgar Laing Stores Block in New York City was designed by James Bogardus. It was the first building constructed with facades of self-supporting cast iron. This corner view shows the Doric-style engaged columns, panels, and spandrel beams; the loss of most of the original ornamental castings give it an austere look. As part of an urban renewal project, the facades were carefully disassembled in 1971 for later re-erection in another location—only to have its iron parts stolen for scrap. Photo: Jack E. Boucher, HABS Collection.

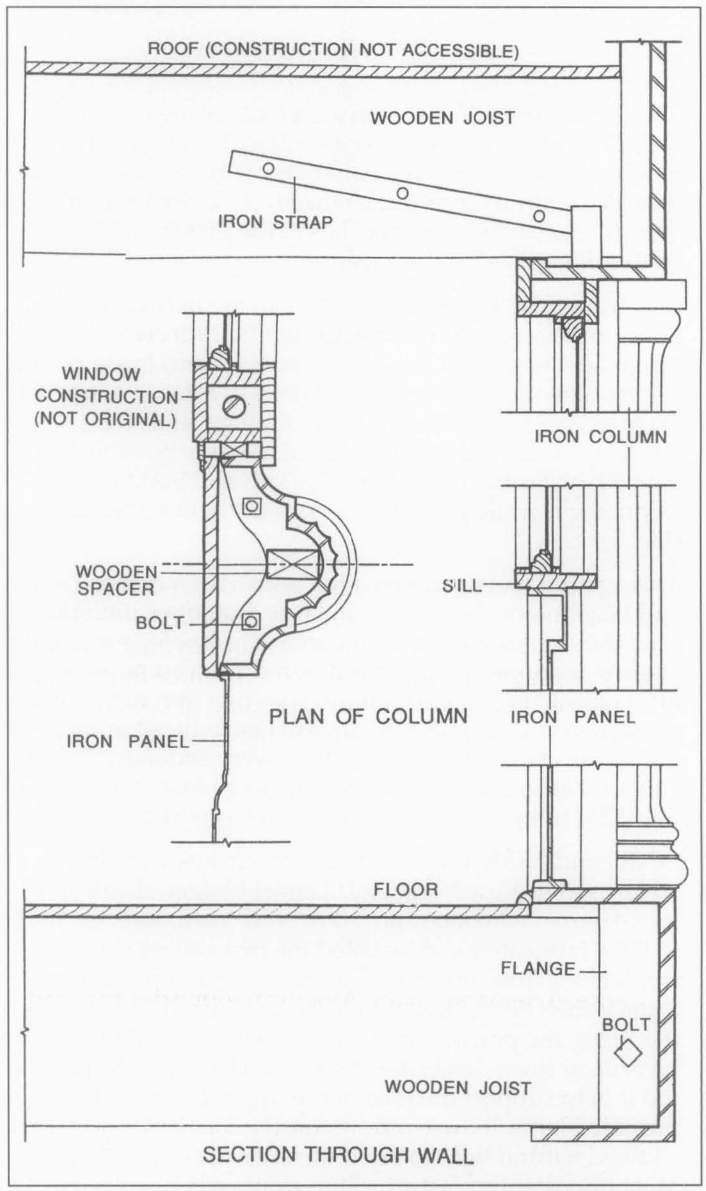

Fig. 3. Section drawing through the wall of Edgar Laing Stores showing how the cast-iron facade components were anchored to the wood floor and roof framing members. Drawing: John G. Waite, HABS Collection.

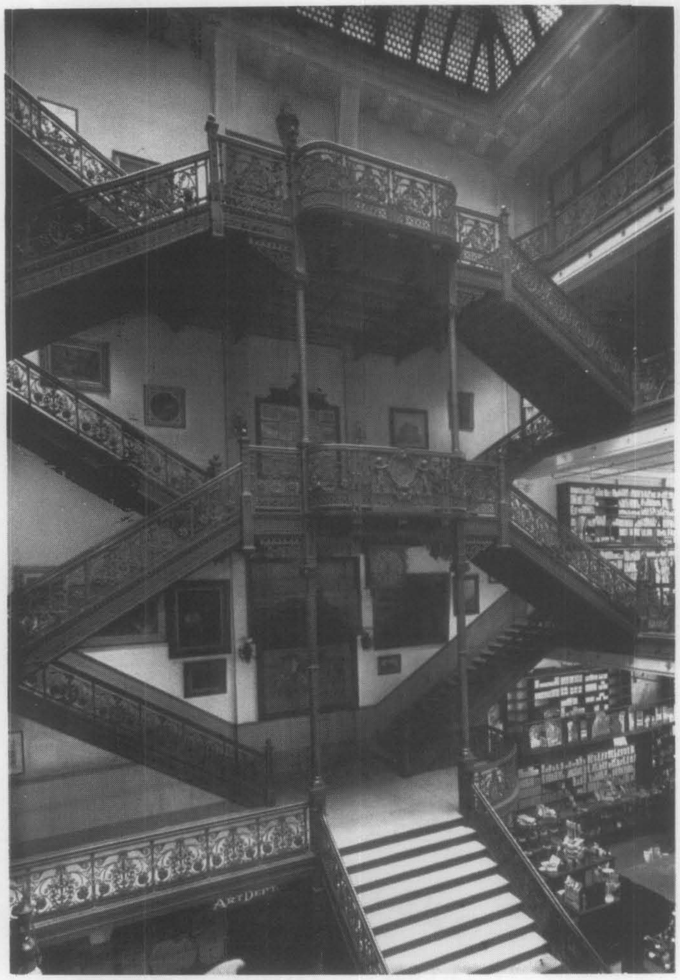

Fig. 4. The 1904 grand stairway of the former Frear's department store in Troy, N.Y. was constructed of cast iron, as was the frame of the skylight above. Some ornamental wrought iron was also employed. This use of iron was typical in major commercial buildings constructed throughout the United States. Courtesy: Rensselaer County Historical Society.

In addition to these exterior uses, many public buildings display magnificent exposed interior ironwork, at once ornamental and structural (Fig. 4). Remarkable examples have survived across the country, including the Peabody Library in Baltimore; the Old Executive Office Building in Washington, D.C.; the Bradbury Building in Los Angeles; the former Louisiana State Capitol; the former City Hall in Richmond; Tweed Courthouse in New York; and the state capitols of California, Georgia, Michigan, Tennessee, and Texas. And it is iron, of course, that forms the great dome of the United States Capitol, completed during the Civil War. Ornamental cast iron was a popular material in the landscape as well, appearing as fences, fountains with statuary, lampposts, furniture, urns, gazebos, gates, and enclosures for cemetery plots (Fig. 5). With such widespread demand, many American foundries that had been casting machine parts, bank safes, iron pipe, or cookstoves added architectural iron departments (Fig. 6). These called for patternmakers with sophisticated design capabilities, as well as knowledge of metal shrinkage and other technical aspects of casting. Major companies included the Hayward Bartlett Co. in Baltimore; James L. Jackson, Cornell Brothers, J. L. Mott, and Daniel D. Badger's Architectural Iron Works in Manhattan; Hecla Ironworks in Brooklyn; Wood & Perot of Philadelphia; Leeds & Co., the Shakspeare (sic) Foundry, and Miltenberger in New Orleans; Winslow Brothers in Chicago; and James McKinney in Albany, N.Y.

Fig. 5. The Slatter Family Tomb in Mobile, Alabama, consisting of a cast-iron mausoleum and fence, exhibits the wide range of uses of the material in the 19th century. Photo: Jack E. Boucher, HABS Collection.

Cast iron was the metal of choice throughout the second half of the 19th century. Not only was it a fire-resistant material in a period of major urban fires, but also large facades could be produced with cast iron at less cost than comparable stone fronts, and iron buildings could be erected with speed and efficiency. The largest standing example of framing with cast-iron columns and wrought-iron beams is Chicago's sixteen-story Manhattan Building, the world's tallest skyscraper when built in 1890 by William LeBaron Jenney. By this time, however, steel was becoming available nationally, and was structurally more versatile and cost-competitive. Its increased use is one reason why building with cast iron diminished around the turn of the century after having been so eagerly adopted only fifty years before. Nonetheless, cast iron continued to be used in substantial quantities for many other structural and ornamental purposes well into the 20th century: storefronts; marquees; bays and large window frames for steel-framed, masonry-clad buildings; and street and landscape furnishings, including subway kiosks.

The 19th century left us with a rich heritage of new building methods, especially construction on an altogether new scale that was made possible by the use of metals. Of these, cast iron was the pioneer, although its period of intensive use lasted but a half century. Now the surviving legacy of cast-iron architecture, much of which continues to be threatened, merits renewed appreciation and appropriate preservation and restoration treatments.

What is Cast Iron?

Cast iron is an alloy with a high carbon content (at least 1.7% and usually 3.0 to 3.7%) that makes it more resistant to corrosion than either wrought iron or steel. In addition to carbon, cast iron contains varying amounts of silicon, sulfur, manganese, and phosphorus.

While molten, cast iron is easily poured into molds, making it possible to create nearly unlimited decorative and structural forms. Unlike wrought iron and steel, cast iron is too hard and brittle to be shaped by hammering, rolling, or pressing. However, because it is more rigid and more resistant to buckling than other forms of iron, it can withstand great compression loads. Cast iron is relatively weak in tension, however, and fails under tensile loading with little prior warning.

The characteristics of various types of cast iron are determined by their composition and the techniques used in melting, casting, and heat treatment. Metallurgical constituents of cast iron that affect its brittleness, toughness, and strength include ferrite, cementite, pearlite, and graphite carbon. Cast iron with flakes of carbon is called gray cast iron. The "gray fracture" associated with cast iron was probably named for the gray, grainy appearance of its broken edge caused by the presence of flakes of free graphite, which account for the brittleness of cast iron. This brittleness is the important distinguishing characteristic between cast iron and mild steel.

Compared with cast iron, wrought iron is relatively soft, malleable, tough, fatigue-resistant, and readily worked by forging, bending, and drawing. It is almost pure iron, with less than 1% (usually 0.02 to 0.03%) carbon. Slag varies between 1% and 4% of its content and exists in a purely physical association, that is, it is not alloyed. This gives wrought iron its characteristic laminated (layered) or fibrous structure.

Wrought iron can be distinguished from cast iron in several ways. Wrought-iron elements generally are simpler in form and less uniform in appearance than cast-iron elements, and contain evidence of rolling or hand working. Cast iron often contains mold lines, flashing, casting flaws, and air holes. Cast-iron elements are very uniform in appearance and are frequently used repetitively. Cast-iron elements are often bolted or screwed together, whereas wrought-iron pieces are either riveted or forge-molded (heat welded) together.

Mild steel is now used to fabricate new hand-worked metal work and to repair old wrought-iron elements. Mild steel is an alloy of iron and is not more than 2% carbon, which is strong but easily worked in block or ingot form. Mild steel is not as resistant to corrosion as either wrought iron or cast iron.

Maintenance and Repair

Many of the maintenance and repair techniques described in the Brief, particularly those relating to cleaning and painting, are potentially dangerous and should be carried out only by experienced and qualified workmen using protective equipment suitable to the task. In all but the most simple repairs, it is best to involve a preservation architect or building conservator to assess the condition of the iron and prepare contract documents for its treatment.

As with any preservation project, the work must be preceded by a review of local building codes and environmental protection regulations to determine whether any conflicts exist with the proposed treatments. If there are conflicts, particularly with cleaning techniques or painting materials, then waivers or variances need to be negotiated, or alternative treatments or materials adopted.

Deterioration

Common problems encountered today with cast-iron construction include badly rusted or missing elements, impact damage, structural failures, broken joints, damage to connections, and loss of anchorage in masonry (Figs. 7, 8).

Oxidation, or rusting, occurs rapidly when cast iron is exposed to moisture and air. The minimum relative humidity necessary to promote rusting is 65%, but this

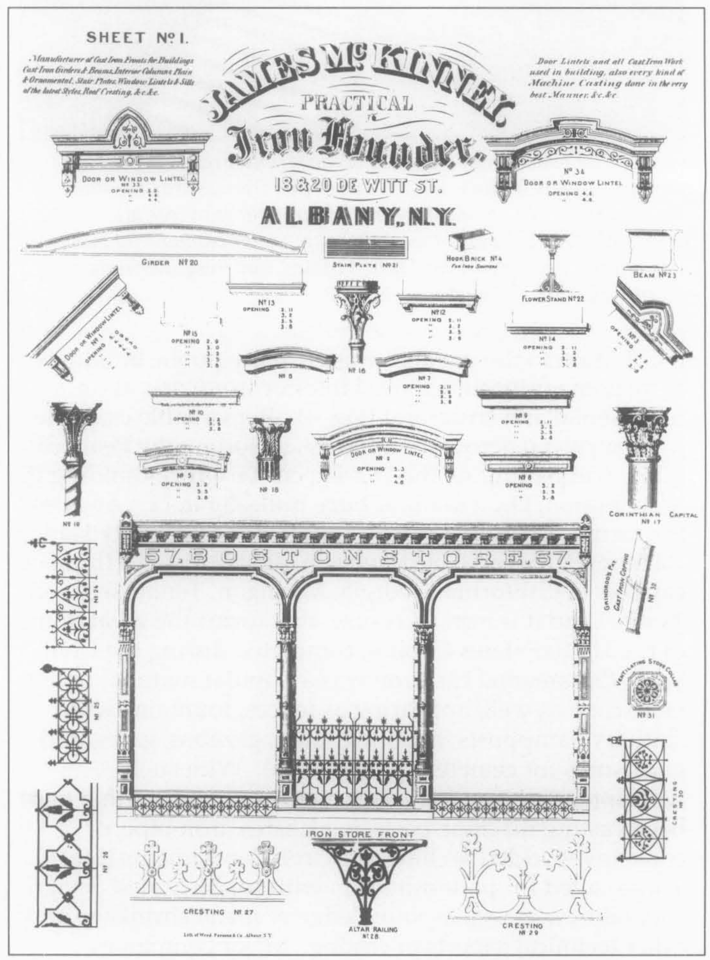

Fig. 6. Sheet from a late 19th century manufacturer's trade catalog illustrates some of the products available from foundries, such as storefronts, girders and beams, columns, stairs, window lintels and sills, and roof crestings. Courtesy: Albany Institute of History and Art.

Fig. 7. Despite an impact that shattered the main castings, this fence post remains upright, demonstrating the great strength of cast iron. Originally, the post was held together by a long bolt that extended from the finial to the base. Photo: John G. Waite.

figure can be lower in the presence of corrosive agents, such as sea water, salt air, acids, acid precipitation, soils, and some sulfur compounds present in the atmosphere, which act as catalysts in the oxidation process. Rusting is accelerated in situations where architectural details provide pockets or crevices to trap and hold liquid corrosive agents. Furthermore, once a rust film forms, its porous surface acts as a reservoir for liquids, which in turn causes further corrosion. If this process is not arrested, it will continue until the iron is entirely consumed by corrosion, leaving nothing but rust.

Galvanic corrosion is an electrochemical action that results when two dissimilar metals react together in the presence of an electrolyte, such as water containing salts or hydrogen ions (Fig. 9). The severity of the galvanic corrosion is based on the difference in potential between the two metals, their relative surface areas, and time. If the more noble metal (higher position in electrochemical series) is much larger in area than the baser, or less noble, metal, the deterioration of the baser metal will be more rapid and severe. If the more noble metal is much smaller in area than the baser metal, the deterioration of the baser metal will be much less significant. Cast iron will be attacked and corroded when it is adjacent to more noble metals such as lead or copper.

Fig. 8. Structural cracks, gaps at joints between components, and a large opening where part of the console bracket is missing are the problems evident in this cast-iron assembly. Photo: Ford, Powell & Carson.

Fig. 9. Galvanic corrosion occurred where a patch of copper was installed alongside the cast-iron cap at the base of a fountain. The use of terne-coated stainless flashings with appropriate caulking would have been a more suitable repair. Photo: John G. Waite.

Graphitization of cast iron, a less common problem, occurs in the presence of acid precipitation or seawater. As the iron corrodes, the porous graphite (soft carbon) corrosion residue is impregnated with insoluble corrosion products. As a result, the cast-iron element retains its appearance and shape but is weaker structurally. Graphitization occurs where cast iron is left unpainted for long periods or where caulked joints have failed and acidic rainwater has corroded pieces from the backside. Testing and identification of graphitization is accomplished by scraping through the surface with a knife to reveal the crumbling of the iron beneath. Where extensive graphitization occurs, usually the only solution is replacement of the damaged element.

Castings may also be fractured or flawed as a result of imperfections in the original manufacturing process, such as air holes, cracks, and cinders, or cold shuts (caused by the "freezing" of the surface of the molten iron during casting because of improper or interrupted pouring). Brittleness is another problem occasionally found in old cast-iron elements. It may be a result of excessive phosphorus in the iron, or of chilling during the casting process.

Condition Assessment

Before establishing the appropriate treatment for cast-iron elements in a building or structure, an evaluation should be made of the property's historical and architectural significance and alterations, along with its present condition. If the work involves more than routine maintenance, a qualified professional should be engaged to develop a historic structure report which sets forth the historical development of the property, documents its existing condition, identifies problems of repair, and provides a detailed listing of recommended work items with priorities. Through this process the significance and condition of the cast iron can be evaluated and appropriate treatments proposed. For fences, or for single components of a building such as a facade, a similar but less extensive analytical procedure should be followed.

The nature and extent of the problems with the cast-iron elements must be well understood before proceeding with work. If the problems are minor, such as surface corrosion, flaking paint, and failed caulking, the property owner may be able to undertake the repairs by working directly with a knowledgeable contractor. If there are major problems or extensive damage to the cast iron, it is best to secure the services of an architect or conservator who specializes in the conservation of historic buildings. Depending on the scope of work, contract documents can range from outline specifications to complete working drawings with annotated photographs and specifications

To thoroughly assess the condition of the ironwork, a close physical inspection must be undertaken of every section of the iron construction including bolts, fasteners, and brackets (Fig. 10). Typically, scaffolding or a mechanical lift is employed for close inspection of a cast-iron facade or other large structures. Removal of select areas of paint may be the only means to determine the exact condition of connections, metal fasteners, and intersections or crevices that might trap water.

Fig. 11. Major cracks in the piers of this cast-iron storefront in Galveston, Texas resulted from the transfer of load onto the iron from internal brick piers eroded by rising damp. This crack was inappropriately filled with concrete, which trapped moisture and accelerated internal corrosion, pushing the iron further apart. Photo: Ford, Powell & Carson.

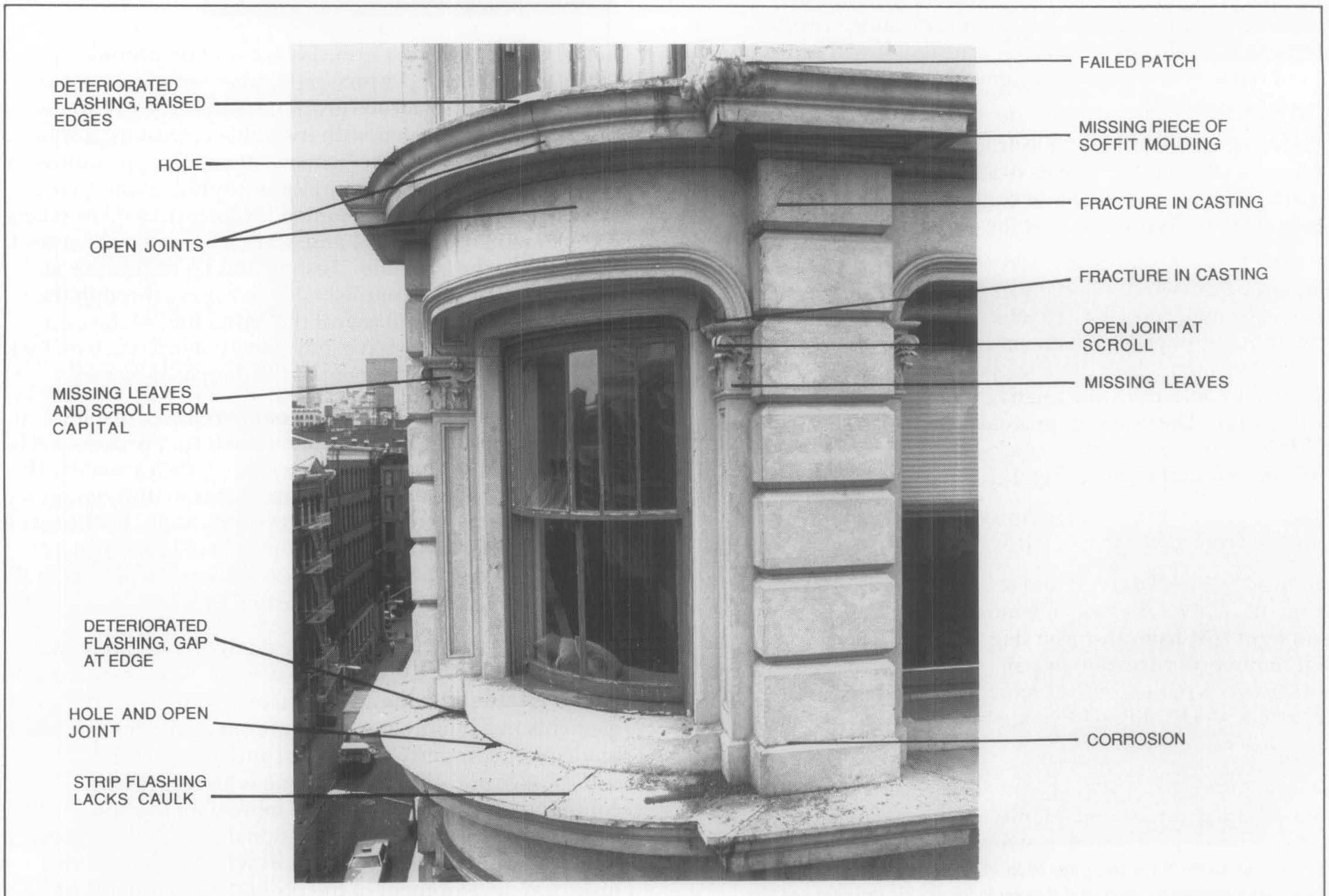

Fig. 10. During close-up inspection of the Gunther Building in New York City, photographs of each bay were taken to use in a survey of existing conditions. Photo: Willcox Dunn.

An investigation of load-bearing elements, such as columns and beams, will establish whether these components are performing as they were originally designed, or the stress patterns have been redistributed. Areas that are abnormally stressed must be examined to ascertain whether they have suffered damage or have been displaced (Fig. 11). Damage to a primary structural member is obviously critical to identify and evaluate; attention should not be given only to decorative features.

The condition of the building, structure, or object; diagnosis of its problems; and recommendations for its repair should be recorded by drawings, photographs, and written descriptions, to aid those who will be responsible for its conservation in the future.

Whether minor or major work is required, the retention and repair of historic ironwork is the recommended preservation approach over replacement. All repairs and restoration work should be reversible, when possible, so that modifications or treatments that may turn out to be harmful to the long-term preservation of the iron can be corrected with the least amount of damage to the historic ironwork.

Cleaning and Paint Removal

When there is extensive failure of the protective coating and/or when heavy corrosion exists, the rust and most or all of the paint must be removed to prepare the surfaces for new protective coatings. The techniques available range from physical processes, such as wire brushing and grit blasting, to flame cleaning and chemical methods. The selection of an appropriate technique depends upon how much paint failure and corrosion has occurred, the fineness of the surface detailing, and the type of new protective coating to be applied. Local environmental regulations may restrict the options for cleaning and paint removal methods, as well as the disposal of materials.

Many of these techniques are *potentially dangerous* and should be carried out only by experienced and qualified workers using proper eye protection, protective clothing, and other workplace safety conditions. Before selecting a process, test panels should be prepared on the iron to be cleaned to determine the relative effectiveness of various techniques. The cleaning process will most likely expose additional coating defects, cracks, and corrosion that have not been obvious before (Fig. 12).

There are a number of techniques that can be used to remove paint and corrosion from cast iron:

Hand scraping, chipping, and wire brushing are the most common and least expensive methods of removing paint and light rust from cast iron (Fig. 13a, b). However, they do not remove all corrosion or paint as effectively as other methods. Experienced craftsmen should carry out the work to reduce the likelihood that surfaces may be scored or fragile detail damaged.

Low-pressure grit blasting (commonly called abrasive cleaning or sandblasting) is often the most effective approach to removing excessive paint build-up or substantial corrosion. Grit blasting is fast, thorough, and economical, and it allows the iron to be cleaned in place. The aggregate can be iron slag or sand; copper slag should not be used on iron because of the potential for electrolytic reactions. Some sharpness in the aggregate is beneficial in that it gives the metal surface a "tooth" that will result in better paint adhesion. The use of a very sharp or hard aggregate and/or excessively high pressure (over 100 pounds per square inch) is unnecessary and should be avoided. Adjacent materials, such as brick, stone, wood, and glass, must be protected to prevent damage. Some local building codes and environmental authorities prohibit or limit dry sandblasting because of the problem of airborne dust.

Fig. 12. Paint stripping exposed a large defect under a faulty patch at a joint of this wide cast-iron watertable. The damage can be repaired mechanically by splicing in a cast-iron replacement piece. Photo: Peter Jensen, Kapell and Kostow Architects.

Wet sandblasting is more problematic than dry sandblasting for cleaning cast iron because the water will cause instantaneous surface rusting and will penetrate deep into open joints. Therefore, it is generally not considered an effective technique. Wet sandblasting reduces the amount of airborne dust when removing a heavy paint build-up, but disposal of effluent containing lead or other toxic substances is restricted by environmental regulations in most areas.

Flame cleaning of rust from metal with a special multi-flame head oxyacetylene torch requires specially skilled operators, and is expensive and potentially dangerous. However, it can be very effective on lightly to moderately corroded iron. Wire brushing is usually neccessary to finish the surface after flame cleaning.

Chemical rust removal, by acid pickling, is an effective method of removing rust from iron elements that can be easily removed and taken to a shop for submerging in vats of dilute phosphoric or sulfuric acid. This method does not damage the surface of iron, providing that the iron is neutralized to pH level 7 after cleaning. Other chemical rust removal agents include ammonium citrate, oxalic acid, or hydrochloric acid-based products.

Fig. 13. Surface preparation may involve several different techniques. Where chemical paint stripping is involved, careful planning of the sequence of work and inspection by an architect or conservator to ensure strict compliance with the contract documents is important to minimize the risk of problems. After the chemical paste and paint was scraped off, the remaining paint and chemical residue were removed with a wire brush (a) and scrapers selected or cut to fit the shape of the iron surfaces (b). The surface was then wiped with solvent to create a completely clean surface prior to repainting (c). Photos: Raymond M. Pepi, Building Conservation Associates.

Chemical paint removal using alkaline compounds, such as methylene chloride or potassium hydroxide, can be an effective alternative to abrasive blasting for removal of heavy paint build-up (Fig. 13). These agents are often available as slow-acting gels or pastes. Because they can cause burns, protective clothing and eye protection must be worn. Chemicals applied to a non-watertight facade can seep through crevices and holes, resulting in damage to the building's interior finishes and corrosion to the backside of the iron components. If not thoroughly neutralized, residual traces of cleaning compounds on the surface of the iron can cause paint failures in the future (Fig. 14). For these reasons, field application of alkaline paint removers and acidic cleaners is not generally recommended.

Following any of these methods of cleaning and paint removal, the newly cleaned iron should be painted immediately with a corrosion-inhibiting primer before new rust begins to form. This time period may vary from minutes to hours depending on environmental conditions. If priming is delayed, any surface rust that has developed should be removed with a clean wire brush just before priming, because the rust prevents good bonding between the primer and the cast iron surface and prevents the primer from completely filling the pores of the metal.

Painting and Coating Systems

The most common and effective way to preserve architectural cast iron is to maintain a protective coating of paint on the metal. Paint can also be decorative, where historically appropriate .

Before removing paint from historic architectural cast iron, a microscopic analysis of samples of the historic paint sequencing is recommended. Called paint seriation analysis, this process must be carried out by an experienced architectural conservator. The analysis will identify the historic paint colors, and other conditions, such as whether the paint was matte or gloss, whether sand was added to the paint for texture, and whether the building was polychromed or marbleized. Traditionally many cast-iron elements were painted to resemble other materials, such as limestone or sandstone. Occasionally, features were faux-painted so that the iron appeared to be veined marble.

Thorough surface preparation is necessary for the adhesion of new protective coatings. All loose, flaking, and deteriorated paint must be removed from the iron, as well as dirt and mud, water-soluble salts, oil, and grease. Old paint that is tightly adhered may be left on the surface of the iron if it is compatible with the proposed coatings. The retention of old paint also preserves the historic paint sequence of the building and avoids the hazards of removal and disposal of old lead paint.

It is advisable to consult manufacturer's specifications or technical representatives to ensure compatibility between the surface conditions, primer and finish coats, and application methods.

For the paint to adhere properly, the metal surfaces must be absolutely dry before painting. Unless the paint selected is specifically designed for exceptional conditions, painting should not take place when the temperature is expected to fall below 50 degrees Fahrenheit within 24 hours or when the relative humidity is above 80 per cent; paint should not be applied when there is fog, mist, or rain in the air. Poorly prepared surfaces will cause the failure of even the best paints, while even moderately priced paints can be effective if applied over well-prepared surfaces.

Selection of Paints and Coatings

The types of paints available for protecting iron have changed dramatically in recent years due to federal, state, and local regulations that prohibit or restrict the manufacture and use of products containing toxic substances such as lead and zinc chromate, as well as volatile organic compounds and substances (VOC or VOS). Availability of paint types varies from state to state, and manufacturers continue to change product formulations to comply with new regulations.

Fig. 14. Major problems can result if work is undertaken without proper sequencing and precautions. On this building, a strong alkaline paint remover was used, and apparently was not adequately rinsed or neutralized. Over a period of months, the newly applied paint began to peel and streaks of rust appeared on the iron. Photo: Kim Lovejoy.

Traditionally, red lead has been used as an anti-corrosive pigment for priming iron. Red lead has a strong affinity for linseed oil and forms lead soaps, which become a tough and elastic film impervious to water that is highly effective as a protective coating for iron. At least two slow-drying linseed oil-based finish coats have traditionally been used over a red lead primer, and this combination is effective on old or partially-deteriorated surfaces. Today, in most areas, the use of paints containing lead is prohibited, except for some commercial and industrial purposes.

Today, alkyd paints are very widely used and have largely replaced lead-containing linseed-oil paints. They dry faster than oil paint, with a thinner film, but they do not protect the metal as long. Alkyd rust-inhibitive primers contain pigments such as iron oxide, zinc oxide, and zinc phosphate. These primers are suitable for previously painted surfaces cleaned by hand tools. At least two coats of primer should be applied, followed by alkyd enamel finish coats.

Latex and other water-based paints are not recommended for use as primers on cast iron because they cause immediate oxidation if applied on bare metal. Vinyl acrylic latex or acrylic latex paints may be used as finish coats over alkyd rust-inhibitive primers, but if the primer coats are imperfectly applied or are damaged, the latex paint will cause oxidation of the iron. Therefore, alkyd finish coats are recommended.

High-performance coatings, such as zinc-rich primers containing zinc dust, and modern epoxy coatings, can be used on cast iron to provide longer-lasting protection. These coatings typically require highly clean surfaces and special application conditions which can be difficult to achieve in the field on large buildings (Fig. 13c). These coatings are used most effectively on elements which have been removed to a shop, or newly cast iron.

One particularly effective system has been first to coat commercially blast-cleaned iron with a zinc-rich primer, followed by an epoxy base coat, and two urethane finish coats. Some epoxy coatings can be used as primers on clean metal or applied to previously-painted surfaces in sound condition. Epoxies are particularly susceptible to degradation under ultraviolet radiation and must be protected by finish coats which are more resistant. There have been problems with epoxy paints which have been shop-applied to iron where the coatings have been nicked prior to installation. Field touching-up of epoxy paints is very difficult, if not impossible. This is a concern since iron exposed by imperfections in the base coat will be more likely to rust and more frequent maintenance will be required.

A key factor to take into account in selection of coatings is the variety of conditions on existing and new materials on a particular building or structure. One primer may be needed for surfaces with existing paint; another for newly cast, chemically stripped, or blast-cleaned cast iron; and a third for flashings or substitute materials; all three followed by compatible finish coats.

Application Methods

Brushing is the traditional and most effective technique for applying paint to cast iron. It provides good contact between the paint and the iron, as well as the effective filling of pits, cracks, and other blemishes in the metal. The use of spray guns to apply paint is economical, but does not always produce adequate and uniform coverage. For best results, airless sprayers should be used by skilled operators. To fully cover fine detailing and reach recesses, spraying of the primer coat, used in conjunction with brushing, may be effective.

Rollers should never be used for primer coat applications on metal, and are effective for subsequent coats only on large, flat areas. The appearance of spray-applied and roller-applied finish coats is not historically appropriate and should be avoided on areas such as storefronts which are viewed close at hand.

Caulking, Patching, and Mechanical Repairs

Most architectural cast iron is made of many small castings assembled by bolts or screws (Fig. 16a). Joints between pieces were caulked to prevent water from seeping in and causing rusting from the inside out. Historically, the seams were often caulked with white lead paste and sometimes backed with cotton or hemp rope; even the bolt and screw heads were caulked to protect them from the elements and to hide them from view. Although old caulking is sometimes found in good condition, it is typically crumbled from weathering, cracked from the structural settlement, or destroyed by mechanical cleaning. It is essential to replace deteriorated caulking to prevent water penetration. For good adhesion and performance, an architectural-grade polyurethane sealant or traditional white lead paste is preferred.

Water that penetrates the hollow parts of a cast-iron architectural element causes rust that may streak down over other architectural elements. The water may freeze, causing the ice to crack the cast iron. Cracks reduce the strength of the total cast-iron assembly and provide another point of entry for water. Thus, it is important that cracks be made weathertight by using caulks or fillers, depending on the width of the crack.

Filler compounds containing iron particles in an epoxy resin binder can be used to patch superficial, non-structural cracks and small defects in cast iron. The thermal expansion rate of epoxy resin alone is different from that of iron, requiring the addition of iron particles to ensure compatibility and to control shrinkage. Although the repaired piece of metal does not have the same strength as a homogeneous piece of iron, epoxy-repaired members do have some strength. Polyester-based putties, such as those used on auto bodies, are also acceptable fillers for small holes.

In rare instances, major cracks can be repaired by brazing or welding with special nickel-alloy welding rods. Brazing or welding of cast iron is very difficult to carry out in the field and should be undertaken only by very experienced welders.

In some cases, mechanical repairs can be made to cast iron using iron bars and screws or bolts. In extreme cases, deteriorated cast iron can be cut out and new cast iron spliced in place by welding or brazing. However, it is frequently less expensive to replace a deteriorated cast-iron section with a new casting rather than to splice or reinforce it. Cast-iron structural elements that have failed must either be reinforced with iron and steel or replaced entirely.

A wobbly cast-iron balustrade or railing can often be fixed by tightening all bolts and screws. Screws with stripped threads and seriously rusted bolts must be replaced. To compensate for corroded metal around the bolt or screw holes, new stainless steel bolts or screws with a larger diameter need to be used. In extreme cases, new holes may need to be tapped.

The internal voids of balusters, newel posts, statuary, and other elements should not be filled with concrete; it is an inappropriate treatment that causes further problems (Fig. 15). As the concrete cures, it shrinks, leaving a space between the concrete and cast iron. Water penetrating this space does not evaporate quickly, thus promoting further rusting. The corrosion of the iron is further accelerated by the alkaline nature of concrete. Where cast-iron elements have been previously filled with concrete, they need to be taken apart, the concrete and rust removed, and the interior surfaces primed and painted before the elements are reassembled.

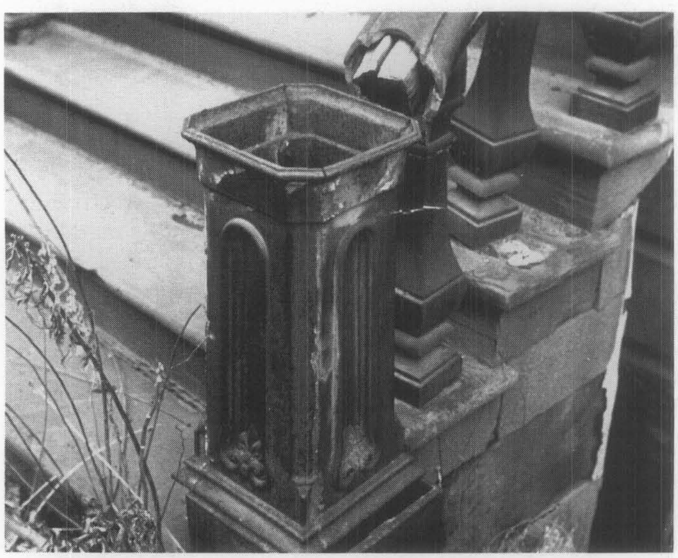

Fig. 15. In an effort to repair this stair railing, concrete was poured around the wood spacer inside the railing casting. Water penetrated the railing and reacted with the concrete to accelerate the corrosion of the iron. Photo: John G. Waite.

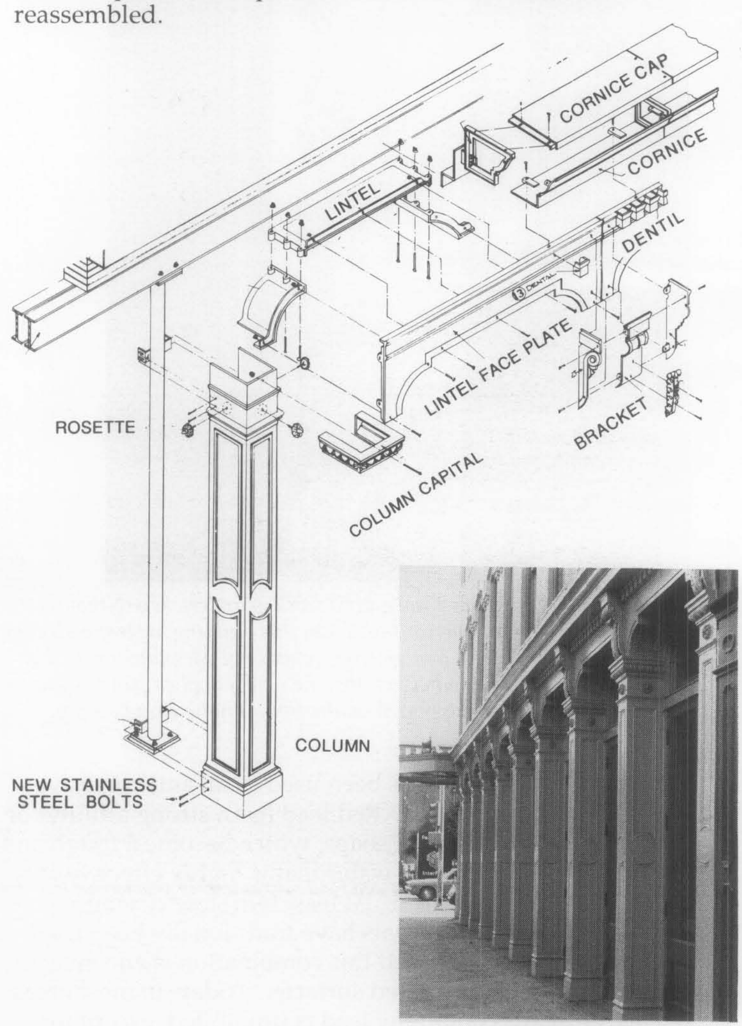

Fig. 16. Architectural cast iron is made of many small components bolted and screwed together. (a) This exploded view of a storefront illustrates the variety of elements, including brackets, fasteners, and holes for bolts. (b) The storefront was replicated in cast iron because of the extensive damage and structural failure, a detail of which is shown in Fig. 11. Drawing and photo: Historical Arts & Casting, Inc.

Duplication and Replacement

The replacement of cast-iron components is often the only practical solution when such features are missing, severely corroded, or damaged beyond repair, or where repairs would be only marginally useful in extending the functional life of an iron element (Fig. 16).

Sometimes it is possible to replace small, decorative, non-structural elements using intact sections of the original as a casting pattern. For large sections, new patterns of wood or plastic made slightly larger in size than the original will need to be made in order to compensate for the shrinkage of the iron during casting (cast iron shrinks approximately 1/8 inch per foot as it cools from a liquid into a solid). Occasionally, a matching replacement can be obtained from the existing catalogs of iron foundries. Small elements can be custom cast in iron at small local foundries, often at a cost comparable to substitute materials. Large elements and complex patterns will usually require the skills and facilities of a larger firm that specializes in replication.

The Casting Process

Architectural elements were traditionally cast in sand molds. The quality of the special sands used by foundries is extremely important; unlike most sands they must be moist. Foundries have their own formulas for sand and its admixtures, such as clay, which makes the sand cohesive even when the mold is turned upside down.

A two-part mold (with a top and a bottom, or cope and drag) is used for making a casting with relief on both sides, whereas an open-top mold produces a flat surface on one side (Fig. 17a). For hollow elements, a third pattern and mold are required for the void. Many hollow castings are made of two or more parts that are later bolted, screwed, or welded together, because of the difficulty of supporting an interior core between the top and bottom sand molds during the casting process.

The molding sand is compacted into flasks, or forms, around the pattern. The cope is then lifted off and the pattern is removed, leaving the imprint of the pattern in the small mold. Molten iron, heated to a temperature of approximately 2700 degrees Fahrenheit, is poured into the mold and then allowed to cool (Fig. 17b). The molds are then stripped from the casting; the tunnels to the mold (sprues) and risers that allowed release of air are cut off; and ragged edges (called "burrs") on the casting are ground smooth.

The castings are shop-primed to prevent rust, and laid out and preassembled at the foundry to ensure proper alignment and fit. When parts do not fit, the pieces are machined to remove irregularities caused by burrs, or are rejected and recast until all of the cast elements fit together properly. Most larger pieces then are taken apart before shipping to the job site, while some small ornamental parts may be left assembled.

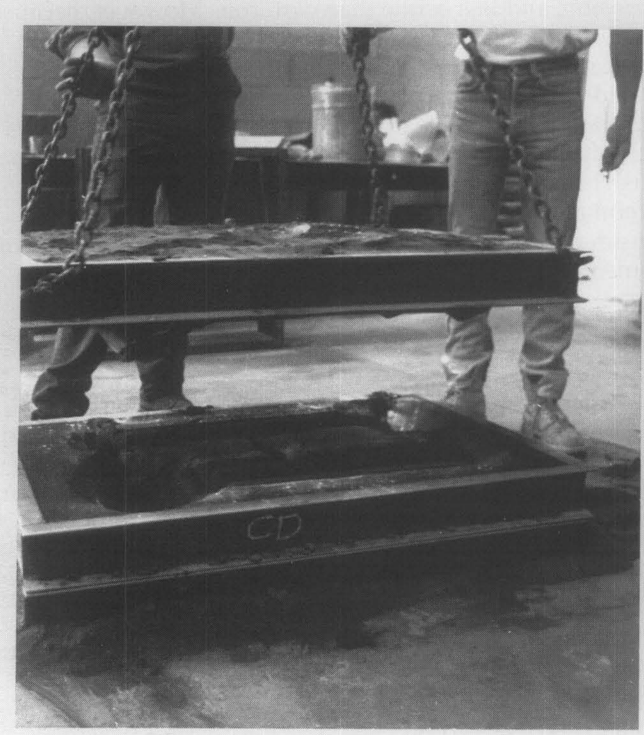

Fig. 17. (a) A two-part mold, consisting of a cope (top) and drag (bottom) for a newel post. Photo: Architectural Iron Company, Inc. (b) Molten iron being poured into a mold containing sand at a foundry. The iron casting process has changed little in the past two centuries. Photo: Karen Huebner.

Fig. 18. This cast-iron storefront cornice was corroded beyond the point of repair, and could not be removed easily for replacement. Terne-coated stainless steel, the most durable metal for flashing cast iron, was applied to the cornice and fitted as closely as possible to the historic profile. Although painting is not necessary to protect terne-coated stainless steel, the cornice should be painted to be consistent with the historic character of the building. A primer which is compatible with the terne coating should be used. Photo: Dean Koga, Robert E. Meadows, P.C., Architects.

Dismantling and Assembly of Architectural Components

It is sometimes necessary to dismantle all or part of a cast-iron structure during restoration, if repairs cannot be successfully carried out in place. Dismantling should be done only under the direction of a preservation architect or architectural conservator who is experienced with historic cast iron. Extreme care must be taken since cast iron is very brittle, especially in cold weather.

Dismantling should follow the reverse order of construction and re-erection should occur, as much as possible, in the exact order of original assembly. Each piece should be numbered and keyed to record drawings. When work must be carried out in cold weather, care needs to be taken to avoid fracturing the iron elements by uneven heating of the members.

Both new castings and reused pieces should be painted with a shop-applied prime coat on all surfaces. All of the components should be laid out and preassembled to make sure that the alignment and fit are proper. Many of the original bolts, nuts, and screws may have to be replaced with similar fasteners of stainless steel.

After assembly at the site, joints that were historically caulked should be filled with an architectural-grade polyurethane sealant or the traditional white lead paste White lead has the advantage of longevity, although its use is restricted in many areas.

Flashings

In some instances, it may be necessary to design and install flashings to protect areas vulnerable to water penetration. Flashings need to be designed and fabricated carefully so that they are effective, as well as unobtrusive in appearance. The most durable material for flashing iron is terne-coated stainless steel (Fig. 18). Other compatible materials are terne-coated steel and galvanized steel; however, these require more frequent maintenance and are less durable. Copper and lead-coated copper are not recommended for use as flashings in contact with cast iron because of galvanic corrosion problems. Galvanic problems can also occur with the use of aluminum if certain types of electrolytes are present.

Substitute Materials

In recent years, a number of metallic and non-metallic materials have been used as substitutes for cast iron, although they were not used historically with cast iron. The most common have been cast aluminum, epoxies, reinforced polyester (fiberglass), and glass fiber-reinforced concrete (GFRC). Factors to consider in using substitute materials are addressed in **Preservation Briefs 16**, which emphasizes that "every means of repairing deteriorating historic materials or replacing them with identical materials should be examined before turning to substitute materials."

Cast aluminum has been used recently as a substitute for cast iron, particularly for ornately-detailed decorative elements. Aluminum is lighter in weight, more resistant to corrosion, and less brittle than cast iron. However, because it is dissimilar from iron, its placement in contact with or near cast iron may result in galvanic corrosion, and thus should be avoided. Special care must be taken in the application of paint coatings, particularly in the field. It is often difficult to achieve a durable coating after the original finish has failed. Because aluminum is weaker than iron, careful analysis is required whenever aluminum is being considered as a replacement material for structural cast-iron elements.

Epoxies are two-part, thermo-setting, resinous materials which can be molded into virtually any form. When molded, the epoxy is usually mixed with fillers such as sand, glass balloons, or stone chips. Since it is not a metal, galvanic corrosion does not occur. When mixed with sand or stone, it is often termed epoxy concrete or polymer concrete, a misnomer because no cementitious materials are included. Epoxies are particularly effective for replicating small, ornamental sections of cast iron. Since it is not a metal, galvanic corrosion does not occur. Epoxy elements must have a protective coating to shield them from ultraviolet degradation. They are also flammable and cannot be used as substitutes for structural cast-iron elements.

Reinforced polyester, commonly known as ***fiberglass***, is often used as a lightweight substitute for historic materials, including cast iron, wood, and stone. In its most common form, fiberglass is a thin, rigid, laminate shell formed by pouring a polyester resin into a mold and then adding fiberglass for reinforcement. Like epoxies, fiberglass is non-

A

B

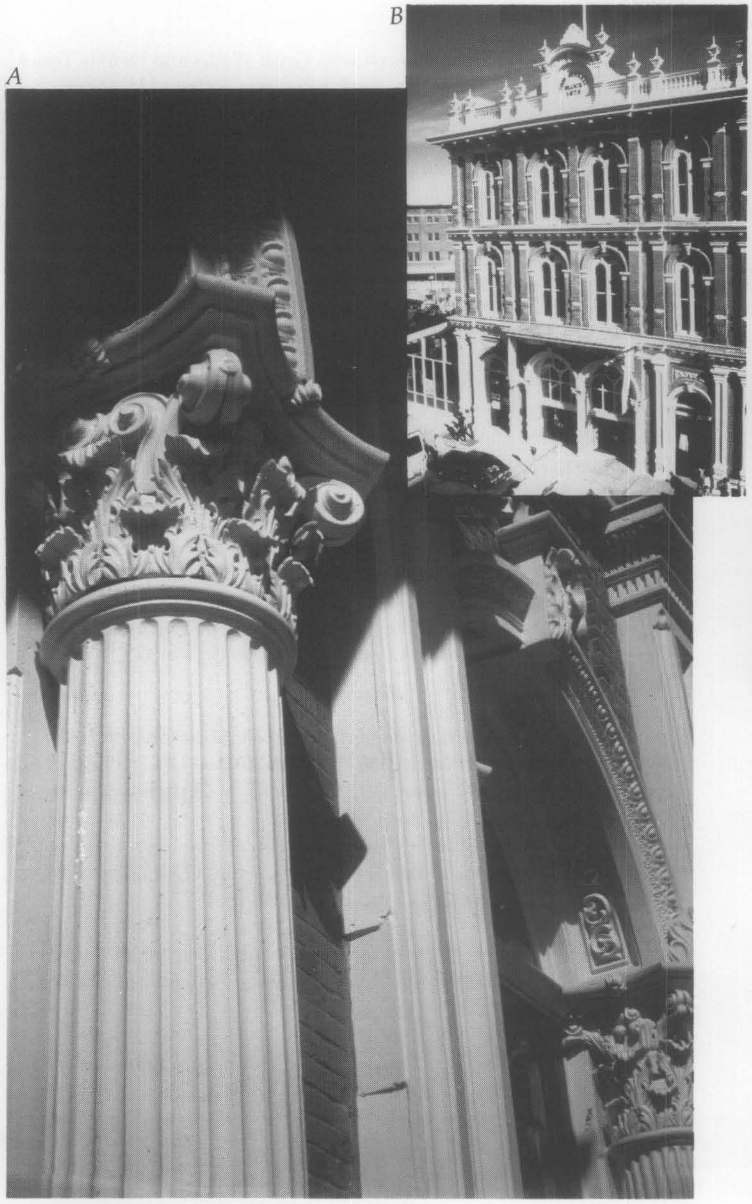

Fig. 19. (a) Fiberglass columns and aluminum capitals were installed to replicate the ornamental features on the east facade of the New Market Theater in Portland, Oregon, that had been destroyed by previous occupants. Like cast iron, crisp ornamental details can be achieved with cast aluminum. Although aluminum may be in contact with fiberglass, galvanic corrosion may result when aluminum is in direct contact with cast iron. Photo: William J. Hawkins, III. (b) The west facade of the theatre retains its original cast iron features. Photo: George McMath.

corrosive, but is susceptible to ultraviolet degradation. Because of its rather flimsy nature, it cannot be used as a substitute for structural elements, cannot be assembled like cast iron and usually requires a separate anchorage system. It is unsuitable for locations where it is susceptible to damage by impact (Fig. 20), and is also flammable.

Glass fiber-reinforced concrete, known as ***GFRC***, is similar to fiberglass except that a lightweight concrete is substituted for the resin. GFRC elements are generally fabricated as thin shell panels by spraying concrete into forms. Usually a separate framing and anchorage system is required. GFRC elements are lightweight, inexpensive, and weather resistant. Because GFRC has a low shrinkage co-efficient, molds can be made directly from historic elements.

Fig. 20. The location of the feature must be taken into account if a substitute replacement material is being considered. This lightweight fiberglass column at street level sustained damage from impact within a few years of installation. The great strength of cast iron makes it ideal for storefronts and elements that must withstand heavy use. Photo: Building Conservation Associates.

However, GFRC is very different physically and chemically from iron. If used adjacent to iron, it causes corrosion of the iron and will have a different moisture absorption rate. Also, it is not possible to achieve the crisp detail that is characteristic of cast iron.

Maintenance

A successful maintenance program is the key to the long-term preservation of architectural cast iron. Regular inspections and accurate record-keeping are essential. Biannual inspections, occurring ideally in the spring and fall, include the identification of major problems, such as missing elements and fractures, as well as minor items such as failed caulking, damaged paint, and surface dirt.

Records should be kept in the form of a permanent maintenance log which describes routine maintenance tasks and records the date a problem is first noted, when it was corrected, and the treatment method. Painting records are important for selecting compatible paints for touch-up and subsequent repainting. The location of the work and the type, manufacturer, and color of the paint should be noted in the log. The same information also should be assembled and recorded for caulking.

Superficial dirt can be washed off well-painted and caulked cast iron with low-pressure water. Non-ionic detergents may be used for the removal of heavy or tenacious dirt or stains, after testing to determine that they have no adverse effects on the painted surfaces. Thick grease deposits and residue can be removed by hand scraping. Water and detergents or non-caustic degreasing agents can be used to clean off the residue. Before repainting, oil and grease must be removed so that new coatings will adhere properly.

The primary purpose of the maintenance program is to control corrosion. As soon as rusting is noted, it should be carefully removed and the protective coating of the iron renewed in the affected area. Replacement of deteriorated caulking, and repair or replacement of failed flashings are also important preventive maintenance measures.

Summary

The successful conservation of cast-iron architectural elements and objects is dependent upon an accurate diagnosis of their condition and the problems affecting them, as well as the selection of appropriate repair, cleaning, and painting procedures. Frequently, it is necessary to undertake major repairs to individual elements and assemblies; in some cases badly damaged or missing components must be replicated. The long-term preservation of architectural cast iron is dependent upon both the undertaking of timely, appropriate repairs and the commitment to a regular schedule of maintenance.

Detail of polychromed cast-iron facade at 23 Petaluma Boulevard, Petaluma, Calif. (1886; O'Connell and Lewis, Architectural Iron Work, San Francisco). Photo: Don Meacham.

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33 PRESERVATION BRIEFS

The Preservation and Repair of Historic Stained and Leaded Glass

Neal A. Vogel and Rolf Achilles

National Park Service
U.S. Department of the Interior

Heritage Preservation Services

"Stained glass" can mean colored, painted or enameled glass, or glass tinted with true glass "stains." In this Brief the term refers to both colored and painted glass. "Leaded glass" refers generically to all glass assemblies held in place by lead, copper, or zinc cames. Because the construction, protection, and repair techniques of leaded glass units are similar, whether the glass itself is colored or clear, "stained glass" and "leaded glass" are used interchangeably throughout the text.

Glass is a highly versatile medium. In its molten state, it can be spun, blown, rolled, cast in any shape, and given any color. Once cooled, it can be polished, beveled, chipped, etched, engraved, or painted. Of all the decorative effects possible with glass, however, none is more impressive than "stained glass." Since the days of ancient Rome, stained glass in windows and other building elements has shaped and colored light in infinite ways.

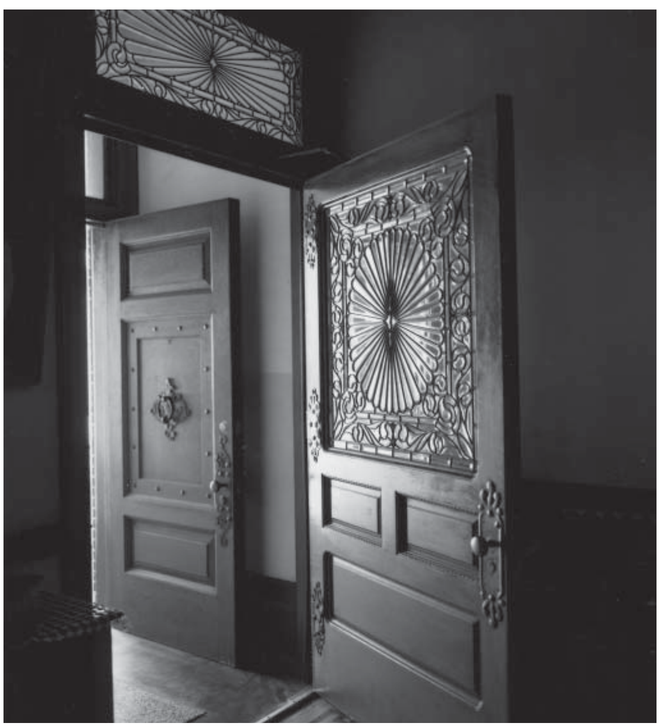


Figure 1. This door and transom suggest the richness of 19th century leaded glass. Photo: Jack E. Boucher, HABS.

Stained and leaded glass can be found throughout America in a dazzling variety of colors, patterns, and textures (Fig. 1). It appears in windows, doors, ceilings, fanlights, sidelights, light fixtures, and other glazed features found in historic buildings (Fig. 2). It appears in all building types and architectural styles—embellishing the light in a great cathedral, or adding a touch of decoration to the smallest rowhouse or bungalow. A number of notable churches, large mansions, civic buildings, and other prominent buildings boast windows or ceilings by LaFarge, Tiffany, Connick, or one of many other, lesser-known, American masters, but stained or leaded glass also appears as a prominent feature in great numbers of modest houses built between the Civil War and the Great Depression.

This Brief gives a short history of stained and leaded glass in America. It also surveys basic preservation and documentation issues facing owners of buildings with leaded glass. It addresses common causes of deterioration and presents repair, restoration, and protection options. It does not offer detailed advice on specific work treatments. Glass is one of the most durable, yet fragile building materials. While stained glass windows can last for centuries, as the great cathedrals of Europe attest, they can be instantly destroyed by vandals or by careless workmen. Extreme care must therefore be exercised, even in the most minor work. For this reason, virtually all repair or restoration work undertaken on stained and leaded glass must be done by professionals, whether the feature is a magnificent stained glass window or a clear, leaded glass storefront transom. Before undertaking any repair work, building owners or project managers should screen studios carefully, check references, inspect other projects, and require duplicate documentation of any work so that full records can be maintained. Consultants should be employed on major projects.

Historical Background

Glassblowers were among the founders of Jamestown in 1607, and early glass manufacturing was also attempted in 17th-century Boston and Philadelphia. Dutch colonists in the New Netherlands enjoyed painted oval or circular medallions that bore the family's coat of arms or illustrated Dutch proverbs. German colonists in the mid-Atlantic region also began early glass ventures. Despite the availability of good natural ingredients, each of these early American glassmakers eventually failed due to production and managerial difficulties. As a result, colonists imported most of their glass from England throughout the 17th and 18th centuries.

Social values as well as high costs also restricted the use of stained and other ornamental glass. This was particularly true with regard to churches. The Puritans, who settled New England, rejected the religious imagery of the Church of England, and built simple, unadorned churches with clear glass windows. Less than 1% of the Nation's stained and leaded glass predates 1700. Considering the enormous loss of 17th-, 18th-, and early 19th-century buildings, *any* window glass surviving from these periods is very significant (Fig. 3). Every effort should be made to document and preserve it.

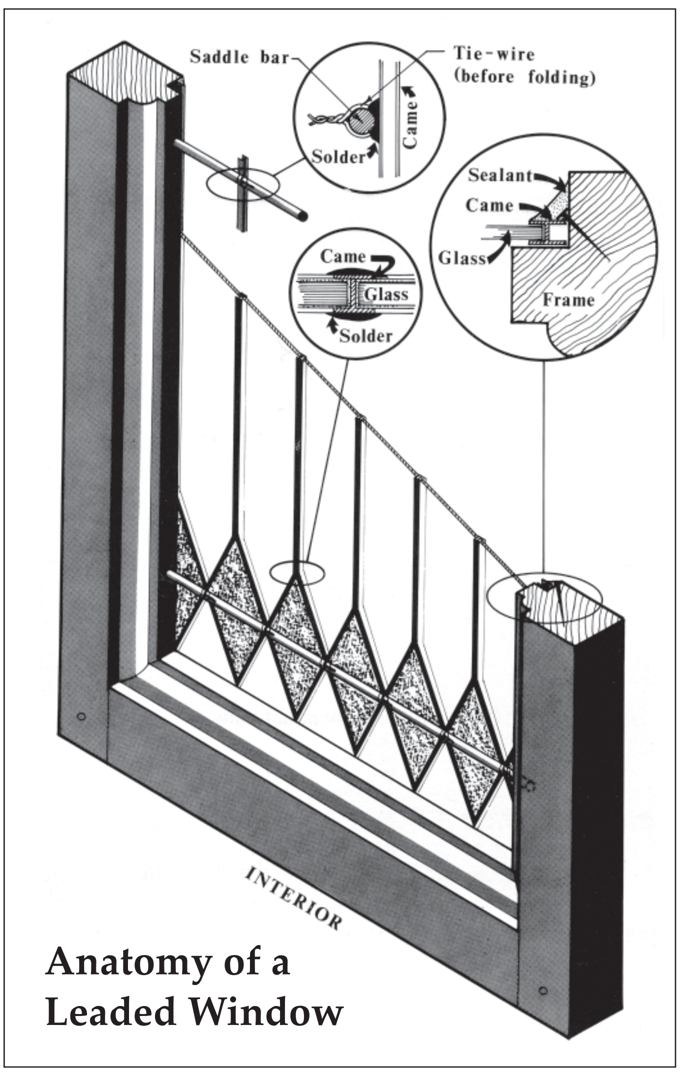


Figure 2. Components of a leaded glass window.

Figure 3. The entrance to the Morris-Jumel Mansion, New York City, is one of the earliest surviving installations of stained glass in the country. It features a fanlight and sidelights of large clear roundels and small bulls-eyes of red and orange glass tinted with silver stains from ca. 1810. Photo: Ken Moss.

Despite many failed starts, the War of 1812, and British competition, American glass production increased steadily throughout the 19th century. Stained glass was available on a very limited basis in America during the first quarter of the 19th century, but American stained glass did not really emerge in its own right until the 1840s. The windows at St. Ann and the Holy Trinity Episcopal Church in Brooklyn, New York, made by John and William Jay Bolton between 1843 and 1848, are perhaps the most significant early American stained glass installation (Fig. 4). Other important early stained glass commissions were the glass ceilings produced by the J. & G. H. Gibson Company of Philadelphia for the House and Senate chambers of the United States Capitol in 1859.

America's glass industry boomed during the second half of the 19th century. (And although stained and leaded glass is found nationwide, the manufacturing was based in the Northeast and Midwest, where good natural ingredients for glass, and coal reserves

Figure 4. The windows at St. Ann and the Holy Trinity Episcopal Church, Brooklyn, New York, were made between 1843-1849 by John and William Jay Bolton. Photo: Leland A. Cook.

for the kilns were available. Moreover, nearly all of the nationally renowned studios were based in major metropolitan areas of the central and northeastern states--near the manufacturers that supplied their raw materials.) In response to this growth, the industry formed self-regulating associations that established guidelines for business and production. In 1879 the Window Glass Association of America was established, and in 1903 The National Ornamental Glass Manufacturers' Association, precursor of the Stained Glass Association in America, was formed.

The 60 years from about 1870 to 1930 were the high point for stained glass in the U.S. In the early years, American stylistic demands reflected those current in Europe, including various historic revivals, and aesthetic and geometric patterns. American patterns prevailed thereafter; they tended to be more vivid, brash, and bold (Fig. 5).

After the 1893 Columbia World's Exposition, the Art Nouveau Style became the rage for windows. Sinuous nymphs, leggy maidens, whiplashed curves, lilies, and brambles became standard subjects until World War I. Among the leading proponents of the Art Nouveau Style were glassmakers John LaFarge and Louis Comfort Tiffany. Both men experimented independently throughout the 1870s to develop opalescent glass, which LaFarge was first to incorporate into his windows. Tiffany became the better-known, due in part to his prolific output.

He attracted world-class artists and innovative glassmakers to his studio. Today, "Tiffany" remains a household name. His favorite and most popular scenes were naturalistic images of flowers, colorful peacocks and cockatiels, and landscapes at sunrise and sunset (Fig. 6). LaFarge, while appreciated in his own day, gradually slid into relative obscurity, from which he has emerged in recent decades. Tiffany and LaFarge are the greatest names in American stained glass.

In dramatic contrast to the American Art Nouveau style was the Neo-Gothic movement that became so popular for church and university architecture across the country. Charles J. Connick was a leading designer of medieval-style windows characteristic of the style (Fig. 7).

Advocates of the Prairie Style, of whom Frank Lloyd Wright is the best known, rejected Tiffany's naturalistic scenes and Connick's Gothic imitations. (Fig. 8). Wright's rectilinear organic abstractions developed simultaneously with the similar aesthetic of the various European Secessionists. The creation of this style was aided by the development of zinc and copper cames in 1893. These cames—much stiffer than lead—made it possible to carry out the linear designs of Prairie School windows with fewer support bars. At first, these windows had only an elitist following, but they were soon widely accepted and proliferated during the early 20th century.

By 1900, stained and leaded glass was being mass-produced and was available to almost everyone. Leading home journals touted leaded glass windows for domestic use, and a nationwide building boom created an unprecedented demand for stained and leaded art glass windows, door panels, and transoms. Mail order catalogs from sash and blind companies appeared,

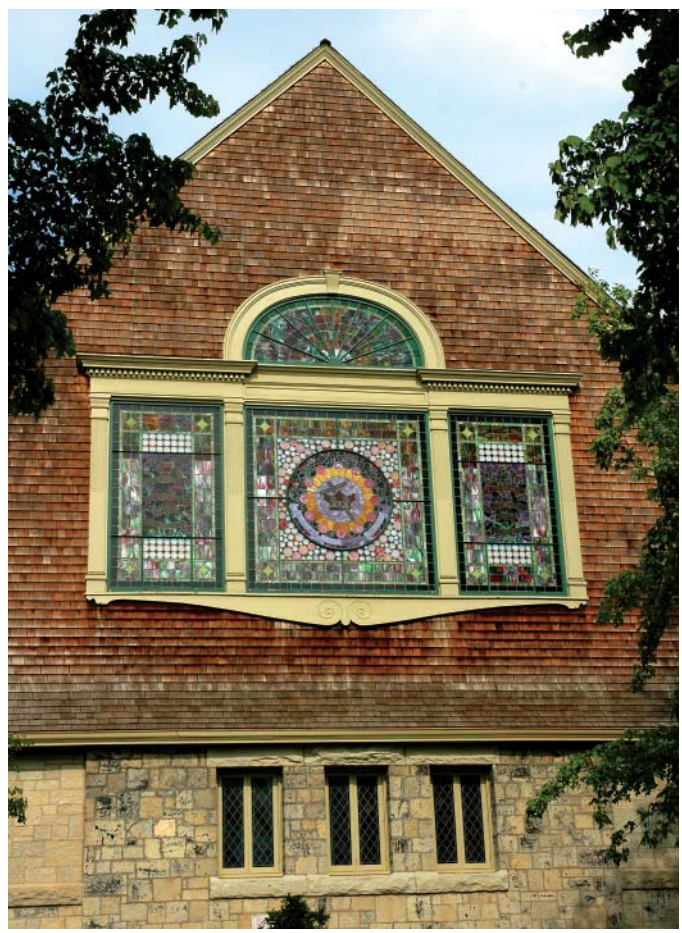


Figure 5. Stained glass is an exterior feature as well as an interior one. As part of any preservation project, stained glass should be photographed from the exterior as well as the interior.

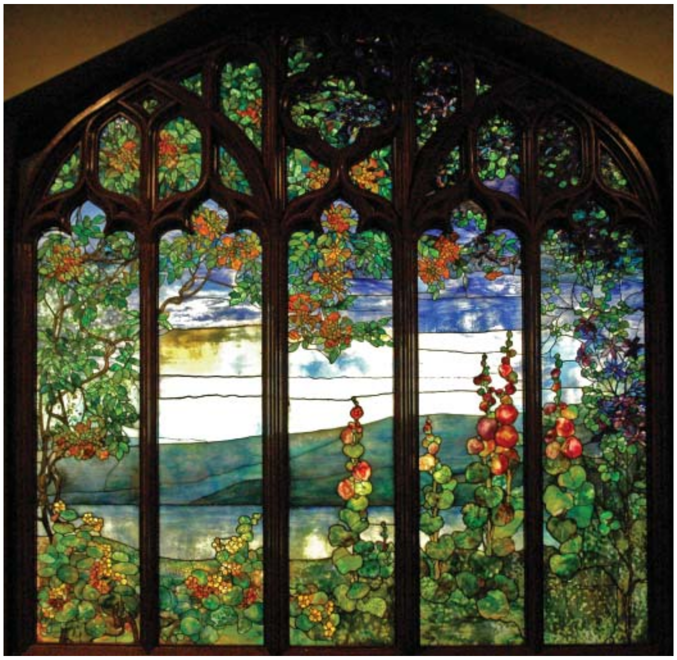


Figure 6. This 1907 landscape window is typical of those produced by Tiffany Studios. Characteristics include the use of opalescent glass, intricate leading and organic copper foil work, acid-etching, plating (i.e., several layers of glass), and a sense of perspective.

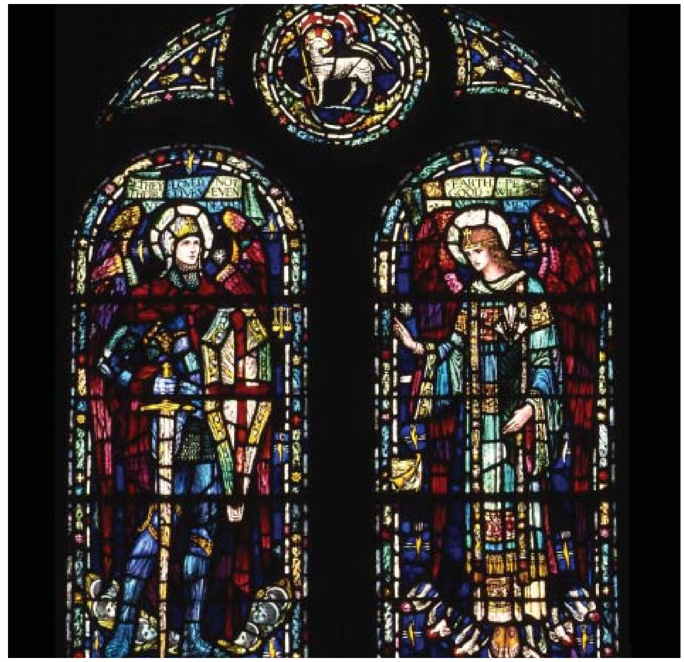


Figure 7. Charles J. Connick was another American master of stained glass. He worked in a modernized Neo-Gothic style. This window is from 1921. Photo: Diana Kincaid.

Figure 8. This 1902 window by Henry Webster Tomlinson reflects the Prairie School philosophy of providing ornamentation while retaining a view through the window.

some offering over 100 low-cost, mass produced designs (although the same catalogs assured buyers that their leaded glass was "made to order") (Fig. 9).

The fading popularity of the ornate Victorian styles, combined with inferior materials used for mass production, essentially eliminated the production of quality leaded glass. The last mail order catalogs featuring stained glass were published in the mid-1920s, and tastes changed to the point that the 1926 *House Beautiful Building Annual* declared: "the crude stained glass windows in many of the Mansard-roof mansions of the 'eighties [1880s] prove how dreadful glass can be when wrongly used."

Some creative efforts expanded leaded glass media in new directions. Lead-overlay or "silhouette" glass was one novelty that climaxed in the late 1920s and early 1930s. Some designers sandwiched glass between layers of hand-cut sheet lead, while others sandwiched the perforated sheet lead between layers of glass. These windows present a playful reversal from traditional stained glass; in "silhouette" glass the lead metalwork, rather than the glass, becomes the primary art form (Fig. 10). However, such novelties failed to catch on during the Depression. World War II delivered the final blow and ornamental glass is seldom found in residential, commercial, and secular architecture after circa 1940. The great age of American stained glass was over. Fortunately, leaded glass panels survived in uncounted numbers throughout the country, and are now once again appreciated as virtually irreplaceable features of historic buildings.

Figure 9. A typical mail-order catalog page of art glass windows available in 1903 from the E. L. Roberts Company, Chicago.

Dating and Documenting Historic Leaded Glass

Before deciding on any treatment for historic leaded glass, every effort should be made to understand—and to record—its history and composition. Documentation is strongly encouraged for significant windows. Assigning an accurate date, maker, and style to a stained glass window often requires extensive research and professional help. A documentation and recording project, however, is worth the effort and expense, as insurance against accidents, vandalism, fire and other disasters. The better the information available, the better the restoration can be. The following sources offer some guidelines for dating leaded windows.

Building Context. The history of the building can provide ready clues to the history of its leaded windows, doors, and other elements. The construction date, and dates of major additions and alterations, should be ascertained. Later building campaigns may have been a time for reglazing. This is especially the case with churches and temples. They were often built with openings glazed with simple or generic clear leaded glass. Stained glass was added later as finances allowed. Conversely, the windows may be earlier than the building. They may have been removed from one structure and installed in another (once again, this is more likely with religious structures). Bills, inventories, and other written documents often give clues to the date and composition of leaded glass. Religious congregations, fraternal lodges, historical societies and other preservation organizations may have written histories that can aid a researcher.

Inscriptions and Signatures. Many studios and artists affixed signature plates to their work—often at the lower right hand corner. In the case of Tiffany windows, the signature evolved through several distinct phases, and helps date the piece within a few years: *Tiffany Glass Company* (1886-1892), *Tiffany Glass & Decorating Company* (with address, 1892-1902), *Tiffany Studios New York* or *Louis C. Tiffany* (post 1902). (Tiffany Studios, like others, did not always sign pieces and the absence of an inscription cannot be used to rule out a particular studio or artist.) Windows may also feature dated plaques commemorating a donor. However, these do not always indicate the date of the window, since windows were often installed before a donor was found. Nevertheless, such marks help establish a reasonable date range.

Composition and Other Stylistic Elements. These elements are more subjective, and call for a fairly broad knowledge of architecture and art history. Do the windows fit the general style of the building? The style of the window may reflect a stylistic period (e.g., Arts & Crafts, Art Nouveau, Prairie School). The imagery or iconography of the windows may also reveal their overall historical context and establish a general time period.

Framing and Surround. Framing elements and the window surround can reveal information central to dating the window. Do moldings match other interior trim? Has the opening been altered? Is the window set in an iron frame (post-1850s), a steel frame (generally post-World War I), a cast stone or terra cotta frame (seen as early as the 1880s, but popular after 1900)?

Reinforcement and Leading Details. Does the window or other element have round bars or flat

Figure 10. This lead-silhouette stained glass face graces a 1928 coach house in Buffalo, and is attributed to D'Ascenzo Studios of Philadelphia.

The Importance of Context

Stained glass commissioned for a particular building was normally designed not only to reflect the shape of the opening but also to coordinate with other aspects of the overall setting such as the architectural style, adjacent materials, and interior decoration. The window opening, frame or sash colors, placement of the reinforcement, alignment with architectural elements, and orientation to natural light also establish the relationship between the stained glass and the building. The vibrant colors of opalescent glass, which can often be read from the exterior, and the linear designs of Prairie School windows, which often harmonize with both the interior and the exterior, are two examples that readily demonstrate the importance of architectural context to ornamental glass.

This important relationship between the glass and its setting, however, can be weakened or entirely lost over the years due to unsympathetic decorating schemes or building campaigns, damage, deterioration, inept repairs, or the mere accumulation of dirt.

Changes to the ornamentation and finish of the structural frame can have an especially pronounced effect on the overall appearance of a stained glass window or dome. In the Chicago Cultural Center dome the historic finishes of the ornamental cast iron frame have darkened considerably over the years, muting the dome's rich personality. In strong sunlight the glass is so dominant that the frame appears only as a silhouette. Restoring the vibrancy of the historic finish is necessary to recapture the equally important contribution of the frame to the original design intent of the dome. After careful investigation to document the historic appearance (right), a mock-up section of the frame was regilded with aluminum leaf (top). The dramatic effect of restoring the dome's overall context is readily apparent after only this small section of the frame was refinished.

bars? Flat bars began to appear about 1890; round bars, used since the Middle Ages, remained in use until the 1920s, when flat bars supplanted them. Cames can also give dating clues. Zinc cames, for example, developed by Chicago Metallic in association with Frank Lloyd Wright, first appeared in 1893. In general, however, dating a window by the came alone is difficult unless it is disassembled to view the "heart" (center web) for millmarks. Over one hundred varieties of lead came were available in the early 20th century. Moreover, came was sometimes produced to look old. Henderson's Antique Leading from the 1920s was made "to resemble the old hand wrought lead" and also carried "easy-fix" clip-on Georgian-style ornaments.

Glass. The glass itself can help in dating a window. Opalescent glass, for instance, was patented by John LaFarge in 1879. Tiffany patented two variations on LaFarge's technique in the same year. (Opalescent glass is translucent, with variegated colors resulting from internally refracted light. It features milky colored streaks.) Pre-1880 glass is usually smooth translucent colored glass (painted or not); glass with bold, deep colors is typical of the 1880s and 1890s, along with jewels, drapery glass and rippled glass. But such flamboyance faded out with the rest of Victoriana by about 1910. However, stained glass styles of the late 19th century continued to appear in ecclesiastical buildings after they passed from general fashion. Leaded beveled plate glass was popular in residential architecture after 1890, and was used profusely until the 1920s.

The level of documentation warranted depends upon the significance of the window, but it is very important to document repair and restoration projects before, during, and after project work. Photographs will normally suffice for most windows. For highly significant windows, rubbings as well as written documentation are recommended. The leading patterns in such windows are complex, particularly in plated windows (which have several layers). Rubbings are therefore encouraged for each layer when restored; they are invaluable if a disaster occurs and reconstruction is required. Annotated rubbings of the leadwork should be done with a wax stone on acid-free vellum.

To document windows properly, inscriptions should be recorded word for word, including misspellings, peculiarities in type style, and other details. Names and inscriptions in or on windows can indicate ethnic heritage, particularly in churches or civic structures where windows often reflect styles and themes from the congregation or community's origins. Lastly, any conjectural information should be clearly noted as such.

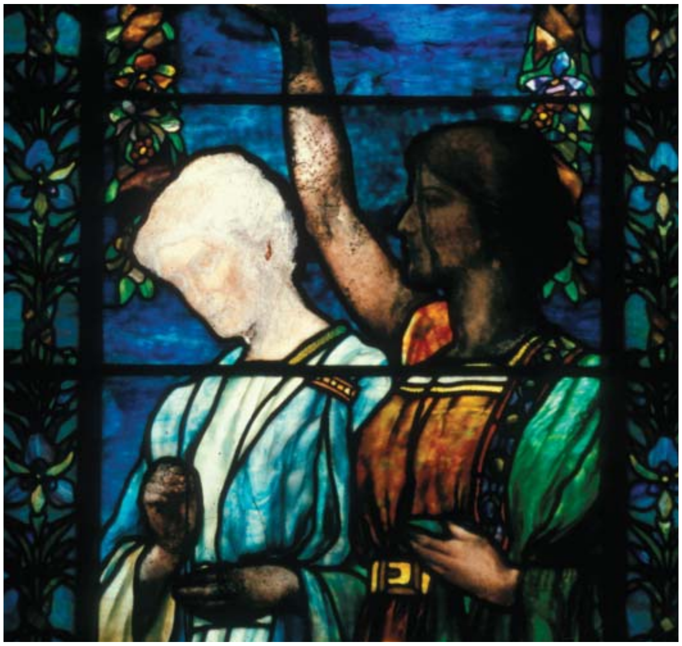


Figure 11. The face paint has failed substantially in the figure at the left. Ghost images of the feature are barely visible. Window (1903) by Edwin P. Sperry, glass by Tiffany Studios; "Old Main," (1891-1893) Illinois Institute of Technology, Chicago. Photo: Rolf Achilles.

Deterioration of Stained and Leaded Glass

Three elements of leaded glass units are prone to damage and deterioration: the glass itself; the decorative elements (mostly applied paint); and the structural system supporting the glass.

Glass Deterioration

Glass is virtually immune to natural deterioration. Most American glass is quite stable—due to changes in glass composition made in the mid-19th century, particularly the increased silica content and the use of soda lime instead of potash as a source of alkali. Rarely, however, glass impurities or poor processing can cause problems, such as minor *discoloration* or tiny internal fractures (particularly in opalescent glass). And all glass can be darkened by dirt; this can often be removed. However, while glass does not normally deteriorate, it is susceptible to *scratching* or *etching* by abrasion or chemicals, and to *breakage*.

The greatest cause of breakage or fracture is physical impact. Leaded glass in doors, sidelights, and low windows is particularly susceptible to breakage from accidents or vandalism. When set in operable doors or windows, leaded glass can crack or weaken from excessive force, vibration, and eventually even from normal use. Cracks can also result from improperly set nails or points that hold the window in the frame, or more rarely, by structural movement within the building. Leaded glass that is improperly annealed can crack on its own from internal stress. (Annealing is the process by which the heated glass is slowly cooled; the process is akin to tempering metal.) Glass can also disintegrate from chemical instability or the intense heat of a fire. Finally, windows assembled with long, narrow, angular pieces of glass are inherently prone to cracking. Often the cause of the cracks can be determined by the path they travel: cracks from impact typically radiate straight from the source. Stress cracks caused by heat or improper annealing will travel an irregular path and change direction sharply.

Deterioration of Painted Glass

Painted glass, typically associated with pictorial scenes and figures found in church windows, often presents serious preservation challenges. If fired improperly, or if poor quality mixtures were used, painted glass is especially vulnerable to weathering and condensation. Some studios were notorious for poorly fired paints (particularly those working with opalescent glass), while others had outstanding reputations for durable painted glass. Paints can be applied cold on the glass or fused in a kiln. Since they are produced from ground glass, enamels do not "fade," as often suggested, but rather flake off in particles. Several steps in the painting process can produce fragile paint that is susceptible to flaking. If applied too thick, the paint may not fuse properly to the glass, leaving small bubbles on the surface. This condition, sometimes called "frying," can also result from poor paint mixtures or retouching. Paint failure is more commonly caused by under firing (i.e., baking the glass either at too low a temperature or for too little time). Unfortunately, in American stained glass, the enamels used to simulate flesh tones were typically generated from several layers that were fired at too low a temperature. This means the most difficult features to replicate—faces, hands and feet—are often the first to flake away (Fig. 11).

Structural Deterioration

The greatest and the most common threat to leaded glass is deterioration of the skeletal structure that holds the glass. The structure consists of frame members, and lead or zinc (and occasionally brass or copper) came that secures individual pieces of glass. Frame members include wood sash and muntins that decay, steel t-bars and "saddle bars" that corrode, and terra cotta or stone tracery that can fracture and spall (Fig. 12). When frames fail, leaded glass sags and cracks due to insufficient bracing; it may even fall out from wind pressure or vibration.

Wood sash are nearly always used for residential windows and are common in many institutional windows as well. Left unprotected, wood and glazing compounds decay over time from moisture and exposure to sunlight—with or without protective storm glazing—allowing glass to fall out.

Figure 12. Stained glass frames are typically wood, steel or stone; however, other materials, and their inherent problems, can also be found as seen in this photograph of cracked terra cotta frames from 1926.

Steel frames and saddle bars (braces) corrode when not maintained, which accelerates the deterioration of the glazing compound and loosens the glass. Moreover, operable steel ventilators and windows are designed to tight tolerances. Neglect can lead to problems. Eventually, they either fail to close snugly or corrode completely shut. The leaded glass is then frequently reinstalled in aluminum window units, which require wider sections for equal strength and typically results in an inch or more of the glass border being trimmed. Instead of relocating glass in aluminum frames, historic steel frames should be repaired. Often the corrosion is superficial; frames in this condition need prepping, painting with a good zinc-enriched paint, and realigning in the frame.

Masonry frames typically last a long time with few problems, but removing leaded glass panels set in hardened putty or mortar can be nearly impossible; as a last resort, glass borders may have to be sacrificed to remove the window.

Occasionally, leaded glass was designed or fabricated with inadequate bracing; this results in bulging or bowing panels; leaded panels should generally not exceed 14 linear feet (4.25 m) around the perimeter without support. More often, the placement of bracing is adequate, but the tie-wires that attach the leaded panels to the primary frame may be broken or disconnected at the solder joints.

Lead and zinc cames are the two most common assembly materials used in stained and other "leaded" glass. The strength and durability of the leaded panel assembly depends upon the type of came, the quality of the craftsmanship, and the glazing concept or design, as well as on the metallic composition of the cames, their cross-section strength, how well they are joined and soldered, and the leading pattern within each panel. Came is prone to natural deterioration from weathering and from thermal expansion and contraction, which causes metal fatigue.

The inherent strength of the assembly system is also related to the cross-section, profile and internal construction of

Came Types and Properties

Lead Came
Lead is a soft malleable metal (it can be scratched with a fingernail). It naturally produces a protective dark bluish-gray patina. In the mid-19th century, improved smelting processes enabled manufacturers to extract valuable metal impurities from lead, thereby producing 100% pure lead came. The industry reasoned that 100% pure lead came was superior to the less pure variety. Although pure lead came is very workable and contributes to intricate designs, time has proven it to be less durable than medieval came, which contained trace elements of tin, copper, silver, and antimony. Unfortunately, the misconception that pure lead had greater longevity continued throughout the glory years of leaded glass use in America. Most glass conservators use a 100-year rule of thumb for the general life expectancy of 19th century came. In the 1970s, "restoration lead" (ASTM B29-84) was developed based on metallurgic analyses of medieval cames, some of which have lasted for centuries. Restoration lead should always be used when releading historic windows, unless the original integrity will be compromised.

Zinc Came
Zinc came is more vulnerable to atmospheric corrosion (particularly from sulfuric acids) than lead, but has proven to be durable in America because it weighs 40% less than lead and its coefficient of expansion is 7% lower. Thus, it is somewhat less susceptible to fatigue from expansion and contraction. Moreover, it is ten times harder than lead, and has three times the tensile strength. Zinc came is strong enough to be self-supporting and requires little bracing to interrupt the window's design. While zinc came is perfect for the geometric designs of Prairie School windows, it is usually too stiff to employ in curvilinear designs. Zinc can also take several finishes, including a copper or black finish. (As a result, zinc can be mistaken for copper or brass.)

Other Came
Other metals, primarily solid brass and copper, were also occasionally employed as came. They are generally found only in windows between ca. 1890 and ca. 1920. Frank Lloyd Wright started with zinc in 1893, was plating the zinc with copper by the late 1890s, and using solid copper by 1906.

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.

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.

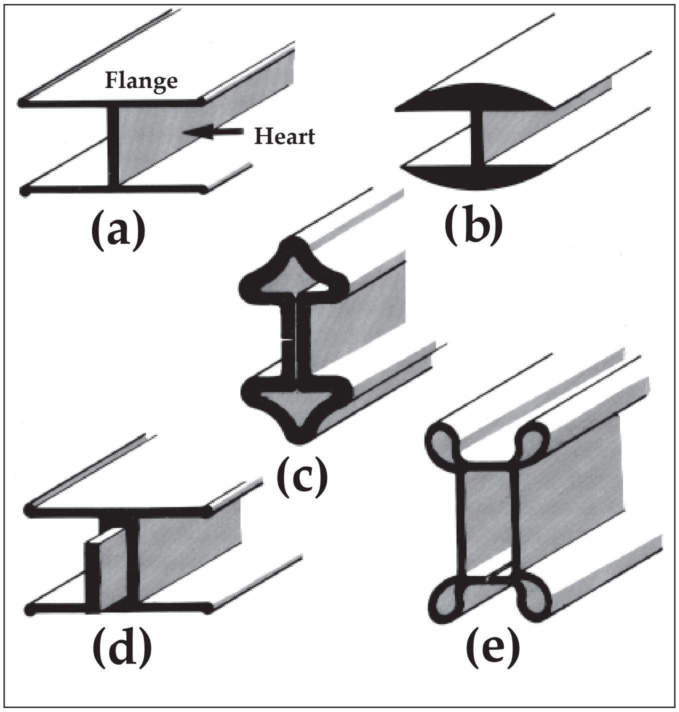


Figure 13. A wide variety of came has been used for ornamental glass in America: (a) flat lead came; (b) round lead came; (c) "Colonial" zinc came; (d) double-heart lead came with a steel core; (e) "Prairie School" zinc came.

Cleaning

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 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.

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

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

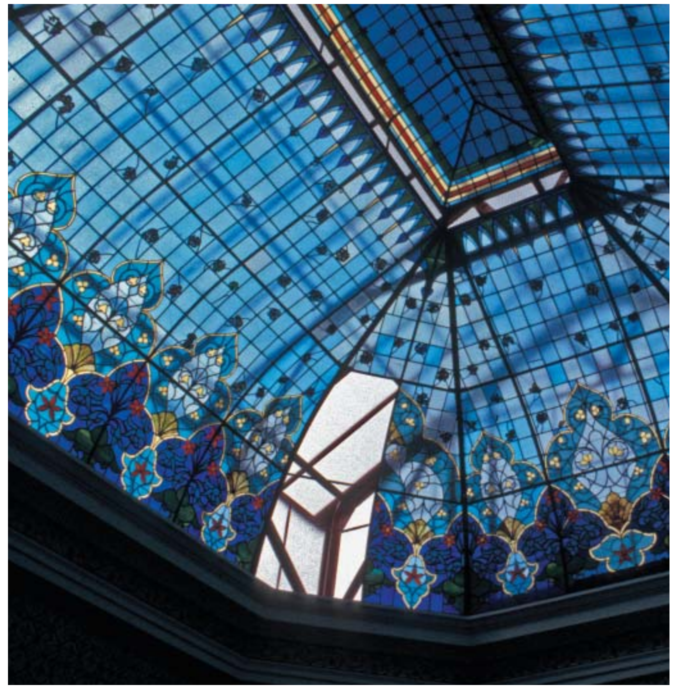
The use of protective glazing (also known as secondary or storm glazing) is controversial. Potential benefits of protective glazing are that it can shield windows from wind pressure; increase energy savings; protect against environmental pollutants and UV light; provide vandalism and security protection, 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.

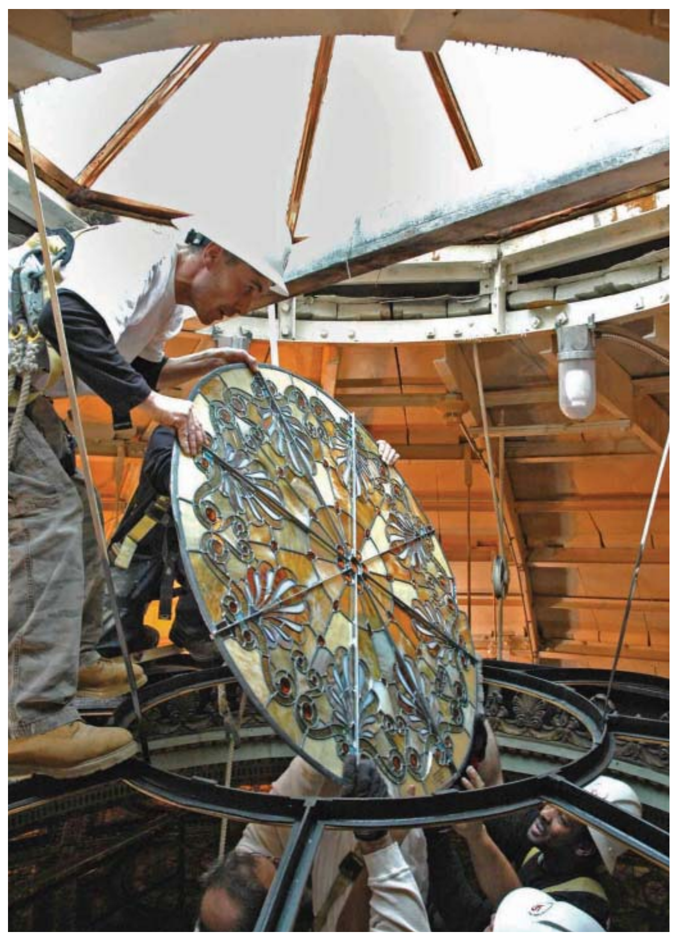
Moreover, stained glass in the horizontal position readily collects dust and dirt over the years and is relatively inaccessible for cleaning. It is also more likely to "creep" or slump when the reinforcement is inadequate. Most importantly, leaded glass cannot be sufficiently weatherproofed in a horizontal (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.

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.

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.

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).

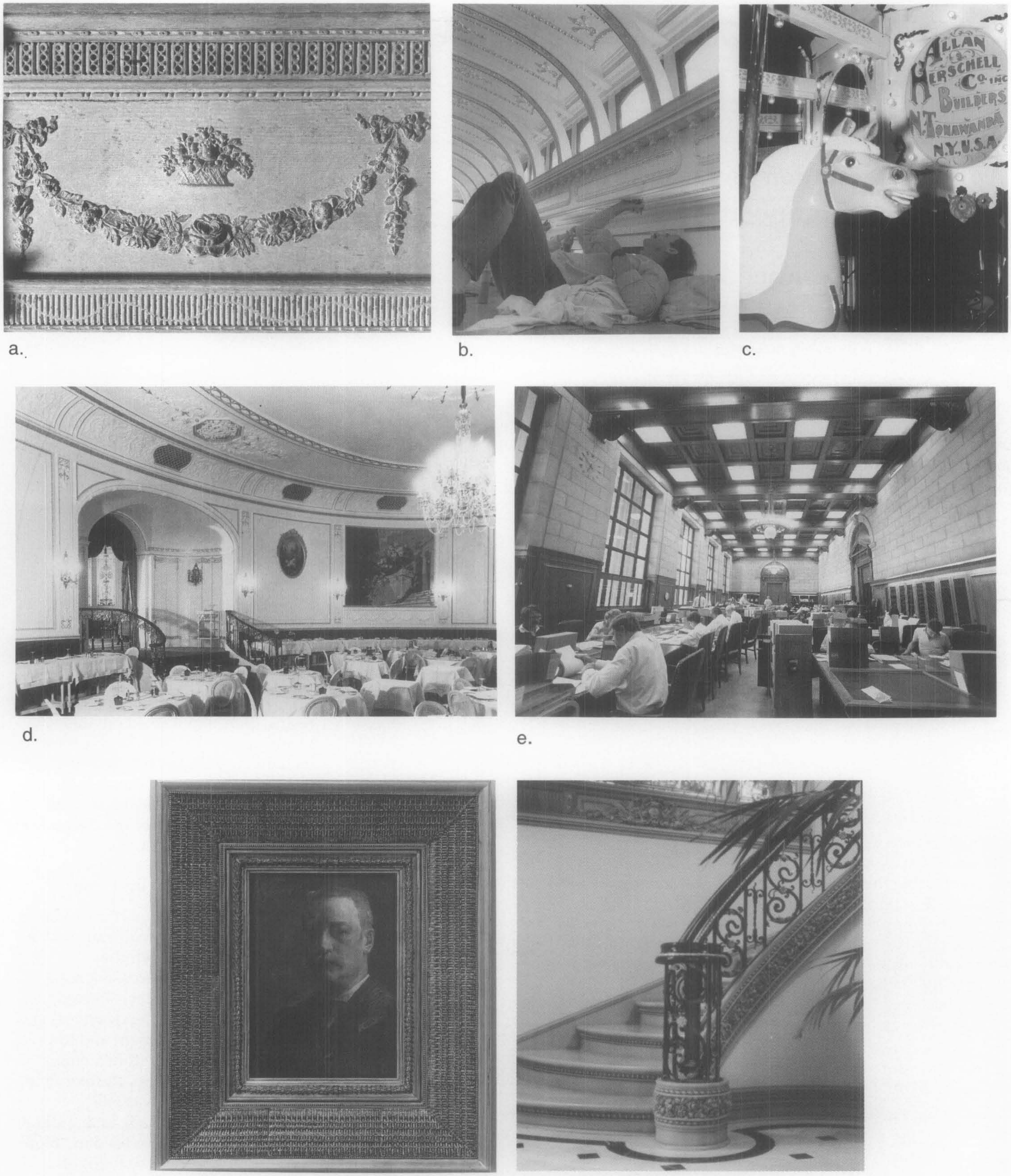

Figure 2. Composition ornament has been used in America for over two hundred years in a variety of applications: (a) a floral festoon and basket in the Adam style for an 1803 mantelpiece; (b) the social saloon of an 1866 steamship, S.S. China; (c) scenery panels on a 1916 Allan Herschell carrousel; (d) 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.

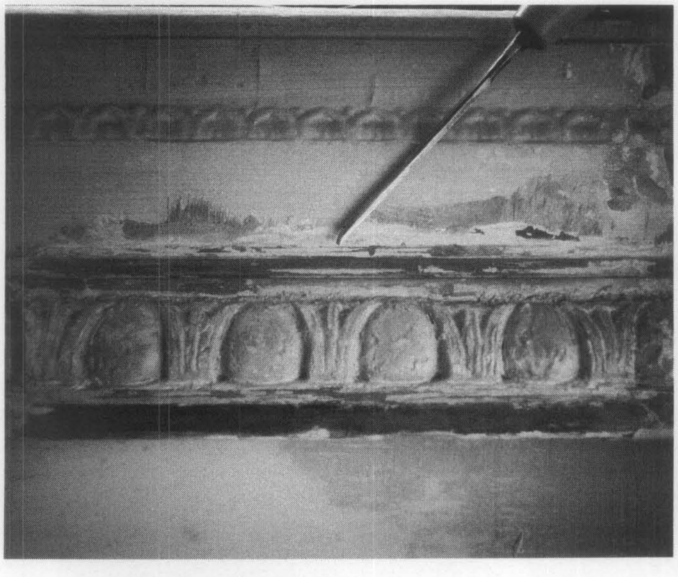

Figure 3. When this historic composition window surround was mistakenly identified as plaster, then treated with a caustic paint stripper, a section of it was destroyed. Photo: Byran Blundell.

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 eftablifhed 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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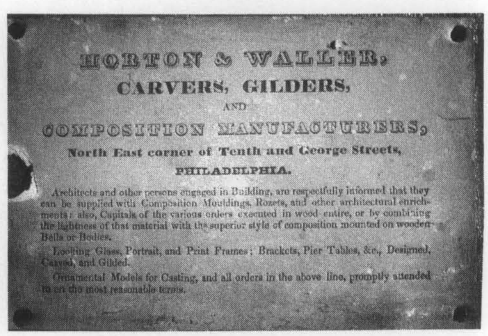


HORTON & WALLER,
CARVERS, GILDERS,
AND
COMPOSITION MANUFACTURERS,
North East corner of Tenth and George Streets,
PHILADELPHIA.

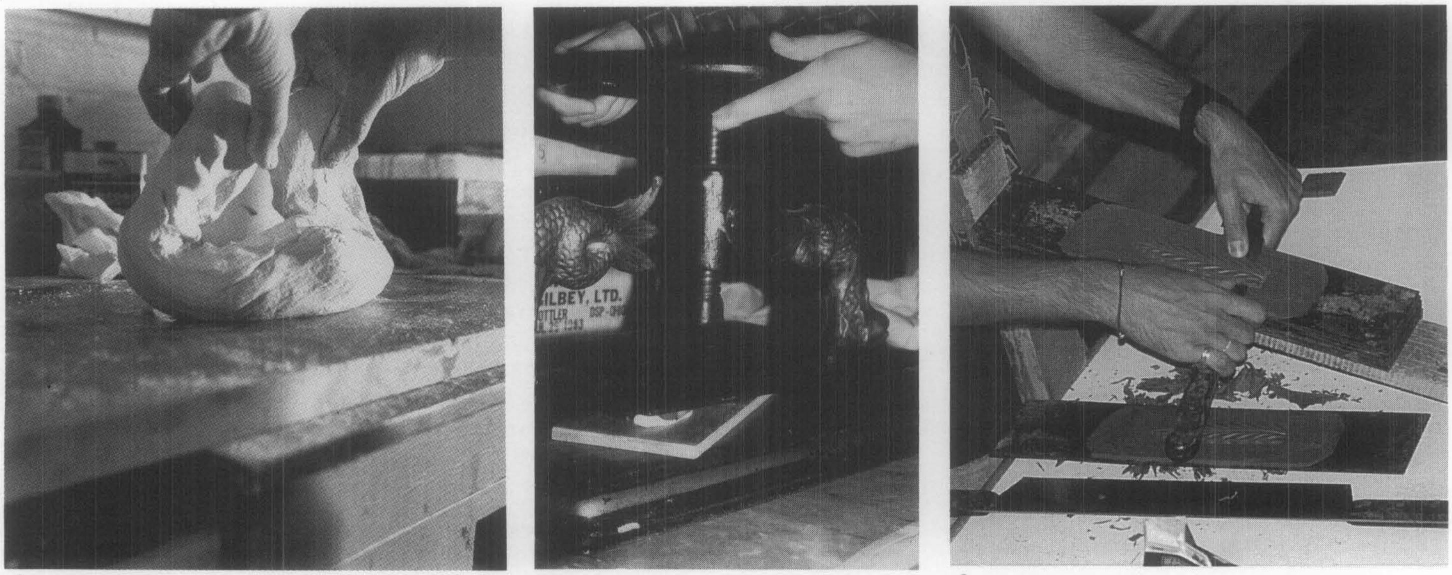
Architects and other persons engaged in Building, are respectfully informed that they can be supplied with Composition Mouldings, Rozets, and other architectural enrichments; also, Capitals of the various orders executed in wood entire, or by combining the lightness of that material with the superior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

a. b. c.



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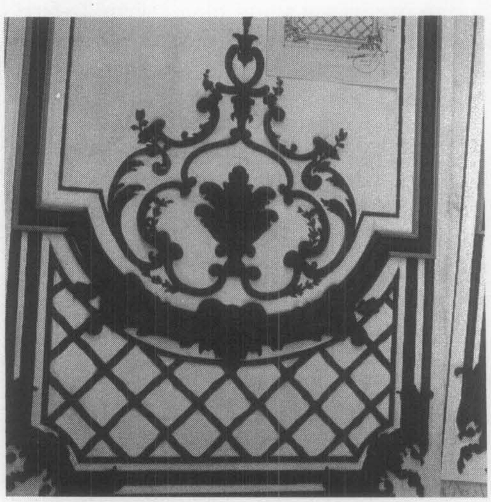

g.

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).

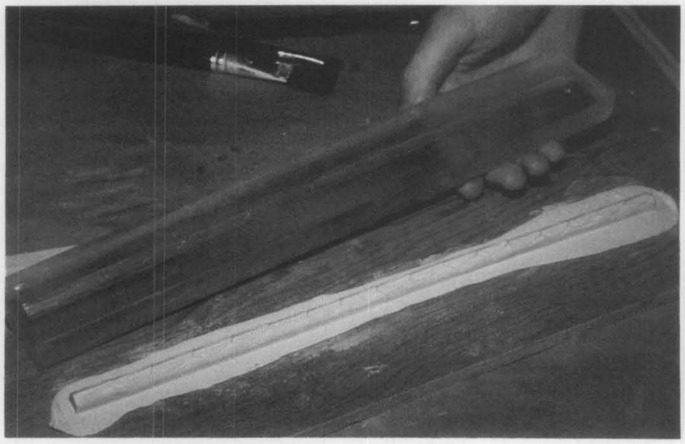

Figure 6. This finished length of compo molding is stuck to its pressing board. The newly made piece will be sliced off the board, then applied. Photo: Jonathan Thornton.

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.

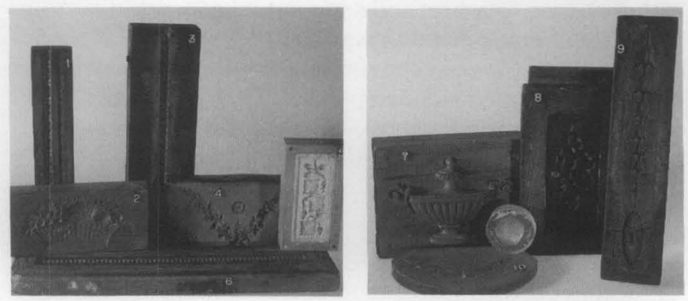

Figure 8. Several historic and reproduction compo molds are shown to underscore the variety of materials used to make them: 1. applewood mold 2. pearwood mold 3. boxwood mold encased in beech 4. boxwood mold 5. sulfur mold encased in maple 6. pewter mold encased in pine and oak 7. positive pattern for 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

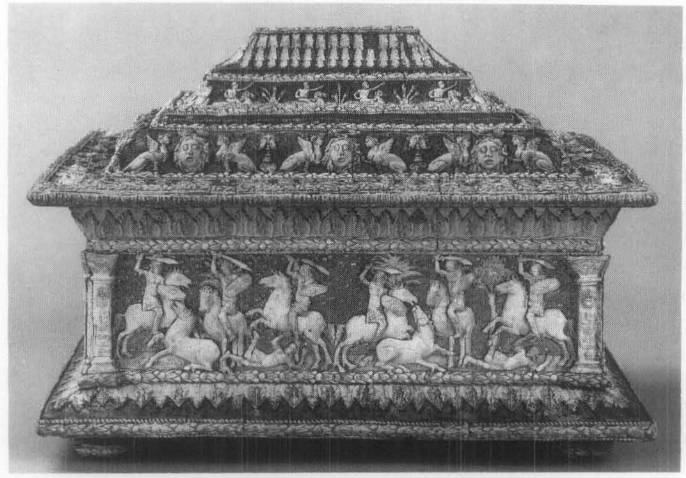

Figure 9. A 16th century pastiglia box from Italy features battle scenes from ancient Rome. Pastiglia was a forerunner of composition as we know it today, and one of a family of press-molded and applied interior ornamentation materials. Photo: Pastiglia Casket. White lead pastiglia decoration on gilt 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.

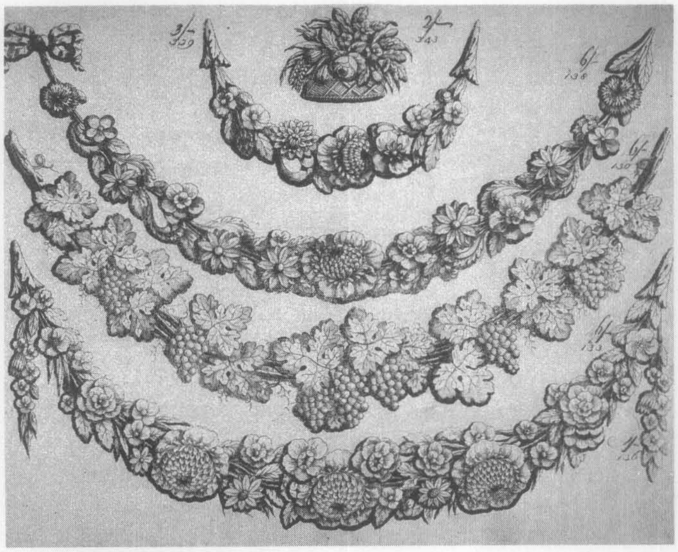

Figure 11. This page of festoon designs is from a Jaques catalog published in England and imported to America in the first decades of the 19th century. Note the similarity of these designs to those shown on the mantelpiece in Fig. 1. Photo: Courtesy, The Winterthur Library: Printed Book and Periodical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

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.

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 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