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TECHNICAL LEAFLET BUNDLE
A PUBLICATION OF THE AMERICAN ASSOCIATION FOR STATE AND LOCAL HISTORY

Historic House Restoration: Inside and Outside

BNDL009

So you have decided to restore a historic building. Do you need to learn more about the components of your building? Do you have enough information to work with your contractor? This bundle of technical leaflets includes information about lighting, wood, brick and stone, paint, and the landscape. This information is manageable and pertinent. You can apply what you read immediately to improve your understanding, planning, and probability of success.

TL 015 - Paint Color Research and Restoration (1968)
TL 077 - Wood Deterioration (1974)
TL 081 - Restoring Brick and Stone: Some Dos and Don'ts (1975)
TL 199 - Historic Landscapes and Gardens: Procedures for Restoration (1997)
TL 207 - Glass Fibre-Optics Lighting for Historic Buildings (1999)

technical leaflet

PAINT COLOR RESEARCH AND RESTORATION

By Penelope Hartshorne Batcheler
National Park Service

The National Park Service in its historic structures restoration program has developed some research techniques in the field of paint color. This short paper was prepared for a National Park Service Historic Structures Training Conference held in July, 1962. The paper was published as part of Technical Leaflet 15 in the December, 1963, issue of History News. *It has been revised, expanded, and put in the newer format presented here in the hope that it will continue to be of use to other restoration projects and will stimulate further contributions to these studies.*

There are no generalizations to follow for the choice of paint colors in restorations. Color fashions do change from period to period, but the restoration of each building should be studied and treated as individually as the people who gave the structure life.

In working with the buildings at Independence National Historical Park, some paint color research and restoration techniques have been developed. We are presenting them in the hope that they will be of use and that they will stimulate contributions from others.

PRESERVATION OF PAINT EVIDENCE

If for rehabilitation it is necessary to remove paint, sufficient evidence should be saved for immediate and future record. Sections of each architectural member and wall areas can be systematically marked off (i.e. in a vertical strip back of a door swing) and their location noted so that they can be painted over if desired. Or, sections of the wood or plaster plus the full layering of paint can be cut out, labeled and preserved. These samples need only be ± 1 inch square.

EXPOSING ACCUMULATED LAYERS, COLOR BY COLOR

With a surgical scalpel cut a shallow bevel through all the layers. With the sequence of colors in mind, begin exposing a limited area of each color down to the wood. This process is more easily done by removing a piece of wood and working at a table under a binocular microscope of 14X-60X, or good magnifying glass, for instance a linen tester (thread counter) or 6X. Care should be taken to expose each layer completely without damaging it.

DETERMINING FINISH COATS

Those layers which fracture off easily, do so because the layer below is apt to have been a finish coat and has a surface with accumulated dirt. This same surface dirt can be spotted by making a cross section slide of the paint and wood. Under a microscope of ± 60X the dirt appears as a dark line between the coats of paint. Cross sections are made by mounting pieces of wood plus paint in paraffin. A cross section vise and microtome knife are used to shave down a smooth surface across the grain of wood and paint layers. The resulting cross section is then mounted on a glass slide.

Woodwork was often primed with a coat made up predominantly of medium. The pigment of a primer was usually the cheapest available, often red iron oxide or a light grey made with white lead and lamp black. Such a coat can be recognized in cross section by its deep penetration in the pores of the wood, and by the lack of a dirt layer between it and the finish coat. Finish glazes of graining layers are also easily discernible by a layer of transparent varnish with some pigment content.

DATING PAINT LAYERS

If it is not possible to date color layers through documentary or architectural evidence, their own pigment characteristics can sometimes help. The hand ground pigments of early paints have non uniform-size particles. A modern paint in contrast has very fine and uniform particles, if not a chemical dye. Many pigments are natural, and the origin of most more than predate the settling of America. Typical of these are cochineal, vermilions, the iron oxides (ochre, sienna, umber, and red iron oxide), Prussian blue, smalts and verditers, lamp black, bone black, white lead, gold and silver.

Some pigments are of relatively recent development. By their presence, they can be helpful in dating the application of the paint. Titanium, for instance, has been in commercial production only since 1916-1919, Viridian green since 1860, zinc since 1850, cadmium yellow since 1846, ultramarine blue since 1830, and chrome yellow since 1818. The laboratories of commercial paint companies have been very cooperative in testing pigment types.

For a listing of pigments, their dates, characteristics, and some tests to which they will react, see Rutherford J. Gettens and George L. Stout, *Painting Materials* (New York: Dover Publications, 1966). Pigment slides for observation of color and size under a microscope of 75X, 150X, and 300X are made by scraping particles of a particular paint layer onto a glass slide. Break up the lumps of paint into smaller particles. Cover with a drop of Canada Balsam to bind the particles to the glass, and carefully add a glass cover. For chemical tests, deposit the scraped paint lumps onto the slide, break these up and test them directly.

DETERMINING MEDIUMS

Painting Materials, by Gettens and Stout, contains full descriptions of the properties of all mediums. In the historic house painting, oil mediums are usually used in painting woodwork, and whitewash or casein mediums are used on plasterwork or woodwork of utility spaces. To distinguish between these two mediums, drop a fragment of the paint into a solution of muriatic acid. Whitewash or casein mediums will totally dissolve in the acid solution, but there will be no effect on oil medium paints.

HOW TO RECOGNIZE PAINT REMOVAL

If on the flat surface of woodwork there are fewer paint layers than in the crevices of adjacent moldings, carvings, or on hard-to-reach surfaces, then there is a strong possibility that there has been paint removal. To confirm this, look for signs of either scorch marks on the wood or its adjacent plaster; pock marks in the remaining paint resulting from heat or chemical action of the remover; or dried remover in the form of a brown powdery layer usually found where it would have been easy for a workman to forget to wash it off.

FINDING EVIDENCE OF PAINT REMOVAL

Check all cracks, carvings, accumulations of dripped paint where one member seats

Equipment used in the examination of paint evidence.

upon another; check dents in woodwork where old paint still remains in the indentation beneath putty infill; and check behind partition or shelving additions. Minute as the evidence found is apt to be, a binocular microscope (14X-60X) will aid in ascertaining layering sequences and in matching the colors.

MATCHING COLORS FOR RESTORATION

Paints may, through time, have visually lost their medium content. To make the pigments optically refract the light correctly, the surface can be treated with a thin layer of acryloid, i.e., replacing the lost medium. There are some pigments which are fugitive. It may be that in one room you will find a variation in the same color. It would be reasonable to suspect that the brighter of these would be the one to match. Conversely, if some pigments are known to darken, the lighter samples would be the ones to copy.

If a large enough area of the desired color can be exposed (with any discolored surface cleaned off), a painter can match the new color directly from this area.

For accuracy in future maintenance, a written record of the paint colors found can be provided by matching the paint evidence to a color notation system. The Munsell Color Book (Munsell Color Company, 2441 North Calvert Street, Baltimore, Maryland, 21218) has charts with removable colored chips which are extremely handy, not only for matching large areas, but when in difficult positions such as matching cornice mouldings when standing on a step ladder, or for matching small quantities of paint under a microscope (14X-60X).

The Munsell color system provides a quick and accurate process of notation. If the desired color falls between the notations of the standard chart, an estimate can be made in the numerical difference of hue, value, or chroma. Or, a fragment of the original paint can be sent to the Munsell Company where, for a fee, they will provide an exact numerical notation of the desired color, and will, as well, provide the degree of matt or gloss finish.

If the original samples are too small for the contracting painters to match with their naked eye, the Munsell Company colored chips and large loose sheets of matt-glossy colors provide an accurate sample to guide the painters.

In mixing to match a dry color, brush test samples on glass (for quick drying) and allow to dry before comparing. When the desired color is achieved, the large quantity should be mixed to match the wet sample of the approved color. Remember, in mixing the large quantity, to use pigments of the same manufacture. The same pigments made by two different companies can vary widely.

PAINT FORMULAS TO US

Depending upon the desired effect and characteristics, paint types to be used in restorations will vary. For the interior woodwork of Independence Hall, the requisites were to have a paint which would be good for the wood, provide a degree of ropiness (brush marks) to emulate eighteenth century paint surfaces, have a semi-gloss surface, and have a surface to which additional paint coats would adhere.

To ensure the adherence of additional paint coats, we used a mixture over which we had control and which could be noted for use in all future repaintings. The formula used was essentially what would have been used in the eighteenth century. It had a medium of raw linseed oil, a thinner of turpentine, some Japan drier, and a predominant pigment of white lead. With the addition of tinting pigments which would have been available in the eighteenth century, we feel this restoration of paint is as faithful as could be achieved.

Maintenance may be an important factor. A dirt resistant and washable modern manufactured paint may be a preferable choice. Or, a clear epoxy coating should be considered to cover surfaces which are subject to the worst wear.

If it is deemed impractical to restore an interior plaster wall with its original whitewash finish, the National Park Service has simulated this finish by using a flat white paint containing a stippling compound (silica) to create the ropiness which whitewash usually has. Before this flat white paint can be applied to a wall which presently has whitewash layers, a water-soluble glue size must be applied first, followed by the primer sealer and then the finish paint coat.

Penelope Hartshorne Batcheler was author of the Paint Color Research and Restoration section of the first edition of Technical Leaflet 15 which also treated Nail Chronology as an Aid to Dating Old Buildings by Lee H. Nelson. The nail chronology section has been revised and expanded and will be published in a separate Technical Leaflet. Mrs. Batcheler is an architect with the National Park Service's Office of Archaeology and Historic Preservation, branch of restorations.

To Anne F. Clapp, who until 1960 was preservation specialist of the museum branch of the National Park Service, the author is most grateful for an introduction to the methods of cross sectioning and making pigment tests, and her generosity in sharing her knowledge of paint. The author is indebted to her also for setting up a laboratory of the necessary microscopes, cross sectioning tools, and other equipment required in paint color research.

TECHNICAL LEAFLET 15

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technical leaflet

WOOD DETERIORATION:

causes, detection & prevention

By William Merrill
Pennsylvania State University

Wood, like all organic materials, is degraded and destroyed by microbial organisms. While this degradation is desirable for decomposing plant debris and disposing of soil waste, it is very undesirable when one is concerned with preserving buildings, tools, and other wooden artifacts of man. The fungi that gradually reduce a fallen tree into a rich brown humus devour with equal gusto the sills and roofs of privies and palaces, covered wagons and Model-T Fords, the hangman's gallows, and other structures and implements peculiar to man's societies.

Because of wood decay there are relatively few wood relics from ancient times. Only wood kept continuously dry or submerged in water will last for thousands of years. Even given those conditions, few historic remains exist: for example, the furniture and other wooden materials placed in the ancient Egyptian tombs; the pilings of the so-called Swiss Lake Dwellers that date back to about 1900 B.C.; and the wrecks of numerous ships, some of which date back to ancient Rome. Since it is impractical to keep wood completely dry or submerged in water, we are constantly faced with the deterioration of wood.

Knowing the causes of wood decay can help you preserve historic structures and wood appurtenances on your grounds. Many historical societies have in their care fences or dock facilities—even wooden tombstones, old automobiles and farm equipment, railroad cars and boats with wooden parts—in addition to buildings. Artifacts of wood inside your museum-house are subject to similar deterioration, although this leaflet concentrates on exterior decay. Described are some of the major signs of wood deterioration, ways to prevent or control it, and where to go for further guidance.

CONDITIONS FOR DETERIORATION

Most wood degradation is caused by various species of fungi, although in some circumstances, particularly in water, bacterial decay also occurs. Fungi are lower plants; they are undifferentiated into stems, roots, or leaves, and they lack chlorophyll. They reproduce by means of minute spores that usually are wind-borne and are normal constituents of the atmosphere both inside and outside of buildings. Thus, organisms that can cause wood deterioration are always present.

Two conditions are necessary for wood to deteriorate: (1) suitable temperature, and (2) suitable moisture content. Since many species of wood-deteriorating fungi can grow in temperatures ranging from around 33° to 107° F, the climate in most

areas is conducive to deterioration during many months. Thus the limiting factor governing deterioration usually is moisture.

Wood will not deteriorate when its moisture content is below fiber saturation point, which is between 20 and 27 percent of its air dry weight depending upon the species. Once the moisture content of the wood is above 25 percent, decay can develop rapidly. In some climates, up to a 90 percent loss in wood strength may occur within three months.

In atmospheres with high relative humidities, wood will absorb water and will reach the fiber saturation point when 100 percent RH is reached. Dry wood placed in such areas will gradually absorb enough water for decay to begin.

Once the wood-destroying fungi begin to decay the wood, they reduce it to water and carbon dioxide. For each gram of wood consumed, 0.56 grams of water are produced. So once the wood has become wet enough for the decay process to begin, the fungi will maintain the wood in a wet condition, particularly in areas with poor ventilation or during periods of the year when the relative humidity is high enough to prevent rapid drying. Thus, ventilation can be a third factor controlling the amount and rate of decay.

TYPES OF WOOD DETERIORATION

Surface mold, commonly called mildew, usually occurs on wood which has been wet for a period of time. The fungi form a spore mass, often loose and powdery, on the surface of the material; colors range from pink to various shades of green, blue-gray, brown, or black. Such fungi normally exist only on extraneous materials which have been spilled on the wood or on sugars or starches stored in the sapwood. Some may also grow on the resin in coniferous wood. These same fungi commonly cause deterioration of historical materials such as books, newspapers, and wallpaper. Although these fungi disintegrate paper products, they do little damage to solid wood products other than discoloring them. Such wood often must be painted to hide the discoloration.

Bluestain is very similar to surface mold except that these fungi penetrate deeply into some wood, particularly sapwood, growing preferentially in the rays. They cause little or no strength loss in coniferous wood since they do not attack its substance, although some loss of strength occurs in hardwoods which have been stained for an extended period of time. Although the main damage to the wood is discoloration, badly stained wood becomes more porous and soaks up liquids faster than sound wood.

Bluestain develops on cut or dead trees, on piled lumber, or even on boards that become wet and remain wet for a few days. At temperatures of 68° to 86° F the strain can develop extremely rapidly. In buildings you will find bluestain around moisture sources, such as water pipes or sink and bathroom fixtures, or where wood is exposed to rain, particularly older wooden window sash. Wooden artifacts stored in damp basements also may develop bluestain.

Soft rot, another important type of wood deterioration, is a decay of the surface layers of wood and seldom extends deeper than a few millimeters. It is most commonly discovered in wood that is either completely saturated with water for extended periods of time, or in wood that has been alternately wet and dry. Look for soft rot in posts, poles, pilings, wooden boats, shingles, window sash, and shutters; or joints in railings, steps, and stairways; and even occasionally in trim boards.

When dry, wood with soft rot usually looks blackened and scaly, as though slightly charred. As the wood weathers away or is mechanically abraded from the surface, the decay progresses deeper. The soft-rot fungi are important because, unlike the higher wood-rotting fungi, they can withstand long periods of desiccation or saturation. In addition, they are much more tolerant of commonly used wood preservatives than true wood-rotting fungi.

True wood-rotting fungi normally form fruiting bodies such as gilled mushrooms or the pored, bracket-shaped bodies commonly encountered on decaying trees and logs in the forest. These include white-rot and brown-rot fungi.

The white-rot fungi normally leave the wood in a fibrous or stringy bleached condition. They digest microscopic holes through the cell walls of the wood fibers, consuming both the cellulose and lignin from wood, and eventually reducing it to water and carbon dioxide. Usually they break the wood down at about the same

Advanced soft rot in oak framing from the whaler *Charles W. Morgan*. When dry, the wood appears charred, and small pieces flake off. (In other instances soft-rotted wood may appear only a "weathered" gray.) Microscope examination usually is required to confirm soft rot. Since this type of decay is a surface phenomenon, the wood retains much of its original strength.

rate as they consume it, causing a more or less straight-line relationship between decay and strength loss.

In contrast, the brown-rot fungi leave the wood with a brown, crumbly appearance; the decayed wood is quite soft, and breaks easily across the grain; when dry, it distintegrates into small chunks much like charcoal. These fungi have a highly active cellulose digesting system, and break the wood down at a much higher rate than they consume it. The solubility of the wood rapidly increases; with very small amounts of decay, up to 90 percent wood strength can be lost.

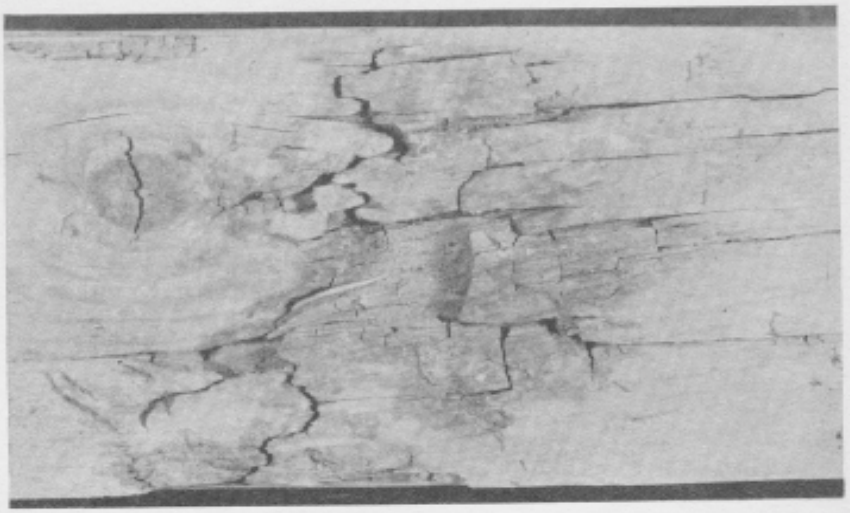
Water-conducting rot, unlike most decay fungi, does not require moist wood. The two major kinds are *Merulius lacrymans,* the so-called "house fungus" of Europe, and *Poria incrassata*, common in the southern United States. These two fungi form water-conducting strands with which they transport water for some distance, wet the wood, and then decay it. Since *Merulius* is a serious problem in Europe, some countries have strict laws regulating the sale of buildings where it is established. The fungus also has been collected in scattered parts of North America. It is detected often only after substantial damage has occurred.

DETERIORATION IN OLD HOUSES

All exterior wood exposed to the elements, and hence to deterioration by microorganisms, will eventually have to be replaced. Preserving historic buildings thus entails periodic close examination of the entire building and frequent, detailed examination of danger points. The following guidelines will help you discover decay before it spreads. Then you can replace the decaying materials and try to eliminate the moisture problem that has led to the decay. If this requires undesirable modification of the building, continual examination, replacement, and restoration of affected areas is essential.

One of the main danger points is the roof. Most modern roofing materials have a guaranteed life, which normally ranges from about 15 to 25 years. When that time has elapsed you must replace it. Begin by determining what kind of roofing you have. Life expectancy of a roof with wood shingles or shakes depends upon your locality, the kind of wood used, and shingle exposure (their orientation with respect to prevailing winds and storms). In New England, for example, the average life expectancy of cedar shingles is 50 to 75 years. Pine shingles last a considerably shorter time.

The visible parts of the shingles gradually weather away. Exposed to alternating freezing and thawing, shrinking and swelling, wetting and drying, the wood constituents are broken down into soluble forms and are leached away. Simultaneously these fibers are attacked by soft-rotting fungi. Because shingles are tapered their thickness is reduced until, at the point where the next row overlaps, the shingles completely weather away or are broken off during storms. Examine wooden shingles periodically. When the exposed butts of the shingles have lost about half of their original thickness, they should be replaced. If storms are severe and frequent, expect to replace them sooner.



Advanced brown cubical rot in a pine board from the sub-flooring under a bathtub. Note that as brown-rotted wood dries, it shrinks and cracks across the grain into small cubes, much like charcoal. The wood usually will have a tan to brown coloration, noticeably darker than that of sound wood. Strength loss is almost total.

Another danger point is around the flashing at the edges and valleys of the roof. In northern climates ice and snow often accumulate here, creating dams that allow water to back up under the shingles. Water may back up past the edge of the flashing and seep down into the ceilings, walls, and eaves. Roof gutters also cause problems. Ice often forms here, creating a dam which may back water up past the edge of the flashing.

Often these danger points are not noticed unless the water seeps through the ceiling, in and around windows, or around the soffit. Substantial decay can occur with no visible symptoms. If you notice peeling or blistering paint around the soffit, then you have a moisture problem whose origin should be discovered and corrected. If the gutters become a problem, either remove them or place an electric heating tape in them during the winter.

Building exteriors normally last many decades without major replacements. You should check to see if sufficient roof overhang exists to prevent water from running down the side of the building where it can seep in around the ends of the clapboards, corner trim, or door and window casings. Other danger spots include wooden steps, outside stairways, porch railings, and ornate gingerbread trim. These have numerous joints into which moisture can seep, causing decay. Especially in the South water collects behind them and lack of ventilation causes the wood to remain wet for a long time. Detecting this type of decay is difficult, so plan on thorough periodic inspection. Often you will not notice it until the paint starts to blister, the wood becomes crumbly, or fruiting bodies of the fungus develop on the exterior.

Rustic log cabins and similar structures have problems, particularly in corners where the logs overlap. Neatly dovetailed joints present less of a hazard than the so-called "pig-pen" joint where one log laps over the other and protrudes for some distance beyond. Water flows into such joints, and the corners of the building may rot away long before the rest of the building begins to decay. The exposed ends of these logs often bear the fruiting structures of wood-rotting fungi. Serious decay in such joints may require a complete rebuilding of the structure. Brush-on water-repellent preservatives such as pentachlorophenol, applied every few years, greatly reduce the amount of decay in such structures. So does yearly maintenance to replace cracked or missing caulking around windows and door casings.

To dispel a myth, *paint is not a preservative*. An unbroken film of paint will prevent the underlying wood from absorbing moisture, but at the same time once water has seeped in through a crack, paint seals the moisture in and prevents the wood from drying out. Any peeling or blistering of exterior paint indicates a moisture problem. Either moisture is accumulating from the outside or, more often, moisture has migrated from the inside of the house through the walls toward the outside. The source of the moisture must be determined and corrected. In some cases it may be necessary to install vapor barriers to prevent moisture migration.

The underside of a house is another high-

hazard area, especially the sills, joists, and flooring. Sills or headers resting on a foundation should be at least eight inches above the soil line. The land around the building should be graded so that at least eight inches of foundation are exposed and it slopes away from the house on all sides. If the building has a basement, you should aerate it to reduce humidity and its corollary decay hazard. Houses shut up for several years are especially decay-prone.

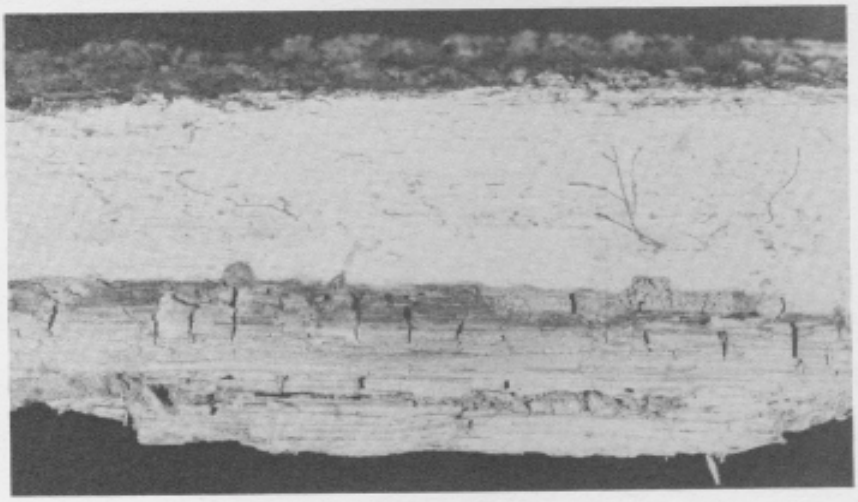
Decay in the floor joists often is not visible to the naked eye. Joists with a thin shell of sound wood may be completely decomposed internally. You can detect this decay by using a sharp pen-knife blade or an ice pick; indeed, this is one of the first tools a building inspector should equip himself with. Stick the blade or pick into the wood and note the distance and ease with which it penetrates. If the joist has only a thin shell of sound wood and is decayed inside, the knife will easily pass into the wood for an inch or more. It is difficult to penetrate sound wood with the blade. This is only a qualitative procedure however; it helps you determine if advanced decay is present, but does not detect the beginning stages.

Basements should be equipped with a floor drain to remove water that may accumulate during rainy periods. You can correct water seepage with some of the new epoxy compounds. If the building has a crawl space, moisture can condense on the floor joists and sills and lead to rapid decay. Cover the soil in the crawl space with polyethylene sheeting or with roll asphalt roofing. Look for water condensation on sewer or plumbing pipes too, particularly during hot humid weather when they are colder than the surrounding air. You may have to wrap the pipes with insulation to prevent this condensation.

Within the building major danger points occur around sinks and bathroom fixtures. Water leaking down behind counter tops or bathtubs can accumulate in unventilated areas leading to rapid decay that will require substantial reconstruction. Caulk around sinks and tubs whenever you notice leaks. Some of the new silicone rubber compounds are excellent sealing agents, but are themselves subject to staining by surface mold. You must replace them periodically. Also examine the grouting in the tile around sinks, tubs, and showers for signs of leaks or mold. If the house has a removable panel (often hidden in a linen closet) to allow repair of tub fixtures, check this area.

Another danger point is the connection between the commode and the pipe. Often this joint develops a slow leak that is not obvious. Water seeps into the floor or underneath the tile. You will not notice the decay until the tiling peels up or the floor begins to sag under your weight. Such decay often leads to substantial reconstruction costs.

Wooden window sash also is prone to decay, particularly in the North. During cold weather moisture from inside the building condenses on the window panes and runs down onto the sash, often supporting a luxurious growth of mold and staining fungi, and eventually the growth of soft-rot fungi. Considerable moisture can cause deterioration within 4 to 5 years. Most modern window sash is treated with



Part of a barn sill which had been partially buried in soil and manure. Upper portion has white rot; lower portion, brown cubical rot. Note that while the brown-rotted wood has shrunk and cracked across the grain, the white-rotted portion has retained its original dimensions and merely appears bleached. Black strands of fungi permeate the white-rotted wood. Although the brown-rotted portion has lost most of its strength, the white-rotted portion retains about 50 percent of its original strength.

a water-repellent wood preservative. But if the new sash is custom made, or if you are using the old sash, treat it with a preservative such as pentachlorophenol.

Restoration requires removing and replacing stained wood. Moisture problems which lead to decay, roof leaks, or poor seals resulting in seepage around doors, windows, and trim should be corrected during restoration. If you plan to exhibit out-of-doors, treat replacement wood.

DECAY OF APPURTENANCES

Untreated *fence posts and telephone poles* last only a few years in the ground before they succumb to decay. The fungi frequently involved are brown-rot fungi, although in some instances white rot does develop, particularly in hardwood fence posts. You can extend their life and prevent deterioration by treating the posts or poles either with pentachlorophenol, pentachlorophenol and coal tar mixtures, or with other wood preservatives. For home treatment of fence posts, consult the numerous government publications on hot and cold soak methods. State agricultural experiment station bulletins often report the longevity of treated and untreated fence posts in your area.

Because wood preservatives penetrate only a relatively short distance into the wood, and then usually only into the sapwood, total preservation of posts and poles is impossible. After the wood drys, it often cracks, allowing entrance through the protected zone. Rot develops inside these poles. Treated poles and posts usually rot off at the ground line, primarily due to the activities of the soft-rot fungi. These fungi tend to be more tolerant of commonly used wood preservatives than are the brown-rot or white-rot fungi.

Post and rail fences, particularly those with holes drilled through them, can decay from water that accumulates and soaks the wood below the holes. They should be constructed either of pressure-treated wood or of a decay-resistant species such as redwood or black locust. Decay from water seepage in joints is a problem in built-up fences, such as some rustic picket or stockade types. Even fences made of cedar may decay rapidly if the cedar consists primarily of sapwood with little resistant heartwood in it. Because no sapwood species is resistant, this so-called "decay resistant cedar fencing" may last only a short time.

Untreated *railroad ties* have a life expectancy of 8 to 10 years. Treated railroad ties have a life expectancy of between 30 and 40 years, according to the area of the country in which they are used. Decay usually is of the soft-rot or brown-rot type, although occasionally in hardwood ties you will encounter white rot. Preservatives such as coal tar-creosote mixtures are usually applied.

Marine piling represents another major preservation problem because of the diversity of organisms involved. Wood is placed in a wet environment so that even the portions out of water often are wet for long periods of time and hence are susceptible to soft rot, brown rot, and white rot. In addition, the portions submerged in water between high and low tide are subject to attack both by marine fungi which cause soft rot and by various wood-boring animals. This decay can be controlled by professional pressure treatment with coal tar-creosote mixtures.

Wood pulp, paper products, and composite products—including books, cardboard boxes, the cardboard coating on both sides of gypsum building boards, wallpaper in houses, and fiber building boards—are subject to a rapid attack by staining fungi and also by many of the soft-rot fungi. The paper is discolored and often is partially consumed so that it becomes brittle.

In gypsum building boards this can be a serious problem. The moisture build-up in the paper causes moisture to collect in the gypsum board itself. Wall materials sometimes support a luxurious mold growth coming through the paint and causing problems in repair and repainting.

Deterioration of books and magazines in libraries and archives is also a major problem, particularly in papers sized with starch and books with vegetable- or animal-based glues in the covers and bindings. You can control this type of deterioration by keeping the storage area between 50 and 65 percent relative humidity, or at less than fiber-saturation point (65% RH).

Fiber building boards, books, and manuscripts also are subject to decay by brown- and white-rotting fungi if a major moisture problem exists in the building. Roofs made of fiber building boards have failed within three years of construction, necessitating

a complete rebuilding of a portion of the building. If this happens, you must immediately correct the moisture build-up in the fiber products. Unfortunately, improper construction practices, structural defects, or improper designs are by no means rare!

Many historic sites have *wooden boats and ships* that are subject to deterioration. High hazard points include the framing in the bow and stern of the vessel and, if there is water in the bilges, the keelson, lower portions of the frame, and the keel itself if the exterior planking is below the water line.

In smaller boats, such as row boats or small sailing craft, soft rot often occurs in the planking as well as in framing members. However, the most common type of deterioration is brown rot in the stem, stern, and gunwales, often starting around the oar locks in the case of row boats. In some sailing boats decay begins in the trunk around the center board.

This type of decay can be prevented by having the materials pressure treated with a paintable pentachlorophenol mixture. For small craft the members can be soaked in a water-repellent pentachlorophenol mixture after they have been cut to size and all machining has been done.

Old automobiles and trucks commonly have extensive decay in the roof slats and the wooden framing in the doors, body, and seats. Little is known about this decay, except that it is usually of the brown-rot type.

Brown-rot fungi also contribute to the destruction of *old wooden bridges and trains*. Microscope examination would probably reveal the presence of soft-rot fungi as well. When restoring old covered bridges or wooden trains you will encounter the same problems as those in a building. Once more a tight roof is your first priority. Check the planking also, because water seepage and condensation lead to decay of both the planking and the supporting stringers. You can usually find fruiting structures of the decay fungi here. Preservative-treated wood should be used in the main structural members and floor planking.

CONTROLLING DETERIORATION

Since the primary factor leading to wood deterioration is moisture, the best control is to dry the wood and keep it dry. In areas where moisture is a hazard, treat the wood with a brush-on application of a preservative such as pentachlorophenol. When you find decayed wood in a building, replace it with treated wood. Examine surrounding wood for the presence of decay and, when in doubt, apply a preservative. Be sure to locate the source of moisture and correct this problem, whether it be a leak or a structural defect.

You can obtain pressure-treated wood from treating companies in cities or order it from larger lumber retailers. Of the various preservatives sold for home treatment, pentachlorophenol is most easily obtained—from hardware stores, lumber retailers, or even garden suppliers. It comes ready to apply in sizes from one gallon. Although the product sometimes is sold under a trade name such as Woodlife, the active ingredient is listed as pentachlorophenol (or just penta).

A major problem in restoring and exhibiting many materials that have become badly decayed is that, as the wood dries out, it shrinks and can crack across the grain, resulting in major strength losses. To prevent such cracking, replace the water in the decayed wood with a polyethylene glycol polymer. This dimensionally stabilizes the wood and keeps it from cracking and chinking. This is a relatively simple, although in some instances time-consuming, operation. It is the best way to preserve materials which have been wet or submerged for long periods.

Using decay-resistant wood can also help control deterioration. Although sapwood is always prone to decay, the heartwood of some tree species is quite reliable. These species include bald cypress, black locust, black walnut, white oak, redwood, cedar, osage orange, and catalpa. Exotic species include mahogany, teak, and several other tropical hardwoods. Especially when replacing wooden parts, seek out decay-resistant wood.

Since most wood and wooden artifacts are subject to decay, frequent inspections are essential. Detection is the first step in controlling wood deterioration. Remember, too, that wood exposed to the elements will eventually have to be replaced.

Even though detecting wood decay is an involved process, there are clues to look for. These include peeling paint, discoloration, staining, and the presence of

fungi. You can also probe the wood with a knife or an ice pick to detect the softness associated with decay. There is no substitute for experience, so start looking today.

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FOR FURTHER READING

Cartwright, K. St. G., and Findlay, W. P. K. *Decay of Timber and Its Prevention*. 2d ed. London: Her Majesty's Stationery Office, 1958. 332 pages. The best technical reference to the broad aspects of decay of timber and wood; extensive bibliography.

Mitchell, H. L. *How PEG Helps the Hobbyist Who Works with Wood*. Madison, Wis.: U. S. Forest Products Lab, 1972, 20 pages. A discussion of dimensional stabilization of water-soaked wood by use of polyethylene glycol, with sources of materials and treatment schedules. Free from U. S. Forest Products Lab, Madison, Wisconsin 53705.

Scheffer, T. C., and Verrall, A. F., *Principles for Protecting Wood Buildings from Decay*. U.S.D.A. Forest Service Research Paper FPL 190, 1973. 55 pages. The best brief illustrated reference available on detecting and correcting decay in buildings. Free from U.S. Forest Products Lab.

Verrall, A. F. *Poria Incrassata Rot: Prevention and Control in Buildings*. U.S.D.A. Technical Bulletin 1385, 1968. 27 pages. A discussion of water-conducting rot: 15¢, from U.S. Government Printing Office, Washington, D.C. 20402.

. *Preserving Wood by Brush, Dip, and Short-Soak Methods*. U.S.D.A. Technical Bulletin 1334, 1965. 50 pages. The best reference for home treatment of wood with preservatives; technical, yet readily understandable: 25¢, from the U.S. Government Printing Office.

William Merrill brings to this leaflet several years of experience consulting with historical organizations on wood decay problems. He has advised Mystic Seaport on their restoration of the *Charles W. Morgan* and the Bath (Maine) Marine Museum on a serious mold problem, among others. As professor of plant pathology at Pennsylvania State University, Merrill has translated his dual interest in wood preservation and historic structures into a special course. Although color photographs are essential in showing early wood decay, the author's illustrations do show its advanced stages. The mast photo, depicting restoration at Ephrata Cloister, is from the Pennsylvania Historical and Museum Commission collections.

TECHNICAL LEAFLET 77

Technical Leaflets are published by the American Association for State and Local History for the purpose of bringing useful information to persons working in the state and local history movement. The series does not follow the same categories month after month, since the selection of subject matter is based upon varied inquiries received by the Association's home office. The leaflets, which are detachable from the magazine, are copyrighted © and should be catalogued as part of History News.

American Association for State and Local History Technical Leaflet 77, History News, Vol. 29, No. 8, August, 1974, *Wood Deterioration: Causes, Detection & Prevention.*

AASLH is grateful to the National Endowment for the Arts for financial assistance in the preparation of this leaflet.

Reprints are available for $.50 each. For information on bulk rates, write to the Association at 1315 Eighth Avenue, South, Nashville, Tennessee 37203.

technical leaflet

RESTORING BRICK AND STONE:

some dos and don'ts

By James Cheston Thomas
Shakertown at Pleasant Hill

Historical societies involved in restoration should acquaint themselves with the general techniques of the field. If the building you are restoring is constructed of brick or stone, this leaflet will help you understand the terminology and the processes contractors use. You are then better prepared to draw on professional expertise to supervise the restoration.

When preservation groups acquire old buildings, they often invest the bulk of their funds in the purchase alone. This leaves a tremendous amount of restoration work to be done on a tiny budget. But with careful planning, you can do the work in phases, as funds become available. Such planning involves deciding on the direction of your interpretive program as well as the particular restoration work to be done.

Seek out qualified help from a restoration architect before starting any work. Historic structures can be ruined by well-intentioned amateurs. A professional consultant can tell you which repairs may be deferred until money is available and which must be made immediately. He can also help your society understand the principles behind restoration, increasing your ability to supervise and plan more effectively.

FINDING A CONTRACTOR

Few local projects are fortunate enough to have their own permanent crew of skilled mechanics, masons, and painters. Unless you can hire and supervise a regular work crew, arrange to have masonry work—and for that matter all restoration—done on a cost plus, fixed fee, or salary basis with a capable contractor. He can usually give at least a budget figure for your guidance in choosing priorities.

Competitive bidding, on the other hand, often leads to inflated costs. The contractor who experiments with delicate work or improvises to ensure him-

Fig. 1. This is an example of horrible brick restoration. The building was sandblasted and the effects are evident in the pitted condition of the bricks. The joints were cut with a saw; corners and edges of bricks have been chipped and made very irregular. The mortar used was gray Portland cement which does not duplicate the original off-white color. The original mortar joints were finely tooled with incised lines; whereas these joints have been repointed with a trowel and made slightly concave. The gray mortar has been allowed to remain all over the face of the brick.

self the highest profit margin can also do irreparable damage. Make absolutely sure the contractor is reputable; and, just as important, check that the workmen in his employ are experienced.

IDENTIFYING DETERIORATION

Restoring masonry correctly is a challenge. The term "masonry" describes any construction of stone or brick bonded together by "mortar"—a mixture of cementitious materials combined with sand and/or clay and water to give it sufficient flow and provide workability. Many elements such as dampness, water (freeze and thaw action), air pollution, vibrations caused by vehicular traffic, poor structural design, and inferior workmanship can cause masonry to deteriorate.

Major structural defects produce bulges and cracks. These may be caused by inadequate building foundations, no foundations, or broken lintels and supporting members. Only a specialized professional should tackle problems this severe.

Water damage is the most common kind of deterioration. Rain water, condensation, mist, or fog can make masonry damp. Water may also rise from wet ground, causing the masonry surface to slough off. In this case, removing plaster, applying an epoxy sealant under pressure, and replastering may be a successful remedy for this rising damp. Another more conventional approach is to insert a dampproofing course under professional guidance.

Spalling or surface disintegration of soft brick is another common malady. There is only one solution—replacement of the soft, deteriorating units. Exercise care in matching the color, texture, and size of the original bricks to be replaced.

Efflorescence is most common in new mortar and brick. Soluble salts, activated by water, leach out of brick and mortar leaving a white deposit on the surface. Brushing and washing will remove telltale signs, but the wall should be kept dry to eliminate efflorescence permanently.

Dampness also causes mortar to loosen and break off. The exact source or sources of the dampness must be found before the mortar is replaced.

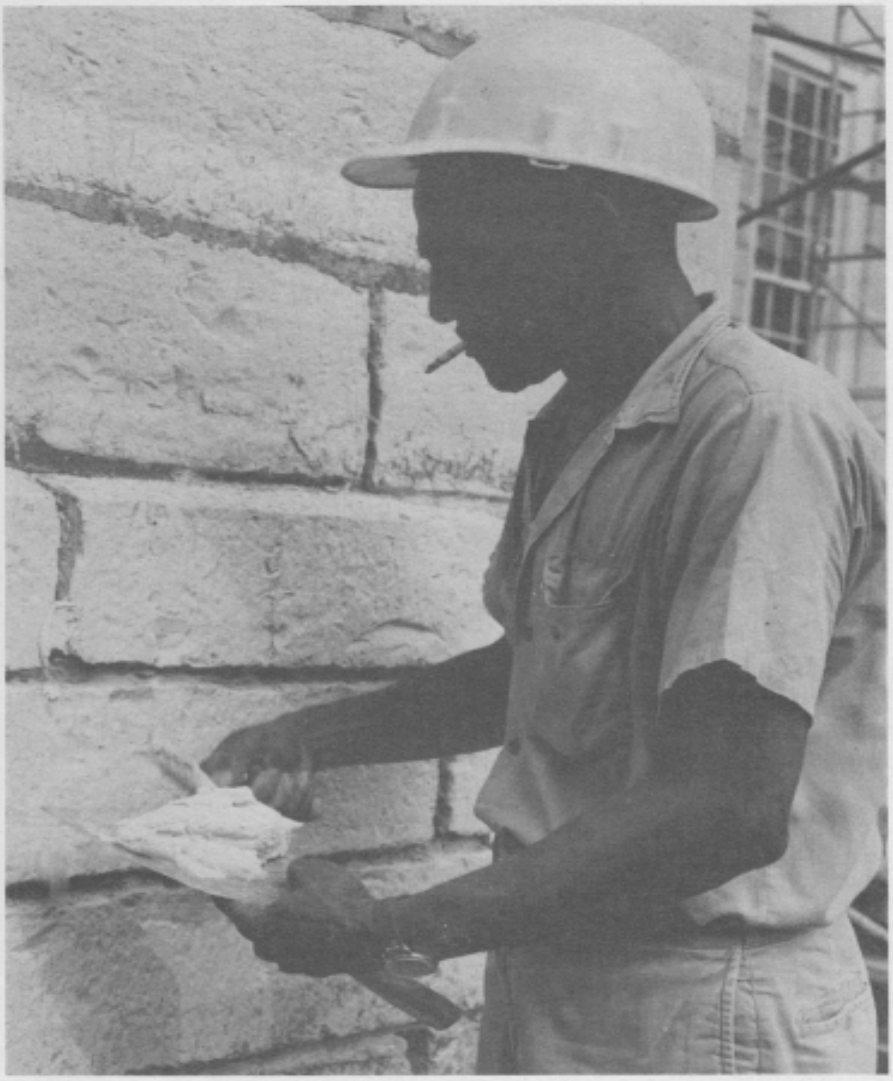

Fig. 2. The mason is pressing the mortar into a joint that has been raked to a depth of ¾" and carefully washed first.

TREATING DETERIORATION

Correct identification of the malady is only part of the solution. The restorationist must concern himself with the proper methods and techniques to counteract them. Certain methods for dealing with brickwork problems have been used by well-meaning individuals and house museum committees with predictably disastrous results (see Fig. 1).

Repointing is the most common method for replacing deteriorated mortar. All loose mortar must be removed first so the joint will be watertight. Rake (or remove) the joint using a hand chisel to a depth of about ¾"–1" (see Fig. 2). Then wash the joints thoroughly to remove loose or powdery particles. A mason *should not* be allowed to saw the joints with an abrasive blade. Invariably, the saw blade cuts into the brick, damaging the edges and corners (see Figs. 3 and 4).

Leakage in brick walls can usually be traced to unsound mortar joints. If this is the case, repointing will solve the problem. But where bricks must be replaced joints should be fully "buttered"—not just covered around the edges. Above all, replacement bricks should be pushed in so that excess mortar exudes from the joint.

A mistake commonly made when repointing old masonry work is disregarding the color, texture, physical nature, and chemical compatibility of the original mortar. In order to achieve a realistic

Fig. 3. Results of poor restoration include oversized joints that have been spot pointed with no regard for excess mortar on edges of the brick. This brickwork has been sandblasted, and as a result the surface has been completely pitted and destroyed. Effects of using a carborundum saw to cut out the joints are very evident.

restoration, these should be matched as closely as possible (see Fig. 5).

The oldest type of mortar, used until the third quarter of the nineteenth century, was composed of lime, sand and/or clay, and water. The color varied according to the sand or clay used; generally it was of a white to tan-white hue. When limestone was not available, for example along the eastern seaboard and especially in Tidewater areas, marl bank (decayed) materials and oyster shells were crushed and used to create a very pleasing white mortar. Depending on the area, the size of sand grains used also varied. Too many private and house museum restorationists have ignored these historical differences. As a result, some eighteenth- and early nineteenth-century brick and stone houses have been pointed with gray Portland cement, a product not made in this country until 1872.

White Portland cement is acceptable in small quantities; it is mixed with hydrated lime, sand, and water. This material is now being used extensively, but is not without fault. It has excellent durability, but is very "hard", and may cause soft bricks and stones to crack. Also Portland cement contracts as it "sets", resulting in minute leakage cracks between the mortar and the masonry unit. These problems can be eliminated by adding more lime to the mixture. A good, workable repointing mortar is one part Portland cement to five parts lime.

A third type of mortar is "patent" or masonry cement, which consists of Port-

Fig. 4. The stonemason is demonstrating the proper way to cut out mortar joints. The use of a hammer and chisel is rather slow, but avoids the pitfalls of using a saw with a carborundum blade.

Fig. 5. A good example of proper spot repointing of brickwork, where the mason has paid due attention to the color and texture of the original pointing material. Excess mortar from each replaced joint has been carefully removed from the corners of the brick with a knife blade to closely approximate the weathered joints in the original work.

land cement, limestone, gypsum, and other materials premixed and bagged for convenience. Many manufacturers offer this masonry cement in a wide range of colors with color charts and bars to aid the customer. Of the three types of mortar discussed here, masonry cement will probably satisfy more needs than the other two (see Fig. 6).

TYPES OF JOINTS

Mortar joints may be classified as either "tooled" or "troweled". The tooled joint is preferred because it is watertight and more attractive. A special tool called a grapevine jointer is used to wedge the mortar tightly in the joint and simultaneously give it shape. Tooled incised lines, sometimes mistakenly called "grapevine" joints, are found in most good early brickwork. A troweled joint was used most often in stone construction when the mason intended to make a raised or flush joint. The excess mortar is "struck" or removed with a trowel, making it recessed from the brick or stone. Figures 7-9 show a mortar replacement process used at Pleasant Hill, a historic Shaker settlement near Harrodsburg, Kentucky.

The raked joint is commonly used in restorations to duplicate old joints in brickwork that have weathered severely. A much better technique is to take a knife blade and tool the joint by tracing the outline of each brick and removing the excess mortar so that the edges show to a depth of ⅛". This is a very time-consuming procedure, but by far the best way to approximate the weathering process. It is particularly important to "weather" the joint when doing spot re-

Fig. 6. The mason is mixing clay that has been sifted with white cement, white sand, and lime. The clay is used to color joints where spot repointing is being done. The mason must have experience matching mortar color in this manner. If he does not, it is recommended that masonry cement, which comes in a variety of colors, be used.

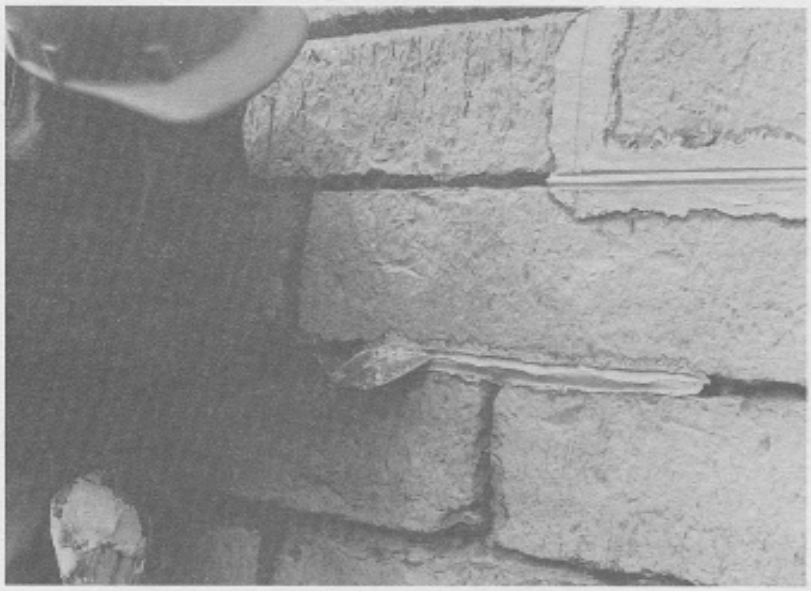

Fig. 7. The mason is "tooling the joint" with his pointing tool.

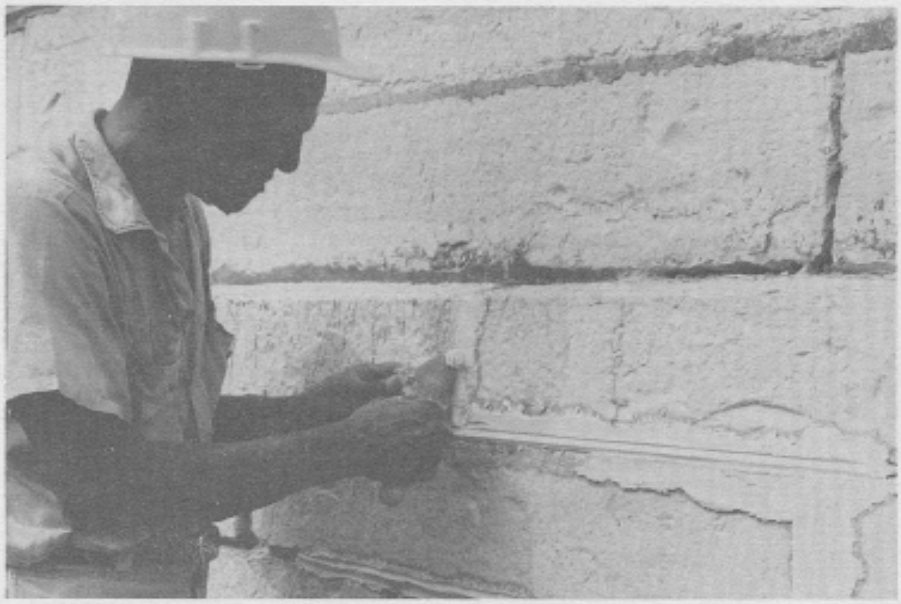

Fig. 8. The mason has tooled the joint with his pointing trowel and is now removing excess mortar from the face of the stone.

pointing. The color and texture might be a perfect duplication of the original mortar joint, but if the mortar is allowed to remain flush with the brick edges, the newness of the joint will be very discernable.

If the color of the patch is contrasting, further blending with the old may be attempted after the mortar ages for a few weeks. Combine a moderately concentrated solution of potassium permanganate with a small quantity of lampblack and brush it on the patch. After about two months the colors of the masonry should blend well.

CLEANING MASONRY

Brick that has been covered with paint or needs cleaning *should not* be sandblasted. Sandblasting removes the outer surface of the brick, leaving it porous and badly pitted, and thus initiates another cycle of deterioration. Joints are usually badly damaged during this procedure, resulting in a costly bill for repointing. In many cases the damaged mortar is the original material used when the building was constructed. The destruction of an original physical document such as mortar is sad to witness

Fig. 9. In this final step in repointing the mason brushes off the mortar that remains on the face of the stone. The original joint that he is trying to approximate is flush with the edges of the stone and raised with a V-profile. The mortar in view above him is a mid-nineteenth-century replacement of the earlier type.

(see Figs. 1 and 3).

First, ask yourself—why does the wall need to be cleaned? Is it absolutely necessary? The preservationist does not necessarily want an old building to be clean and bright like a brand new one.

If you do decide to clean the building you may want to examine the chemical masonry cleaners made to remove dirt, atmospheric carbon, algae, chalking paint runs, and solid paint surfaces. A test cleaning should be made on a small section of wall before the entire job is begun since this indeed is a trial-and-error proposition. Many of these compounds are concentrated acid products; therefore, great care should be exercised by the user. It bears repeating that under no circumstances should brick be sandblasted.

When ready to remove mortar stains from masonry, wait until the new mortar is at least ten days old and well hardened. You can then pre-wet and thoroughly rinse the masonry surface, and clean it with a mild muriatic acid solution. Acidic materials will brighten brick and can give it an undesirable "fresh" look if they remain longer than a few minutes. Be sure to read the specific directions for the solution you are using.

Conventional liquid waterproofing of masonry should be avoided unless the water-tightness of the joints and units becomes a problem. Clear, penetrating materials such as silicone are relatively expensive and are only effective as water repellents for a few years. A coat of 3% water-soluble silicone can be applied to stone surfaces. Brickwork is best treated with a 4%–6% solution of naphtha-based silicone.

Hard stone can be cleaned, *as a last resort*, by dry sandblasting under a pressure of 90 to 100 pounds of air. Similarly, wet sandcleaning using water and sand with pressures under 60 pounds can be attempted. However, repointing the entire wall surface is often necessary due to the abrading effects of sandblasting. Like brickwork, soft stone should *never* be sandblasted.

The use of water under high pressure is a third method for cleaning stone. Pressures exceeding 1000 pounds are reached as water is directed on the stone after a thorough pre-soaking. The results are usually not as effective as those obtained by sandblasting.

The author has achieved excellent results cleaning local hard limestone with just a wire brush. Our stonemasons have

been able to satisfactorily remove dirt, rust stains, and the like with vigorous use of a stiff, non-ferrous wire brush.

Steam cleaning of masonry surfaces can be an effective method for removing dirt and certain types of paint. While it has been used quite successfully by such large restoration operations as Colonial Williamsburg, its drawbacks should be understood. First, unlike the use of water under high pressure, the steam method sends a tremendous amount of humidity into the structure being cleaned. Second, there is a certain danger factor in using live steam since the mechanic is dealing with steam in excess of 250° F, applied with pressure that is usually over 200 pounds.

CONCLUSION

Restoration in its simplest terms is a series of carefully executed details. Accurate masonry restoration is achieved only if the preservationist exercises great concern for details. He should find qualified professional help *first* and then, with professional guidance, plan and properly supervise the work to be done. The results will be worth all of the care and attention you give.

FOR FURTHER READING

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Through his comprehensive experience with restorations James C. Thomas brings expertise to the writing of this leaflet. He took part in the restoration of George Rogers Clark's home, Locust Grove, in Louisville, Kentucky. Now vice-president and curator for Shakertown at Pleasant Hill near Harrodsburg, Kentucky, Thomas directs the restoration program and maintenance of the buildings and grounds. In addition, he is in charge of operation and interpretation of Pleasant Hill's exhibition buildings. He has recorded structures for the Historic American Buildings Survey and acted as consultant for a number of private and public restoration projects.

TECHNICAL LEAFLET 81

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American Association for State and Local History Technical Leaflet 81, History News, Vol. 30, No. 1, January, 1975, *Restoring Brick and Stone: Some Dos and Don'ts.*

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HISTORY NEWS TECHNICAL LEAFLET

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FOR STATE AND LOCAL HISTORY

Historic Landscapes and Gardens: Procedures for Restoration

BY JOHN JAY STEWART, 1974
REVISED BY DEANNA J. KERRIGAN, 1997

Landscapes by their very nature are always changing. Unlike architectural remains, which are static, landscapes undergo constant alterations, even when they are intact. Erosion and neglect modify land forms; plants as they grow affect the appearance of an area and finally transform it. It is important to remember when planning a restoration that a landscape or garden will have already gone through a series of changes, and that these changes can accentuate the challenge of bringing a historic landscape "back to life." The same ethic that steers curators away from the "stuffed and mounted" period room also applies to historic landscapes and gardens.

Curators at many historic sites, such as Colonial Williamsburg, Monticello, and the Jourdan-Bachman Pioneer Farm, recognize that history is interpreted as much through how we have used the land as through the battles we fought and the buildings we erected. Any historical society can and should consider the potential of recreating historic landscapes and gardens in interpreting history to visitors. In fact, a historic landscape need not be associated with an architectural monument or a large and well-staffed organization. Whether a domestic yard, a park, or a rural cemetery, the landscape may be just as educational as buildings and their furnishings. The procedures discussed in this leaflet will help you portray developing attitudes toward the land and to show what role it has played at different times and places.

The process of accurately recording specific details as fully as your knowledge will permit is far more important than how your end product looks. It is the care you take at the early stages that counts.

SURVEY EXISTING CONDITIONS

The first step in landscape restoration is careful examination and recording of the site as it currently exists. Creating "as-found" drawings, akin to measured "as-built" drawings of historic buildings, is crucial to the process. Not only will the site have an effective document to work from, but future curators will have a record of what was done and when. These drawings should include current plans and photographs of conditions at the site. Survey the entire area, indicating the contour lines—two-foot intervals are sufficient—with spot elevations around buildings and key features such as large trees.

These drawings should also include the location of shrubs, hedges, flower beds, turf grass areas, water features, walkways and paved areas, and retaining walls. Indicate accessory structures as well as main buildings. Features such as telephone, water, and sewer lines, and other utilities should be noted on the plan. An accurate record of existing utilities is important to operational aspects of the restoration. Their location could be critical in deciding what to restore and how to phase the total restoration.

Detailed plans showing especially important areas may be necessary. For example, where an elaborate garden existed, a separate plan showing the layout on a larger scale is useful. A plant list keyed to the overall plan, giving both common and botanical names, should be included. Measured drawings of architectural details that relate to the landscape, such as trellises, fences, and gazebos, can also be helpful. Paint remains and other features that are still identifiable should be noted on these drawings.

Photographic documentation is basic in recording the as-found condition. Views from a second-story window or a tall tree can provide a birds eye perspective of the landscape areas. Photographs of details and accessory structures are good supplements to measured drawings. Color film can help distinguish between plant materials that might not be identifiable in gray tones, while black and white film helps bring out shapes and textures that otherwise might be lost in a sea of green.

Never clean up the site before as-found drawings have been made. Tidying up often results in losing valuable information. Vestiges of old features can provide important clues. Limit any early maintenance to picking up litter and to maintaining the existing fabric of plant material and structures on the site.

As-found surveys can vary from elaborate architectural blueprints to simple sketches, depending on the site's resources. The process of accurately recording specific details as fully as your knowledge will permit is far more important that how your end product looks. It is the care you take at the early stages that counts.

HISTORICAL RESEARCH

Accurate historical research is of paramount importance in implementing a restoration. The same care and consideration should be given to the landscape and plantings as is given to the interior of a historic house. The physical aspects of the site as well as how it was used, and by whom, must be studied. If your site is a historic home, attention must be paid to the lives of family members and their use of the site. If the site was a fort, what sort of activities occurred on the grounds? Did the soldiers raise crops? Were there parade grounds? Where were livestock kept? Farm sites require an understanding of agricultural systems of the time, methods of homesteading, which crops were grown, what animals were raised, and methods for processing, storing, and trading farm products. Although this "how" and "by whom" research may seem obvious, it is a slow and generally tedious process of unearthing primary evidence.

Sources such as diaries, miscellaneous private papers, letters, sketch-plans, travelers' reports, and early books and periodicals may contain clues on the original form and fabric of the historic landscape.

Sources such as diaries, miscellaneous private papers, letters, sketch-plans, travelers' reports, and early books and periodicals may contain clues on the original form and fabric of the historic landscape. Also of use are inventories of goods bought and sold, period cookbooks—especially if regional—and archaeological records of nearby areas (if not the site itself). Period accounts of gardening, how-to books and periodicals, and visual images such as paintings or engravings can also be of assistance.

An effective approach to take if research is being done by volunteers is to work in groups, each responsible for a certain area of study. One group may agree to study newspapers and other printed publications, while another may tackle Department of Agriculture documents and private papers. In documentary research, the best attitude is "don't believe it until you find a primary source."

STRUCTURAL RESEARCH

Archaeological investigation is also important in authentically restoring a once-extant landscape. For example, at the Eleutherian Mills garden site in Wilmington, Delaware, an archaeological excavation added surviving evidence to meager documentary material. A stone-walled well and a cold frame in addition to the greenhouse complex were unearthed. Traces of all former garden paths could be discerned from a high tree adjoining the garden area.

Sites whose grounds do not include elaborate gardens with walls and structural foundations may not merit an extensive archaeological program. A good deal of information can be discovered, however, through ground penetrating radar as well as a technique known as landscape archaeology. The technique combines documentary research with field work, although no digging is actually done. Vegetative evidence and other signs of human occupancy such as fence lines, earth mounding, and path and road outlines provide clues to property layout.

Vegetative evidence, unless someone has used a bulldozer on the site, is especially revealing. It requires keen observation and the ability to recognize types of plant material. For example, large clones of common lilac are a sure indication of former habitation. Day lily (Hemerocallis fulva) is another. Among the exotic plants that persist long after a site has been abandoned are peonies, tulips, and narcissuses. Other indicators include Norway spruce, black locust, Lombardy poplar, and in certain regions Osage orange.

The placement of plants is another clear signal of human occupancy. Native sugar maples do not grow naturally in straight lines, evenly spaced twenty five to thirty feet apart. Trees of the same size or clumped in an unnatural way indicate a possible planting program and some attempt at landscaping. Sometimes custom dictated where particular plants should be placed. In Upper Canada, for example, peonies were always in the back yard. Similarly, lilacs became almost synonymous with outhouses in certain areas, and lily-of-the-valley with the north wall of the house.

The location and orientation of a vegetable garden can often be determined by persistent plants, such as rhubarb and asparagus. Domestic fruits such as apples and raspberries persist for a long time without tending. Burdock grows abundantly in rich soil, indicating a possible barnyard area. The presence of stones and rocks sometimes suggests the remains of a fence line. In other areas plants and trees such as hawthorn, wild grape, Eastern Red Cedar, and chokecherry were frequently part of a fence row. Often, a scar ringing a tree trunk indicates where a fence once girdled it.

Vegetative evidence, unless someone has used a bulldozer on the site, is especially revealing. It requires keen observation and the ability to recognize types of plant material.

Plants can provide authentic materials for the restoration as well as indicating occupancy. It is like finding the original planting plan along with the plants. The gnarled old apple tree, just barely alive with one green branch, can provide old-variety grafting material on new root stock. Often these remnants of the original landscape are lost, however, by the well-intentioned person who just wanted to clean up the site.

PROPOSALS AND PLANS

Once the as-found drawings have been completed and the site has a substantial amount of primary evidence—research is never finished—the site will have a fairly clear picture of the original appearance as well as how the grounds were used during various periods. This is where some of the most difficult work begins. Choosing a period for interpretation, and the related decisions that this involves, can bring up contentious issues. This is where it pays for staff and the public to understand the site's mission as well as the purpose for the overall restoration.

Questions to address include: How much of the existing fabric is original? How much of the current site is the organization willing to alter? What are the public's perceptions of the site and how will restoration plans alter those perceptions?

Progressing from research to implementation may seem easy, but the truth is that most of us have connections to specific landscapes. On the part of the community, these connections may be quite emotional. For example, will your site eliminate popular—albeit inaccurate—features during the reconstruction? How will this be explained to the public? Would the site destroy a well-documented nineteenth-century landscape with a good portion extant in order to reconstruct a hypothetical herb garden from an earlier period? Clearly, the organization needs to develop an easily understandable rationale for what will or will not be acceptable as part of the reconstruction.

While architectural elements may have remained consistent over the course of decades, a landscape or garden is a modified ecosystem where controlled succession was constantly taking place.

Landscape and architectural dates do not need to be identical. While architectural elements may have remained consistent over the course of decades, a landscape or garden is a modified ecosystem where controlled succession was constantly taking place. Much like interior furnishings, landscapes and gardens were more likely to be affected by aesthetic trends than were buildings and other structures. The same principles of interpretation that curators use to interpret buildings as they were used by various occupants also apply to gardens. Their appearance and use changed quickly according to the occupant's aesthetic tastes and culinary needs as well as outside market forces.

Plant growth in time affects and finally transforms the appearance of an area. Thus, the cut-off date is often determined by the character and pattern of the landscape rather than by a fixed form, as in architecture. During the planning process, staff should consider carefully the historical relationship between the buildings and the nature of the extant landscaping.

A recurring problem in landscape restoration, for example, is whether or not to remove mature trees planted later than the selected terminal date, or which, through lack of maintenance, no longer exhibit their intended form. There is no patent answer. Usually, if the material reflects the character and pattern of the landscape, it should be preserved. But make each decision on an individual basis.

The location of contemporary facilities associated with the landscape must be considered. Take particular care to estimate how much parking will be needed and where it will be located. Take into account how services such as electricity, telephone, and water will be brought to the site. Outdoor furniture, benches, waste disposal units, directional signs, and lighting should also be reviewed.

Controlling visitor use can be a major problem. Grounds originally designed for use by five or six persons may be expected to absorb hundreds. You may require design solutions that are not historical. Where the scale is such that too many people will destroy the intimacy of the grounds, give serious consideration to limiting visitation or excluding visitors from certain areas of the site.

Many projects fall short by over-emphasizing a garden when, in fact, the open spaces tell more about the persons who lived there. Unless the house was a formal mansion, research usually turns up scanty information about garden layout. The average landscape was arranged for utility and convenience rather than pure aesthetics. Look for such things as the woodpile and chopping block, outhouse, ash pit, well, chicken yard, cold frame, and orchard to understand this earlier way of life. Remember that the garden and plant materials are only elements of the restoration.

PLANT MATERIALS

Prepare a preliminary planting scheme along with the layout. Express the ideal in this plan. If it is not possible to obtain certain plants, you can then look for substitutes. If the organization's staff is not familiar with period design, a landscape architect or restoration specialist can be of invaluable assistance, especially if the research phase has not provided enough evidence from the site.

The secret to successful period landscape planting is perseverance and continual searching. A number of commercial nurseries specialize in indigenous and heirloom varieties, and many restored sites trade and sell period seeds and cuttings.

Begin a program of research and acquisition of plant material once a terminal date has been selected. This will involve locating and propagating plants appropriate to the period and region. A difficulty in researching and in restoring early landscapes is the fact that plants, unlike furniture, do not live on indefinitely, particularly when neglected. Also, plant varieties often naturally cross pollinate, and many appear later in different forms and under different names. Most heirloom varieties can, however, be located. The secret to successful period landscape planting is perseverance and continual searching.

A certain amount of material may be located through the landscape archeological program. Do not limit yourself to the site. Seeds, roots, and cuttings can be obtained from old private gardens, graveyards, and rural areas where plant material has escaped. A number of commercial nurseries specialize in indigenous and heirloom varieties, and many restored sites trade and sell period seeds and cuttings. See the enclosed plant resource guide for assistance.

Botanic gardens, agricultural colleges, and the agricultural extension service have experts who will aid in identifying plants, give information on their propagation and maintenance, and do soil testing. They also have good reference libraries for research purposes. Local garden or horticultural societies can possibly provide expertise and manpower in searching out materials. Master Gardener programs run through county extension services require members to complete volunteer hours each year. Do not overlook their assistance and cooperation.

Very early in the restoration project, while research is underway, you may want to establish an in-house nursery. It does not need to be a large area, but should be well-organized along the lines of a professional nursery, with all material located and cataloged. A nursery will allow you to receive, propagate, and properly maintain plant material as it is acquired. This is particularly advantageous if the restoration project involves site changes. Material displaced during the restoration process will be preserved. By caring for a large quantity of material in a small area, you can also cut down on maintenance costs. Most important, material is acquired when available, and where large quantities are required these can be propagated from a few cuttings.

THE RESTORATION PROGRAM

Restoration work builds on the research and established plans. Based on the proposal and the cost estimates, working drawings or computer-generated plans are prepared. From these drawings landscape construction will be carried out. The actual construction should be under the technical direction of one person who is experienced in working with landscape contractors. This person will work with the landscape contractor, supervising construction and use of proper materials. It is imperative for this person to ensure that working drawings are followed and existing landscape features are not damaged during construction.

If budgetary considerations are paramount, establish a phased program in which construction takes place over several years and costs are spread out. This phased project can be handled in several ways. For example, a site may decide to restore the kitchen garden and house-

If budgetary considerations are paramount, establish a phased program in which construction takes place over several years and costs are spread out.

related plantings in year one, agricultural farmland in year two, and a pleasure garden in year three or four. Another approach is to plant all major trees and shrubs in early phases—giving them time to establish and grow—as well as major physical structures such as walkways or walls, with primary perennials in the middle phase, and lesser perennials or annuals in final phase. This extended planting, while not instant gratification, can provide excellent opportunities to increase visitation, volunteerism, and much-needed fundraising throughout the project.

MAINTENANCE

Maintenance is a vital part of the restoration and interpretation. A landscape restoration is dependent of the ongoing maintenance it receives. A point of interpretation is who originally did the maintenance? While most restored gardens are interpreted from the pleasure point of view, a new restoration also opens up new opportunities to address labor issues, household hierarchy, and gender-based roles. Prepare guidelines on all aspects of maintenance, including the types and location of annuals to be planted each year; a schedule of care for site structures; length and regularity of grass cutting; what to do about weeds; what to do about bugs; and interpretive information on historical use and maintenance of the area.

Options for maintenance include hiring full or part-time staff, working with volunteers to augment maintenance staff, and contracting with an outside mainenance provider. Anyone involved with the landscape maintenance should be well trained and familiar with the maintenance plan. At times both economics and staff considerations require that modern machinery be used to maintain the landscape. Arrange to use such equipment after hours, as it adds nothing to the restoration, and can be confusing—if not annoying—to visitors.

Restoring a historic landscape is a rewarding project that provides history organizations with opportunities to strengthen site interpretation. With sound research and good planning, it can be a positive experience that not only enhances the site's relevance within the historical field, but within the community as well.

RESOURCES FOR INFORMATION

Abundant Life Seed Foundation
PO Box 772
Port Townsend, WA 98368
Non-profit preservation project that operates the World Seed Fund. Members receive seed catalog and periodic newsletter.

Alliance for Historic Landscape Preservation
82 Wall St., #1105
New York, NY 10005
Professional organization.

American Daffodil Society
1686 Grey Fox
Milford, OH 45150

American Living Historical Farms and Agricultural Museums (ALHFAM)
John Patterson
Historic Rugby
PO. Box 8
Rugby, TN 37733

American Society for Landscape Architects
Historic Landscape Committee
4401 Connecticut Ave., NW
5th Floor
Washington, DC 20008
202-686-2752

California Garden and Landscape History Society
PO Box 1338
Sebastopol, CA 95473

CORNS
c/o Carl L. & Karen D. Barnes
Rt. 1, Box 32
Turpin, OK 73950
Preserves and sells old open-pollinated varieties of dent corns, flint corns, and popcorns.

Eastern Native Seed Conservancy
CRESS Heirloom Seed Conservation Project
PO Box 451
Great Barrington, MA 01230
Regional seed exchange program specializing in heirloom varieties of the Northeast. Members receive an annual seed list and can order samples to grow and share.

Heritage Seed Program
RR 3
Uxbridge, Ontario Canada L9P 1R3
A grassroots seed exchange founded by the Canadian Organic Growers and dedicated to preserving heirloom and endangered varieties of vegetables, fruits, grains, herbs, and flowers.

Landis Valley Museum Heirloom Seed Project
2451 Kissel Hill Rd.
Lancaster, PA 17601
A historical site that incorporates its own heirloom seed project.

Native Seeds/SEARCH
2509 North Campbell Ave., #325
Tucson, AZ 85719
A nonprofit organization working to conserve traditional crops of the U.S. Southwest and northern Mexico, as well as their wild relatives. Members receive quarterly newsletter and a ten percent discount on all purchases.

Old Sturbridge Village Museum Gift Shop
One Old Sturbridge Village Rd.
Sturbridge, MA 01566
Features information on kitchen and doorway gardens, with an emphasis on nineteenth century seeds.

Seed Savers Exchange
Flower and Herb Exchange
3076 North Winn Rd.
Decorah, IA 52101
The largest non-governmental organization in the world working to save heirloom varieties of vegetables and fruits from extinction. Publishes the Garden Seed Inventory, the most extensive catalog available, listing all open-pollinated varieties carried by U.S. and Canadian seed companies.

The Thomas Jefferson Center for Historic Plants
PO Box 316
Charlottesville, VA 22902-0316
Offers a seed listing of heirloom flowers and a few vegetables as well as an informative newsletter.

RESOURCES FOR HEIRLOOM SEEDS/BULBS

Abundant Life Seed Foundation
PO Box 772
Port Townsend, WA 98368
(206) 385-7192
Excellent variety of untreated, heirloom seeds.

Ken Allen
536 MacDonnell St.
Kingston, Ontario Canada K7K 4W7
Send SASE for price list
Specializes in sweet potato varieties and other vegetables.

Bentley Seeds, Inc.
16 Railroad Ave.
Cambridge, NY 12816
(518) 677-2603
Heirloom vegetables and flowers.

Elizabeth Berry
Galina Canyon Ranch
PO Box 706
Abiquiu, NM 87510
Heirloom beans and seeds.

Bountiful Gardens
18001 Shafer Rand Rd.
Willits, CA 95490
(707) 459-6410
Also publishes a Rare Seeds catalog.

D.V. Burrell Seed Growers Co.
PO Box 150
Rocky Ford, CO 81067
(719) 254-3318
Over 300 varieties of herbs, vegetables, and flowers.

Comstock, Ferre & Co.
263 Main St.
Wethersfield, CT 06109
(203) 529-6255

The Cook's Garden
PO Box 535
Londonderry, VT 05148
(802) 824-3400
Strong selection of salad greens and flowers.

Deep Diversity
PO Box 15189
Santa Fe, NM 87506-5189
Many heirloom and rare varieties.

Degiorgi Seed Company
6011 N Street
Omaha, NE 68117-1634
(402) 731-3901
Mix of heirloom and hybrid varieties.

Down on the Farm Seed
PO Box 184
Hiram, OH 44234
Untreated seeds; emphasis on open-pollinated varieties.

Filaree Farm
Rt. 2, Box 162
Okanogan, WA 98840
(509) 422-6940
Specialty in garlics; all organic.

Garden City Seeds
1324 Red Crow Rd.
Victor, MT 59875-9713
(406) 961-4837
Specializes in open-pollinated seed varieties adapted to the northern Rocky Mountains and northern Great Plains. Untreated seeds, many organically grown.

Heirloom Seeds
Box 245
West Elizabeth, PA 15088-0245

J.L. Hudson Seedsman
PO Box 1058
Redwood City, CA 94064
Terrific catalog with some of the most complete information available for many plants.

D.L. Landreth Seed Co.
PO Box 6426
Baltimore, MD 21230
(301) 727-3922
Established in 1784.

Old House Gardens
536 Third St.
Ann Arbor, MI 48103-4957
(313) 995-1486
e-mail: ohg@arrownet.com
Excellent selection of heirloom bulbs.
Catalog has good information.

Perrenial Pleasures
2 Brickhouse Rd.
E. Hardwick, VT 05836
(802) 472-5104
Herbs, flowers, and vegetables available as plants or seeds.
Informative catalog.

Peters Seed & Research
407 Maranatha Lane
Myrtle Creek, OR 97457
Open-pollinated vegetables for areas with a short growing season.

Plants of the Southwest
Agua Fria
Rt. 6, Box 11A
Santa Fe, NM 87501
Native plants and ancient vegetable varieties adapted to the Southwest.

Ronniger's Seed Potatoes
Star Route 59
Moyie Springs, ID 83845
Organically grown seed potatoes; many rare varieties.

Seeds Blum
HC 33
Idaho City Stage
Boise, ID 83706
Large selection of heirloom grains and vegetables.

Seeds of Change
PO Box 15700
Santa Fe, NM 87506
(505) 438-6500
One of the top selections of heirloom and traditional varieties; all certified organic.

Shepherd's Garden Seeds
30 Irene St.
Torrington, CT 06790
(203) 482-3638
Good selection of heirloom and open-pollinated varieties from Europe.

Southern Exposure Seed Exchange
PO Box 170
Earlysville, VA 22936
(804) 973-4703
Selection of untreated seed especially adapted for mid-Atlantic states.

The Thomas Jefferson Center for Historic Plants
Monticello
PO Box 316
Charlottesville, VA 22902
(804) 984-9816
Seed list and newsletter.

This Technical Leaflet was originally written by John Jay Stewart as Leaflet #80 in 1974.
This updated and revised version was prepared by Deanna J. Kerrigan, Director of Programs at AASLH and Tennessee Master Gardener.

HISTORY NEWS TECHNICAL LEAFLET

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FOR STATE AND LOCAL HISTORY

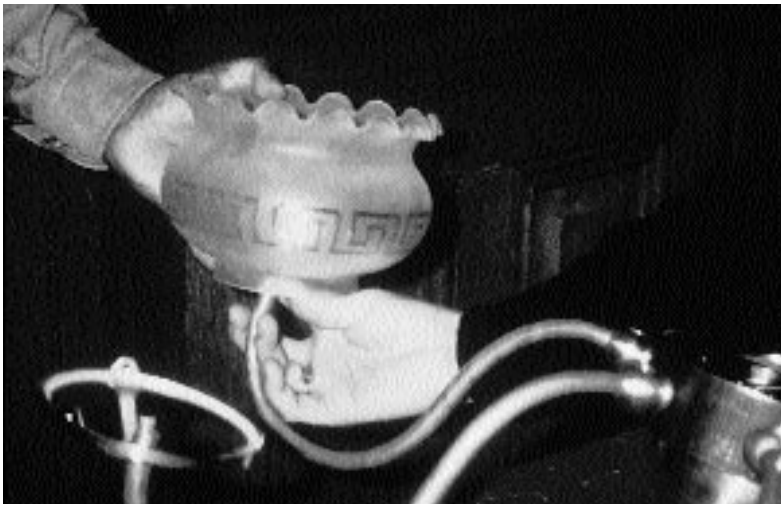
Glass Fibre-Optics Lighting for Historic Building

This technical leaflet is adapted from *Fibre-Optics in Architectural Lighting* (G.N. Kay, McGraw-Hill, 1998) with permission of the McGraw-Hill companies.

BY GERSIL N. KAY

Introducing electric light into older buildings where it was never used originally often presents a problem. In fact, the maintenance, repair, upgrade, or installing anew of any modern mechanical/electrical system (such as life safety, heating/ventilating/air conditioning, plumbing, security, communications, elevators, and lighting), if not done competently and with sensitivity, may cause horrendous cost overruns, untold aggravation, or even permanent damage to original design and fabric. Although *light is essential to see or do all human endeavors,* it, along with an unbalanced temperature/humidity level, is also one of the most destructive elements for cultural heritage. Infrared rays, emitted by ALL light, natural or manmade, dry out fugitive organic materials like wood, textiles, paper, leather, ivory, lacquer, and feathers; and ultraviolet rays fade irreversibly. To avoid this damage, better methods of illumination have been sought ever since the discovery of fire.

Glass fibre-optics meets all of these requirements. It is virtually free of infrared and ultraviolet rays, and substantially delays the inevitable deterioration caused by continued exposure to all types of light. Miniaturized, it is eminently suited for use in historic venues because it does not impact on the décor. Very energy efficient and long lasting, it requires minimal maintenance. Its halogen-free 'green' components create a cool, glare-free environment that improves individual comfort to increase attendance, production, and sales.



Retrofitting late 19th century gas wall sconces with glass fibre-optics. (All photos courtesy of Building Conservation International.)

Hot, obtrusive, glaring illumination, not in keeping with historic light levels and color, can do much more than merely spoil the mood of the place. Historic buildings, including museums, shops, art galleries, libraries, conservation laboratories, and indeed all types of display applications, can benefit from this innovative system. This technology can provide illumination for task, display, architectural contours, ambient light or even dependable *baseboard* emergency lighting in places of assembly, such as the historic Savoy Theatre in London. The interior of this 1882 structure, which was the first theatre to have electric light, was redesigned in the Art Deco style in 1929. Several years ago, it mysteriously burned, then later restored exactly as it was the day of the fire. (In smoke-filled spaces, EXIT signs near the ceiling cannot be seen, and the only place to find air to breathe in an escape route is at the floor level.)

In this country, due to the lack of publications and professional education in the use of glass fibre-optics for *functional* architectural lighting, the impression persists that fibre-optics is only for decorating discos, aquariums, and gambling casinos, or perhaps to be put in occasional display cases. Because of the heavy promotion of plastic fibre-optics in the Northern Hemisphere, whenever the term *fibre-optics* is used, Americans, generally unaware of the older glass version, assume plastic is the only material. Or, others confuse this system with glass fibre-optics for *communications.* It should be noted that the immutable physical principles of optics remain the same for this as for conventional systems. This allows the same lighting techniques used with traditional systems, to be applied with fibre-optics.

Because of its many long-sought-after properties, glass fibre-optics offers another useful instrument for creating good practical lighting. In addition to safety, one of its most important features is longevity of service, especially important where there is only money to do the job once. All the millions of feet of communications fibre being employed worldwide is glass exactly for that reason. Conversely, man-made materials have a relatively short finite life, not suited for long term architectural applications. Another of its properties is flexibility for changing conditions. Historic light levels can be replicated, and the glass can be retrofitted into most antique chandeliers, wall sconces, and other light fixtures. Even proprietary realistic flickering fibre-optic candle- or gas-light is available.

Glass fibre-optics is not always meant to be the only choice. However, it is indispensable where conventional architectural lighting is inaccessible or expensive to maintain; where modern fixtures would be obtrusive in historic locations; where period light levels or other special effects are desired; where energy conservation is necessary; in wet, electromagnetic or hazardous environments; to protect antique buildings and their irreplaceable contents; or wherever discreet yet sophisticated and affordable illumination is required.

When people realize that the actual installation of glass fibre-optics is the same or easier than conventional copper wire, much of the mystery of this product is removed. The power and control wiring still have to be done as before, as does fishing through interstitial walls, floors, or ceilings to conceal the light

guides. In other words, it is just another lighting job.

What is different is that a considerably smaller number of lamps are required to produce multiple points of functional, as opposed to decorative, light. With less wattage, less electrical power is consumed. The convenient, accessible location for the light sources, away from where the light is needed, removes the necessity of entering the space or trafficked area for relamping, so maintenance is simplified. The attendant need for ladders and scaffolds is virtually eliminated. Since heat, normally produced by light, is absent ventilating and air conditioning loads are greatly reduced, further lessening the energy consumption for illumination.

After the end of the World War II, people got used to very high wholesale light levels, which are really energy-wasteful. Just as the high ceiling of a church need not be heated since the congregation is seated on the floor, so blazing flat light at the ceiling is ineffectual when task illumination is needed to read prayer books at the lower level. *A better understanding of where light is really required, and how to deliver it, can do much to reduce energy use, while actually improving illumination.* Whole rooms-full of same-level light will then be obsolete, replaced by brighter task-oriented *directional* light paired with a suitable lower *ambient* type. Using this system, designers are limited only by their imagination in creating lighting that is syncopated like rhythmic music, and is not flat and uninteresting like 'Johnny-one-note'.

Those fragile items most sensitive to the harmful rays of light should be lit with conservation level (50 lux, or 5 footcandles) light. However, this is not possible if the general illumination around them is much higher. The human eye accommodates to the brightest light it perceives, automatically closing so that objects in adjacent darker surroundings cannot be seen as well. This means that the illumination en route to displays requiring conservation level must decrease progressively until the person reaches them. This gives the eye time to adjust and makes the dimmer light more visible.

In addition to empirical experience and proficiency with lighting techniques, producing the best results for the lowest price for historic venues also requires a thorough knowledge of earlier construction methods, engineering, architectural history, and museum conservation. One does not suddenly wake up one morning being adept in this discipline, because more than a mere salesman's skills are needed. Therefore, administrators of pre-1940 structures should be extremely careful about their choice of consultants and contractors. For the good of the institution and its collections, those practitioners whose marketing departments are stronger than their technical expertise should be avoided.

Unfortunately, lighting is usually the last item considered in building plans, and the first to be jettisoned during the budget crunch. This is a pity, because the efforts of all other professions and crafts could be enhanced with the proper illumination. Besides, in a practical vein, administration costs could be significantly trimmed with adroit lighting design. *Even small house museums lacking large budgets can benefit from considerable savings in installation and operation, making payback on initial outlay speedy.* Moreover, the life of the historic fabric in care is extended substantially.

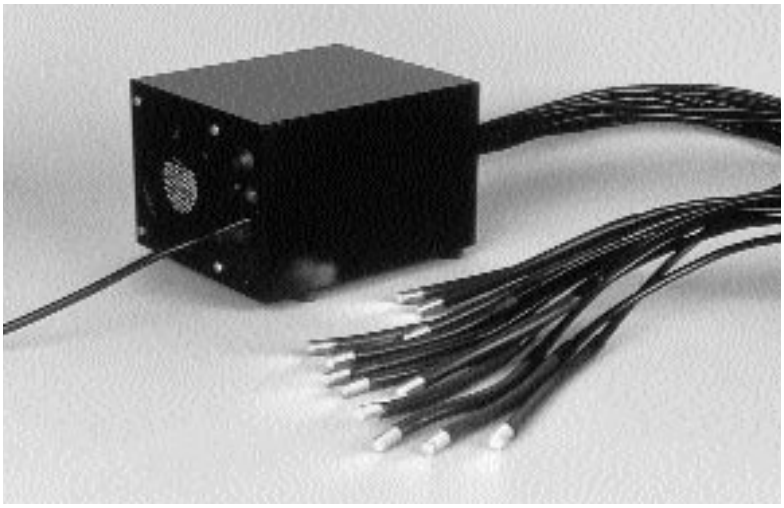
Inquiries should be made to each state's electric utility companies, whose Demand Side Management sections encourage energy-efficient methods of lighting. Financial aid might be available, in the form of rebates on monthly bills, or even advance loans for retrofitting or installing anew. In addition, setting up a small pilot project exhibit using glass fibre-optics is very helpful in gaining funding and contributions.

COMPONENTS OF THE SYSTEM

Glass fibre-optics lighting is composed of three parts: the shoebox size **light source** (a lamp in a metal enclosure called an illuminator or projector); attached to it is the octopus-like **harness** (a bundle of thin, flexible glass **'tails'**); and an optional variety of miniaturized optical glass **lenses** screwed onto tail ends to control or alter the beam of light. The light guides (tails) are composed of strands of glass, in multiples of 400, each the size of a human hair. With the *end-emitting* type, the light rays travel along the length of the opaque-sheathed tails until they emerge at the end, supplying points of practical light where needed. The footprint of light depends upon the size of the light guides. Tails usually range in diameter from 1mm up to 12 mm (½") or more, and can fit into constricted spaces where conventional lighting fixtures could never go. High light levels over distances can be produced, as well as an even spread of light over an area. The *side-emitting* ver-

sion looks and acts like neon. Being strictly decorative, it can delineate, but cannot produce high levels or evenly spaced light over distances.

The harness arrives completely assembled and only has to be inserted into the light source, saving a great deal of labor on the job. It can also be reused again elsewhere.



Light source and harness of tails.

Naturally, all three components must be compatible, and the quality of the glass should not be above 200 dB/kM at 450 nanometres. A wise client will ensure that materials of suitable criteria are supplied. If color rendition is important, the rule of thumb is to keep the length of tails emerging in any direction from the projector between 8-10 metres (24-30'). This figure is actually doubled with tails going to the right and left out of the light source. Quartz glass, while more expensive, can be extended for much longer distances, if necessary.

COST SAVING TIPS

Remember costs escalate if skilled craftsmen must move furniture in their way. Such items should be removed beforehand. If the project is an existing space with significant architectural features, decoration and furnishings that must remain during construction, everything should be securely protected *before* any work starts. Expensive insurance claims can be avoided that way. Specifications should caution that furniture should not be used in place of ladders. Neither should there be food, drink, or smoking on site, especially if the venue is historic. The use of open fire on site, unless carefully supervised, should be banned altogether. One project in a timber-framed structure also forbade loud radio playing lest a fire alarm could not be heard by the crew.

On the first day of construction, it is a good idea to introduce all members of the team to the fibre-optics system. This will eliminate the curious stopping their work to investigate it. As personnel change, new members should be acquainted with the presence of this equipment.

If a lighting consultant can smell the fresh paint upon being called for the first time to a job site, it is really too late for good lighting. Until 'wireless' lighting arrives, it is still not possible to gesture god-like and declare "Let there be Light!" without breaching already finished surfaces. Such duplication of effort after walls, floors, and ceilings are closed in, is costly, and may also require the services of specialists to repair ornamental components.

GLASS FIBRE-OPTICS IN APPLICATION

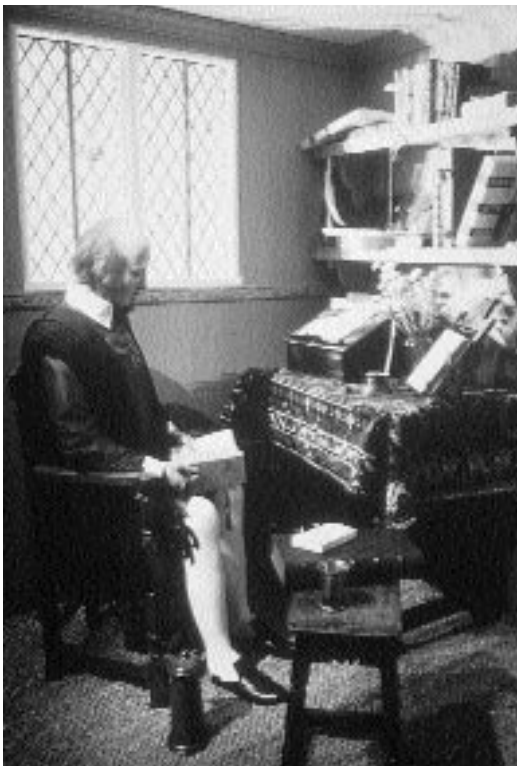
A National Historic Landmark employing glass fibre-optics is the popular Lucy the Elephant, in Margate, New Jersey. This 1882 architectural folly was erected by a property developer who wanted to call attention to his latest housing project. The gigantic three-story wooden Indian elephant is complete with howdah. Lucy has been a real estate office, a hotel, a tavern, and is now a museum. Only glass fibre-optics could safely fit into the tight spaces and provide general interior lighting, illuminate the four staircases, and special exhibit areas.

The Georgia State Capitol, also from the end of the 19th century, has an 80-foot high rotunda, making the now-electrified gas wall sconces almost inaccessible. Glass fibre-optics has been retrofitted into the fixtures providing a simple solution to the maintenance problem. This equipment will also light the Georgia State Museum display cases placed around the atrium. The use of green- or blue-tinted glass in the vitrines should be avoided. This will give a ghostly look to the objects

within and change color rendition markedly. Low-iron (extra clear) glass, coated on one side to eliminate reflections, should be specified for exhibit enclosures. If sunlight or other high level artificial light plays on the cabinets, an ultraviolet (UV) filter can be laminated to the glass panes. Contrary to popular belief, there *are* affordable sources for non-reflecting glass.

In 1994, the elegant 19th century Ballantine House at the Newark (New Jersey) Museum had a 25-foot sealed display case for changing exhibits, and a large alcove containing an elaborate Victorian secretary, lit with glass fibre. These two exhibits are now very popular with both the guides (who prefer to stand near the cool illumination) and the public, who are intrigued to discover the source of the light.

Perhaps one of the most fascinating commissions for this technology was to light 34 large stuffed animals taken by a big-game hunter. Similar to Theodore Roosevelt's menagerie in his wonderful house in Oyster Bay, Long Island, New York, this group of creatures—an elephant, rhino, Cape buffalo, two lions, a leopard holding a gazelle, four kinds of large bears, a bongo elk, an ox, and twenty smaller beasts—was not to suffer the same fate as Teddy's. The fur of those poor animals has become bald and faded from the hot, glaring light shining on them for so many years. Twenty-two illuminators and 255 tails provide both ambient and directional light in a two-story entrance lobby, 24' x 30' x 30' high. Each animal is lit with a different color so that it stands out from the African savannah surroundings, and looks as alive as possible. The client was so pleased, he left the lights on for everyone to see. However, after a few weeks, in an O. Henry dénouement, more people were coming to see the *lighting* rather than the exotic animals!



Shakespeare lit with glass fibre-optics in Stratford-upon-Avon.

Many locations abroad have long employed fibre-optics, except there, the term *fibre-optics* is understood to be *glass.* A very early application was a chapel in the stone undercroft of the venerable Canterbury Cathedral. The high-Victorian Foreign Office in London now shows off its spectacular painted ceiling invisibly lit with glass fibre-optics. The National Trust properties in Great Britain include:

Calke Abbey, Derbyshire

Glass fibre-optics were used to illuminate a magnificent 18th century State Bed with silk embroidered hangings. Fibre-optics provided the flexibility needed to illuminate, with no heat or ultraviolet light, awkward places such as under the canopy. The bed is displayed in a glass box which has conditioned air passed into it from the adjacent room where the fibre-optics light source is housed. This is a lucky textile. There are many others being systematically bleached and desiccated by hot incandescent bulbs.

Chartwell, Kent

This was the home of Winston Churchill. Fibre-optics is used to illuminate wartime uniforms in a special museum display.

Beatrix Potter Gallery, Hawkshead, Lake District

In the home of the creator of Peter Rabbit, fibre-optics lights a display of her watercolors.

In New Zealand and Australia, as well as Japan and Hong Kong, glass fibre-optics has been used in museums and historic houses for decades. The British Museum regularly uses glass fibre for special exhibits. The Victoria and Albert Museum redid its entire Silver Collection with this material. The Mona Lisa in the Louvre has had several versions of the technology as it has developed. Institutions in Germany, Austria, France, Italy, and Denmark routinely select it as another lighting tool. Years ago, Inigo Jones' Queen's House in Greenwich, and Buckingham Palace were early converts to this system, while Shakespeare's birthplace in Stratford-upon-Avon was recently lit with it. The Scottish, British, and Danish Crown Jewels have long been lit with glass fibre.

GUIDELINES TO FOLLOW

It is not necessary to become an engineer or electrician to recognize practical lighting procedures and then request them from contractors. **Glass fibre-optics lighting standards for historic places should include:**

1. Correct and realistic light levels for the period: Older light levels were considerably lower than today. Glare should always be eliminated and light sources baffled.

2. Employ the correct color of light: Candle- or gas-lit interiors had a different color than those later spaces using incandescent or fluorescent lamps. Both of these elements affect the colors selected for surroundings and furnishings.

3. *Have sufficient dissipation of heat from light sources.*

4. If the public is allowed into the building, provide effective emergency lighting and alternate power generation.

5. If fugitive organic materials are illuminated, what level of conservation lighting is needed?

6. Include correct styles of lighting apparatus: (For example, do not provide Art Deco uplights in a Victorian setting, unless that effect is desired.)

7. Always make provision for *ready access for maintenance.*

8. Monitor the quality of glass fibre and fittings supplied.

9. Have suitable specialists available to repair penetrations made in decorative features.

10. Check that the proper type of lamp source is planned.

11. Employ only professional installers familiar with fishing through walls, floors, and ceilings *carefully.* Use volunteers for other than this highly technical work.

12. Design to include *enough components* to do the job required.

13. Unless retrofitting decorative antique lighting fixtures, other lighting hardware should be concealed wherever possible.

Upon undertaking any type of construction, there are no substitutes for the following practical procedures:

• *Before* ever going to outside firms, those in charge of the institution should first determine their lighting 'wish list' among themselves. This may be the most difficult step of all, but from the outset there has to be a 'meeting of the minds' on the scope of work contemplated before the first plan is drawn or nail hit. The contractors will "get you" on the extras, if you don't do your homework first! Near-future needs should also be anticipated to avoid extensive work soon after completion of the initial project. For best results, give the lighting consultant/designer *full details* on objects or area to be lit. No matter how long the work will take, develop a *Master Plan,* so that it all comes out evenly in the end.

• Only *qualified* participants with training and experience should be invited to do this type of work. Don't rely on lamp salesmen. The incompetent low bidder may cost considerably more in the end, and could do irreversible damage. Visit at least three previous projects completed by those invited to quote, and ask for those clients' frank comments. Never depend solely on slick architectural photographs, which can make a hovel look like a castle.

• Ensure full communication, cooperation, and coordination within the construction team.

• Where all systems are already in place in an existing structure, a holistic approach, considering the impact of one service on another, must be taken. Therefore, design should include early input from *all members* of the team. No trade should be viewed in isolation.

• The concept of 'fast-track' is counterproductive in this field. Here there is a need for *adequate advance research and planning* before starting the actual work.

• Consult a design team who will check the building from top to bottom. Intensive initial investigation of an existing property is essential. A complete inspection report can avoid many unexpected surprises later. Until the correct cause of any problem is diagnosed, the proper solution cannot be applied.

• For the participants' life safety, ensure structural stability, and stabilize the property before starting anything else.

• Is the existing electric service safe and adequate?

• Be assured that *sufficient* lighting components are specified to do the job. Otherwise, every dollar spent will be wasted. Also refuse low quality glass and fittings—they will not work.

• The simplest way to determine correct tail lengths is to use colored string lines from the light source to where to points of lights are to emerge.

• Insist on a *mock up* on site before equipment is fabricated.

• While communication, coordination, and cooperation are necessary for all types of construction, they are critical for successful treatment of existing structures. Therefore, prior to creating design, and during the course of work, require sufficient meetings of the *entire team* to ensure this occurs.

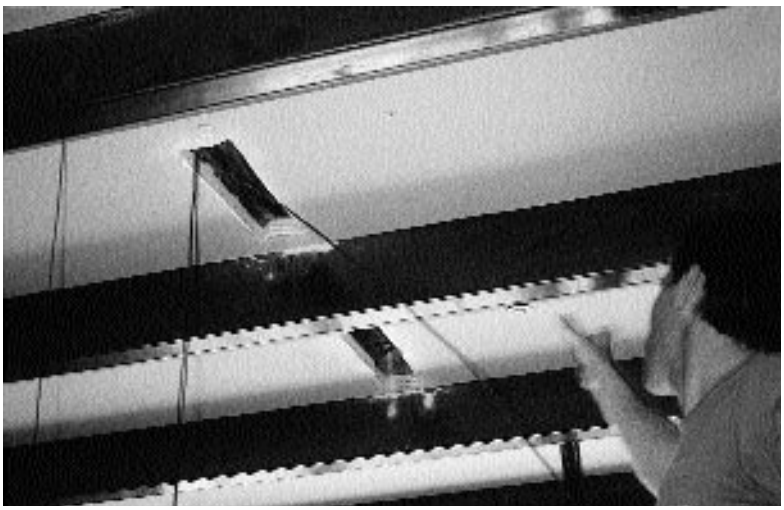
Use the following criteria to determine the fate of historic fixtures and fittings:

a) Can they be refurbished and reused?

b) Can they be inactivated, but left to complete the whole historic picture?

c) Can modern systems be discreetly concealed to do the necessary work?

• A logical schedule has to be devised to eliminate repetition of effort. NEVER do decorative work before completing installation of mechanical/electrical systems. For example, do not lay new carpet and then dig up the floor, or paint before the lighting or mechanical equipment is concealed. Don't laugh—these silly things have both been done many times.



Fishing the tails through the ceiling of an historic house.

• For existing structures, no holes should be made until authorized by the professional in charge, and then they should be as small as possible.

• Design should include:

a) *Ready access* for maintenance and repair of all systems

b) Advance planning for manmade or natural disasters

c) Accommodation for the disabled

d) Placement of all switchgear, emergency generators, and other power-producing equipment should be ABOVE grade, and not below, where water can disable it immediately.

e) If insertion of modern lighting is called for, efforts should be made to employ reusable existing interstitial spaces, chases, ducts, and conduits. Lacking them, imaginative use of furnishings should be made for concealment.

The job specifications should include:

a) The team's path of travel in and out of the property and/or landscape

b) Adequate location to store and stage materials, tools, and equipment to avoid theft and damage

c) Proper protection for the building, grounds, and those architectural components and furnishings which cannot be removed during construction

d) Strict fire and security rules

e) Neat housekeeping standards

f) Adequate and safe temporary lighting (no tungsten halogen!)

g) Restrictions on unnecessary penetration of original fabric: Permission must be sought from the person in charge before any holes are made. If decorative features are involved, is there a specialist to repair resulting damage?

h) Documentation of the actual work done, for future reference

i) Establishment of a *scheduled* maintenance program and instruction for the staff in how to implement it

j) *Make sure that all construction workers are acquainted with these criteria.* Sub-contractors seldom receive the full set of specifications, or if they do, rarely read them. If any digging in the street or on the property is involved, contractors MUST contact the appropriate utilities (phone, water, gas, etc.) first.

• On the first day of construction, the client should meet with the entire team and explain the expectations for the project. Never hesitate to ask a qualified craftsman how to solve a problem. Each has spent a lifetime in his/her particular trade and has probably encountered the situation before.

The reader will notice that all of these suggestions are simply common sense, to be followed for *any* construction work done on either historic or contemporary venues.

SUMMARY

Administrators charged with the conservation of the public's cultural heritage might consider employing this lighting tool because of its many beneficial properties. While the building and contents may be antique, there is no reason not to use the latest practical techniques to extend their life, value, and usefulness. The caveat is to seek only thoroughly knowledgeable practitioners who can provide suitable and affordable illumination.

One unfortunate impecunious institution with a very tiny exhibit space was snookered by a very high-powered salesman into $69,000 worth of LED equipment *plus* installation costs for what was represented as *functional* lighting. The system was supposed to go for *eleven years* without replacement! ***No type of lighting lasts that long without diminishing in light level.*** Note that this latest craze for LED's (like the little light that indicates the coffee pot is on) cannot supply *directional light* to allow details to be seen. Naive clients believing otherwise would probably purchase TWO Brooklyn Bridges, if offered them. Let the buyer beware!

CREDITS

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