Consolidants, Adhesives, and Fillers

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Many products used in conservation and in building share at least some common or similar ingredients. Terms that describe these products--such as "consolidant," "adhesive," and "filler"--often refer mainly to the way the materials are used. Plaster of Paris, for example, is an inorganic material that can serve either as a filler or as an adhesive (used to secure a plaster ornament to a flat ceiling). An understanding of the ingredients found in common in many products simplifies the selection of products for use in restoration and equips the practitioner to make custom materials for special purposes.

The consolidants, adhesives, and fillers described here will include examples of both "store-bought" products and "home brews," of archaic composition and of more modern character.

Some Informal Definitions

A consolidant may be defined informally, but usefully, as "a penetrating liquid soaked into something crumbly and porous to bind it together." A powdery glue distemper paint (calcimine) in a decorative scheme on plaster, or in a wallpaper pattern, is an example of a material that can require consolidation -- and one that poses quite a challenge to the conservator.

An adhesive is a substance used to bind separate things together. At a microscopic scale, a consolidant is a kind of adhesive in that it binds together the particles of a crumbly, porous substance, but the term "adhesive" is generally restricted to more viscous (thicker) products that are applied directly into a gap to hold two things together. An example of an adhesion process in interior restoration is sticking flaking paint back to its plaster support.

A filler is a bulky material designed to fill a gap or void in something, or to fill in rough spots. Joint compound is a common filler. This is the sense in which the term "filler" is used in the title of this paper. I will also use the term to mean something else: a powder comprised of solid particles, that is mixed with a fluid binder to create a bulky material which may then serve as a "filler" as first defined. Chalk and woodflour are two particulate fillers that have been used for many years. Consolidants, in order to have penetrating power, consist only of a low-viscosity liquid binder and contain no fillers (solid particles). Adhesives may or may not be "filled" with solid particles. An adhesive or filler is assigned to a certain chemical class according to the character of the binder in it, not the solid particles, just as an "oil" paint derives its name from its binder, rather than from the solid pigment it contains.

Identical or closely related binders can serve as the defining ingredients in consolidants, adhesives, or fillers. Thus, a good way to organize the subject in one's mind is according to the type of binder.

The great majority of binders in consolidants, adhesives, and fillers are organic, that is, comprised of compounds of carbon. Furthermore, they are polymers, or form polymers after application. Polymers are substances having large molecules consisting of repeating units. There are also some important inorganic binders; two examples are mentioned below. Whereas organic polymers have

advantages of solubility, flexibility, and adhesive power, inorganic materials generally excel in resistance to deterioration caused by light and oxygen.

Organic binders can be grouped into chemical classes, such as oils and acrylics, but it can be more instructive to arrange them in a related but modified scheme: according to the mechanisms whereby they solidify. Clearly, a binder must have this ability to be applied as a liquid and then form a solid that holds particles, or larger pieces of something, together.

Binders that Solidify by Solvent Loss

A great many binders solidify by solvent loss. The binding substance is a solid that has been dissolved in a solvent and that re-forms as a solid when the solvent evaporates. Shellac and animal glue are two traditional binders of natural origin that solidify in this way, by evaporation of the solvent in which they have been dissolved and applied--alcohol and water, respectively. Both these materials well demonstrate that the same binder can be the defining ingredient in a consolidant, adhesive, or filler. A form of animal glue dissolved and greatly diluted in water has been used as a consolidant for powdery distemper paints. As a thicker paste containing less water, animal glue is a traditional adhesive for interior woodwork. Compounded with solid particles (fillers) it has served as one of the binders in traditional spackles for patching plaster.

The best of today's synthetic polymers are more resistant than most traditional ones to biological attack and to degradation by oxygen and light. Rohm and Haas *Acryloid*® B-72 is an acrylic polymer that has proven highly resistant to oxidative degradation. Dissolved in organic solvents such as toluene, it is used in countless ways in conservation. *Acryloid*® B-67--only a little less stable chemically--is soluble in less noxious solvents such as mineral spirits, and for this reason is more convenient to use in building interiors. I have used as much as 250 gallons of a B-67 solution as a consolidant for plaster in one building (sprayed onto the back side of the plaster). I have also employed the material as a protective varnish for decorative paintwork, and for other purposes.

Emulsions: Solidification by Coalescence

Polymers that solidify solely by solvent loss can present a dilemma. If the polymer is soluble in water, it will remain susceptible to damage by moisture and will probably undergo cyclical expansion and contraction in response to changes in relative humidity. Polymers that are insoluble in water, on the other hand, generally require organic solvents in order to be dissolved, and these are usually flammable and present problems of toxicity. For some decades polymer emulsions have provided a way out of this dilemma. Although not very useful as consolidants, they serve well as adhesives and in fillers. They are the "latex" binder in latex paints. A polymer emulsion is a suspension of microscopic spherical particles of polymer in water; the polymer is not soluble in the water. The emulsion (or any paint, adhesive, or filler made with it) can be applied using water for dilution or cleanup. As the emulsion dries, the water evaporates, and the polymer particles merge and fuse together. The end product is insoluble in water.

Emulsions are not widely useful as consolidants, because the particles of polymer are too large to pass into the pores of most materials. However, emulsions make fine adhesives, in part for the very reason that they are not drawn away out of gaps into the pores of the materials being joined. An emulsion is compact: a lot of polymer can be carried by a moderate amount of water, whereas a solution containing such a high proportion of polymer would typically be too viscous to apply. Thus emulsions can be used with less dilution and can fill space well, drying without much shrinkage.

Many store-bought adhesives for wood gluing or other purposes are emulsions of poly vinylacetate in water.

A standard adhesive application of emulsions in architectural interiors is as bonding agents for plaster. Being "water based," emulsions are compatible with wet plaster and have many uses in plaster restoration. They can be painted onto old wood lath, for example, prior to the application of new plaster, and will bond the plaster to the lath. Emulsions sold for this purpose are generally poly vinylacetates, a class of polymer considered somewhat subject to degradation by moisture and by the alkalinity of

lime plaster. For assured long term service with lime plaster, it may be better to use acrylic emulsions, such as *"Acryl 60®,"* that are sold as masonry bonding agents and that have exterior-grade durability. They are not so convenient in that they must not be allowed to dry before the plaster is applied.

The natural gap-filling property of emulsions can be enhanced by the addition of particulate fillers. In the 1970s I designed gap-filling adhesives for loose plaster that are bound by acrylic polymer emulsions and "bulked" with lime, hollow glass microballoons, and fluid coke (a gas-producing shrinkage compensator). The spherical shape of the emulsion particles, microballoons, and coke helps to insure that the adhesive will flow easily under light pressure. These adhesives are easily injected through 3/16" holes in lath or plaster, flow readily into the space between lath and plaster, and dry with little shrinkage.[1]

Some new spackling compounds (fillers, in other words) resemble these plaster adhesives in the use of acrylic emulsions as binder and microballoons as filler: the properties desired in the end product are similar. *Onetime®* Spackling made by Red Devil, is such a product.

Binders that Solidify by Chemical Reaction

Some organic binders are comprised of relatively small molecules when in the liquid state; in the solidification process these molecules are joined together to form cross-linked polymeric structures. Linseed oil, used in myriad building products, is an example of a traditional binder that solidifies by means of such a chemical reaction.

Epoxies are an especially useful class of binders that solidify in this way, generally by reaction with an amine that is provided as a separate component. Epoxies can be diluted with solvents, so as to have a particularly "thin" consistency. (This does not mean that solvent loss is the mechanism of solidification.) Using Domaslowski's method, solvent-thinned epoxies can provide excellent consolidation of stone--and no doubt other materials--while scarcely affecting appearance.[2] This method is inconvenient to use, however. Epoxies of inherently low viscosity make penetrating consolidants without dilution; used without solvents, they markedly change the appearance of consolidated objects, but are easy to use and free of fire hazards. They have proven appropriate for somewhat "coarse" treatments, like consolidating fire-damaged interior painted woodwork and plaster.

Epoxies have strong adhesive properties and, when undiluted by solvents, solidify ("cure") with virtually no shrinkage. For these reasons, epoxies are standard adhesives where very strong bonds are needed, and where good gap-filling properties are desired. Microballoons used as filler give epoxy pastes the property of being carvable and sandable when cured; commercial fillers of this type, mainly intended for patching holes in wood, are available, and a flexible version modified with polysulfide rubber is easily made.[3]

Epoxies are available as emulsions in water, and can thus be used in or with plasters and mortars to provide added toughness and adhesion. Epoxy emulsions cure by chemical reaction after evaporation of the water.

A difficult and costly technique of consolidation, but one yielding a highly satisfactory product, involves the formation of acrylic polymer from its component "monomer" molecules. The polymer has a linear chain-like structure (it is not crosslinked). This has worked well on wooden furniture; I have used it on oak timbers, exposed to a building interior, that could be removed for treatment. The polymer is virtually immune to yellowing and does not change the appearance of the wood. The process can be used on other materials.[4]

Materials that Solidify by Cooling

Several types of adhesives used in affixing flaking paints are of the "heat-seal" type. They melt at low temperatures and, introduced behind paint flakes in various ways, can be melted with a warm iron or other heat source. On cooling, they bond paint to plaster. Such adhesives have been based on waxes, poly vinylacetates, and ethylene vinylacetate polymers.

Inorganic Binders

Inorganic binders generally solidify by means of chemical reactions. Plaster of Paris solidifies

("sets") by reaction with water and through the attendant growth and interlocking of crystals. Like lime and cement, plaster of Paris has both binding and space filling properties; it sets with no shrinkage, and serves as its own filler. It has myriad applications in patching holes.

A consolidant that solidifies by chemical reaction to form an inorganic end product (silica gel) is *Conservare*®OH, marketed by ProSoCo. Designed as a stone consolidant, this ethyl silicate preparation has been used by conservator Constance Silver to consolidate, simultaneously, powdery paint and its crumbling plaster support.

Combinations, Variations, and Hybrids

There have always been materials of intermediate or complex character. Some old-fashioned spackling compounds, for example, contained a combination of separate binders, such as animal glue for stickiness, emulsified linseed oil for durability, or a measure of plaster of Paris for hardness and shrinkage control. Sometimes modern formulations can be simpler than old ones.

Besides such combinations or mixtures, there have long been polymeric hybrids, materials of which the individual molecules contain portions related to different chemical families of polymers. Traditional varnishes are hybrids of oils and hard resins; epoxy esters (epoxy-modified oils) and siliconized acrylics are examples of more modern hybrids that are widely sold to homeowners and tradesmen. The number of such hybrids is steadily increasing.

To add to the confusion, there are what can only be called variations. Thus joint compounds have been bound by water-soluble natural polymers (such as starches), and more recently by poly vinylacetate; some dry-bagged products, the *Durabond*® line made by U.S. Gypsum, contain an addition of plaster of Paris. All these products will differ in moisture sensitivity when dried, and in other properties.

A particular treatment in restoration may be a kind of procedural hybrid. For example, I have found a handy way to fill very shallow depressions where a few layers of paint are missing in a decorative paint scheme being inpainted. Water-soluble joint compound is used, and allowed to dry. It is then easily smoothed with a damp sponge, to a perfectly flush butt joint with the surrounding intact paint. After drying again, it can be made much tougher and more water-resistant by consolidation with a solution of *Acryloid* B-67 in mineral spirits. In this example, a consolidant is being used as part of a filling process.

An Important Newer Technology

In the last couple of decades, increasing concern about air pollution has provided a strong incentive for the development of polymeric products, such as coatings, that are free of organic solvents. Water has increasingly been the vehicle of choice. Polymers that are insoluble in water not only are being supplied as emulsions in water, but also have been "tricked" into water, forming dispersions of much finer particle size. Some of these materials resemble solutions and make penetrating consolidants. Ammonia and volatile amines are the most commonly used solubilizing agents in the preparation of these materials.

Polymers of various chemical classes are supplied in these new waterborne forms, such as polyurethanes for varnish and acrylics for floor polishes. Solidification occurs through water loss, followed by evaporation of the ammonia or amine, and then sometimes by cross-linking chemical reactions. The end product is insoluble in water and thus resistant to moisture. The number of these newer waterborne polymers is large and increasing, and many have the chemical stability required in materials for conservation. These materials will surely find many varied uses in our field.

With the support of the Getty Conservation Institute I have been studying acrylic resins of this type for use as plaster consolidants and in other conservation applications where freedom from the fire and toxicity hazards of organic solvents are of importance. Although the familiar solvent-borne polymers may be functionally superior in most applications, their hazards can be unacceptable, and there are some instances where waterbornes may have advantages besides safety. Conservator Susan Munro suggested to me that the acrylics I am studying might make good consolidants for curled and powdery distemper paints on walls or

wallpapers. Being water-borne, they would soften the old water-soluble glue binder of the paint, permitting flakes to be pushed flat; after application, they would become relatively insensitive to atmospheric moisture.

Conclusion

Often, replacement of a deteriorated building component makes the most sense. However, the variety and quality of materials available today makes it more feasible than ever to preserve deteriorated old things that are felt to have artistic, historic, or nostalgic value. Generally, there is something that would be effective as a treatment, and resistant to deterioration. Some kinds of conservation treatments can be made wholly or partially reversible by chemical or physical means. Where this highly desirable goal of reversibility is unattainable (as in large-scale consolidation processes), at least treatments can usually be designed that do not preclude future re-treatment.

More research is needed into newer materials that can be used in consolidants, adhesives, and fillers, and may answer three complaints commonly raised against some element of an old building: "it's falling apart, it's coming unstuck, and it's full of holes."

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NOTES

[1]Morgan Phillips, "Experiences in the Use of Acrylic Plaster Adhesives," in *Case Studies in the Conservation of Stone and Wall Paintings*, International Institute for Conservation, London, 1986.

[2]Charles Selwitz, *Epoxy Resins in Stone Conservation*, The Getty Conservation Institute, Marina del Rey, California, 1992.

[3]Morgan Phillips and Judith Selwyn, *Epoxies for Wood Repairs in Historic Buildings*, Technical Services Division, Heritage Conservation and Recreation Service, Washington, D.C., 1978.

[4]Morgan Phillips, "Acrylic Precipitation Consolidants," in *Science and Technology in the* for Conservation, London, 1982.

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Exposing Period Decorative Finishes

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In the past decorative painting was a standard tool in the design of interior spaces. The tradition remained unbroken from Colonial times through the Victorian era, and even into the twentieth century. As styles changed, the work of previous generations was routinely covered over to allow the expression of a fresher impulse which might itself be overpainted in turn. In the early twentieth century, with the emergence of the International Style, this continuous tradition was endangered by an aesthetic that found surface decoration trivial and even immoral. New decorative paint work virtually stopped, and, with regrettably few exceptions, that which had survived succumbed to brushes and rollers, many grimly united by loads of unrelieved white paint. As this style, too, has passed, and as we have developed an enormous interest in historic interior treatments, we have begun to develop techniques that will allow us to uncover and describe lost decorative paint schemes.

On occasion period decorative work can be easily retrieved. In cases where a new wall or ceiling many have been constructed in front of an existing one, we can recapture schemes in whole or in part for the price of careful demolition and minor restoration. In other cases the work survives under wallpapers which, when the underlying paints are not readily soluble, may be removed with relative ease. These cases are gifts for which we thank the muse.

Partially Obscured Treatments

Another class of examples are those in which decorative schemes have escaped entire overpainting but may have been retouched or allowed to become so dirty that their original intentions are difficult to read. The Sanford-Covell House is a privately owned building protected by SPNEA stewardship covenants in Newport, Rhode Island. Its interiors represent some of the earliest surviving American painted decoration inspired by Owen Jones' *Grammar of Ornament*. Recently, when restoration of the stair tower was planned, we were asked to examine the paints and to make recommendations. Our study determined that, while the work of the third story was essentially intact, that of the two lower stories had its fields painted out twice. This is very typical. Historically, when painted schemes became dirty, or when their colors have perhaps become unfashionable, their fields were often overpainted. In this case, the colors, a rich red on the first floor and a blue on the second, had not drifted too far from the originals. But investigation did reveal that one of the repaintings had sacrificed a row of bead and reel lozenges in the lower red field area below a running band. These were restored in the recent work, returning an original feature long lost to living memory.

We encountered a similar case in Portland, Maine. The privately owned Butler House had been extensively decorated when built in the 1860s. The trompe l'oeil panel treatment of its stair hall apparently survived, though darkened to a blackish gray by years of coal soot and neglect. When we began cleaning it became apparent that most but not all of its field areas had been overpainted at a time when the soiling was well advanced. Having been matched to dirt, the later gray was a jarring contrast to the light, purplish sandstone color of the original, and had to be repainted.

The initial cleaning revealed a further defect. Some of the stripes composing the trompe l'oeil moldings cleaned well. Others held their dirt, remaining extremely dark, and destroying the trompe l'oeil illusion. We could not let this stand, and feared that it would be necessary to overpaint surviving original work to restore the intended effect. We tried every cleaning material in the standard paintings conservation repertoire and then some. None worked. Fortunately, the observance of a chance effect led to a solution. In a few areas adjacent to patched cracks the true colors showed. We determined that the patching material had been a traditional lime mortar, and discovered that we could repeat the cleaning action with a mixture of hydrated lime and plaster of paris. (We have since further refined the mix.) While this was an extremely unconventional approach, it worked, allowing us to save those recalcitrant stripes and restore the panels to their proper look.

Mechanical Exposure

In the more usual case, decorative work has been painted out entirely. Occasionally there is an inherent weakness in the layering that allows retrieval by mechanical means. Sometimes this takes the form of a protective varnish weaker than the paints, sometimes it is enabled by oily dirt or the residue of cleaning materials, and sometimes it is unclear what advantage is operating. When SPNEA was asked to research the original decorative treatment of the Senate President's Office in the Massachusetts State House, tests showed that simple scraping, if done carefully, revealed the decoration. The completed job shows the actual period paints with relatively few modern repairs.

A very simple technique relying on the same conditions was useful in the description of the original ceiling decorations of the northeast parlor of the Norlands Mansion in Livermore, Maine. When wide duct or other tape, or, for greater coverage, contact paper, is applied to a surface, burnished, then quickly ripped off, it can reveal decorative work if an easy cleavage plane is present. At Norlands further chemical removal work was necessary, but the initial tape work quickly told us the type and placement of ornament.

A third type of mechanical exposure is sometimes very useful in the exposure of early decorative treatments on wooden substrates. It depends on tough, well-adhered decorative layers with thick, brittle accretions of oil paints on top. I refer to it as the "percussive technique," as it consists of light, controlled impacts that shatter the upper layers and expose the decorative work, sometimes in remarkably good condition. In fact, this technique can, on occasion, allow the complete retrieval of the actual decorative layer.

I first used this approach some years ago in a private Federal period house in Duxbury, Massachusetts. In the east parlor four original grained doors had escaped overpainting, though successive varnishes had darkened them considerably. It was not known that the four doors of the matching west parlor had also been grained (as had the mantle, window sills, chair rail and mop board) until a worker knocked into one of them, exposing a tiny bit of the work. I wondered if I could duplicate the accident over a broader area. I took a nail set, turned it upside down, and, with a tack hammer, gave it gentle taps as I moved it over the surface. This loosened the overpaints and revealed, except in the worn areas around the knobs and bottom rails, virtually intact early nineteenth century graining. I did all four doors, which, with minimal restoration, were reinstalled.

This percussive method is now standard in my repertoire. I have seen it work not only on original decorative work but also on decoration which was a second treatment. As stated, it only works on wood, and possibly only on soft wood. It can be effective in the exposure of graining and also marbleizing. However, great

caution is necessary as it can easily crush the surface, leaving an uneven field of divets. To minimize this effect it is important to use only the force necessary to break the intra-coat bond, and to keep the tool absolutely perpendicular to the surface. (This is not a technique I would recommend for museum-quality furniture.

Chemical Exposure in Architectural Settings

The above techniques are useful, but work only in a limited number of situations. The more usual job requires chemical exposure whose efficacy is in part dependent on the skill of the worker and in part on the chance combination of layers on a given surface. Typically the exposure process begins with a series of very empirical trial and error tests using materials largely borrowed from fine arts conservation.

It is important to draw the distinction between the often very different approaches of the fine arts conservator and the architectural conservator in dealing with apparently similar problems. The fine arts paintings conservator most usually is called upon to remove a limited number of coatings or amount of dirt. I know of no case in which a Titian has needed to be cleared of multiple layers of tenaciously bound house paint.

In the uncovering of architectural decoration, we may need to remove very similar layers one from another, and, while surveying to find work that might be hiding in a number of different layers, we may need to do this repeatedly in multiple spots.

There are further differences of scale and budget. Paintings are usually of a manageable size, and are often of enormous value. Architectural surfaces may be huge, and are difficult to ascribe a value to. We may know what the worth of the building is, but what is the worth of its north parlor wall or, even more elusively, of a lost period treatment of that wall? Buildings may be owned by anyone, from the most enlightened and well-heeled aesthete to the most rapacious slash-and-burn developer. Therefore the decisions made for a building can vary from best case study and conservation to actual demolition. And even those who might hope to treat their building in an optimum fashion may need to spend a limited budget keeping the rain out. Therefore, in the study of lost architectural decoration, we often must design the most expeditious approach or a given job may not happen or may happen in too limited a fashion. And too often we must satisfy our own inner demands for quality while keeping a keen eye on the clock.

Study Prior to Chemical Exposure

Chemical paint exposure is laborious and potentially toxic. Fortunately there are ways by which we may sometimes know things about the type and placement of designs before paint stripping begins. Painted stripes and banding may leave surface ridges, as may stenciling. Freehand work done with a full brush can also leave a tell-tale surface relief. These can be exaggerated by raking light.

Trenching

One very helpful surveying technique is to cut narrow trenches in the surface and to read them with a field microscope. By cutting across areas of suspected ornament, especially in two directions, we can begin to confirm or deny the presence of decoration. Work in the first floor hallways of the New York State Capitol Building in Albany used this approach. In each of the four main hallway quadrants and in two of the major lobbies we located successive generations of decorative banding on the plaster walls, most above high stone wainscots and, in some schemes, also at the spring level of the barrel and groin vaulted ceilings. We made straight cuts with a Mototool using a reinforced abrasive wheel attachment. We smoothed one side of the cuts with a scalpel and read down the cuts with a portable 20x power microscope. In a normal layering of architectural paints, each layer creates an unbroken running line. When a line ends, or when a new paint suddenly appears, it is likely that you have found the edge of a decorative motif. As we saw these changes, we recorded them on a piece of masking tape applied parallel to the cut. This gave us the rough outline of the successive bandings and pinstripings which we later sorted out both mechanically and chemically.

In a few instances we felt the need to see these layering changes under better light and at higher magnification. To do this we made long cast cross sections. We started by making a cut as deep as possible and at about forty five degrees to the surface with the same abrasive cutting wheels used for trenching. We then taped over the first cut with broad masking tape to hold the long plaster slice in place while we made a second parallel cut, meeting the earlier cut in a V shape. With great care, using broad joint tape knives, we detached the sections, putting them on a rigid backing to allow intact transport. Constructing narrow trays around them with foam core and clay, we covered them with casting resin. While we ordinarily use epoxy resins marketed for biological castings for typical small cross sections, in this case we substituted hobbyist's resin because of the large amount needed and the lower cost of the latter material. When set, we polished the tops with successively finer sandpaper grits on a stationary shop sander. This allowed us to examine the layering under the better conditions of the laboratory.

The same trenching approach can also be done chemically. Using narrow brushes and hardware store paint remover, it is possible to go through successive layers, examining the exposed strip of each for decoration. This technique, however, is quite crude, and will damage a layer perhaps later found to be amenable to entire exposure.

Infrared Photography

Another preliminary surveying technique is the use of infrared technology, although its use is limited. We had very good luck with infrared study at a private house in Hudson, Massachusetts. Several of its second floor rooms preserve early nineteenth century Moses Eaton stencils. In a major restoration of the 1920s new distemper stencil work was done mimicking the original, parts of which were left in most rooms. Because some rooms had been created from earlier smaller rooms, and because we had questions about motifs and placements, we were very curious to examine any earlier stenciling surviving below the later work but did not want to damage the existing surfaces. In some cases this was easy.

Because distemper paints derive their hiding power in part from the formation of porosity in drying, if they are wetted they become somewhat translucent, allowing more deeply pigmented underlying paints to be seen in areas of lighter field. (This approach is not without drawbacks, in that the wetting can leave tide marks at its outermost edge.) Unfortunately, in the northeast chamber, a layer of blue oil paint intervened between the presumed early nineteenth century work and that of the 1920s. By investigating in areas of existing damage, we were able to surmise that Moses Eaton work was, indeed, hidden below. We were confident that enough of the earlier paints contained lead-bearing pigments that they might have been partially read by X-ray, but, as the blue layer also contained lead, this was not possible. We decided to try infrared. With a Hamamatsu Photonic Systems model C 2741-03 Compact High Performance Infrared Camera connected to a monitor in the room, we were able to survey the wall and determine not only that the earlier work was there, but what its shape and distribution was.

Unfortunately, this approach will not always be fruitful. We were asked recently to investigate painted signs in Boston's Boylston Street Subway Station, which is, with the neighboring Park Street Station, one of the two oldest in the country. It was known from photographs that the station originally had painted signage, but the photographs were not clear enough to show its script. Nor did they show its extent. By chemical means we were able to uncover a typical letter, oddly an eponymous "T", the local nickname of the system. It was a stencilled letter with serifs and was shadowed by handpainted gray lines. This provided enough information for a rough reconstruction of the alphabet, but many questions and only limited budget remained. The chemical removal had been slow, and we wondered if infrared investigation would help. We had the perceived advantage that the letter paints contained carbon, a material that infrared has a good track record in sensing.

We arranged with Harvard's Fogg Museum Center for Conservation and Technical Studies to provide the equipment and do the testing.

Through the very thick accretion of paints we were unable to see any trace of lettering, even in places where we had good reason to believe it was present. To test the limits of the technology, we successively removed layers until, when we were only two layers away, we picked up faint traces. At a distance of one layer we had a fairly good look. Therefore, in those rare cases where decorative work has been painted out by not more than a single time, and where it is preferable to be non-invasive, infrared technology may be a boon.

Chemical Techniques

In the chemical exposure of decorative paints there is a range of possible solvents and possible results. The most ideal theoretical case would be oilbound work covered only by water soluble distempers which could be perfectly exposed with a wet rag. The next best case would be one in which the decorative work was covered by only one or a few layers of an easily soluble paint. This was the case in a private residence in Royalston, Massachusetts, which had most of its rooms stenciled very shortly after building in the early nineteenth century. Some of the work survived but most had been overpainted. Perhaps to prepare the house for sale, the previous owners had painted out very weakened stencils in the northeast chamber. The plaster substrate was quite rough, a type of surface that is often the least amenable to the exposure of period layers. Fortunately, the single coat of overpaint was a latex which we were able to dissolve with acetone on cotton. While, because of the surface, the exposure was far from perfect, it was adequate for us to document the color, shape, and placement of the stencils for possible future reconstruction.

In the most typical case, decorative work has been directly painted out and recoated with multiple layers of strong oil paints. A number of solvents and combinations of solvents are able to dissolve those layers. The challenge is to find one or to use one in such a fashion that it does not go on to dissolve the target decorative layer we hope to describe. On occasion we are fortunate to find enough of a chemical difference between adjacent layers that the solvent action will simply stop at a controllable point. In other cases we have to adjust our timing and removal technique so that a solvent which has the ability to dissolve a subsequent layer is stopped before it is able to do so. And, as our testing proceeds, we have to make realistic assessments of just what is possible in each case.

The most widely used solvent is hardware store paint remover of the non-caustic type. While there is variation from product to product, they are virtually all based on methylene chloride, usually with methanol and toluene and additional additives to thicken, retard drying, etc. Even when I finally use other solvents for the fine exposure work, I usually use a standard stripper to clear away thick upper accretions of paint which may have little interest. For either type of work it is imperative to remove each layer or group of layers in the most even manner possible. The results of poor work on an upper layer may cause difficulties later on. Therefore it is imperative to apply the material evenly over a workable area, to allow an equal dwell time (surface contact time) for all portions, and to use the removal tool with equal pressure and at a similar angle. I prefer a tool which is not too sharp, as it may cut into unsoftened paint. Unless mechanical exposure is an option, always let the solvent do the work, using the tool to removed material that has already been softened. Various putty knives are useful, but my tool of choice is a blade holder with a replaceable straight blade which I have intentionally dulled. I keep emery paper on hand for the purpose. When using the tool there is a danger that more pressure will be applied to one side than the other, giving a tiger stripe effect and making subsequent even removal difficult. This tendency is easy to see and easy to correct.

When clearing paints from a large area, and especially when those paints may remain exposed, it is important to control the edges of each block of work area. If the solvents go beyond the present area into one already taken down to that level, you may create strips which have cut too deeply. Conversely, if you do not approach neighboring areas closely enough, you will create ridges. In addition to the careful application of solvent up to but not beyond borders, it is helpful to slightly change the dimensions of each pass such that the borders of the last pass are included in the field area of the

next. Therefore the approach would be to take the entire area down to a given level by incremental work on adjacent blocks, then to reach the next level by working on shifted blocks. Any slight ridges that remain can be removed with spot application of solvent with tiny brushes.

The "dwell time" mentioned above is critical. The same solvent will work to different levels depending on the time it is allowed to sit. A skillful worker will begin to sense what this time is, testing readiness periodically with the tool.

As stated, hardware store strippers are the most common solvent used in exposures, especially when the goal is description for recreation. We relied on them almost entirely in the description of a Victorian ceiling scheme in the main court room of the Greek Revival Superior Courthouse in Barnstable, Massachusetts. After our exposure and documentation the scheme was reproduced by others.

Of course, sometimes they do not work, or do not work well enough to allow adequate description of a motif. This was the case with a running stenciled pattern in the first floor northeast hallways of the New York State Capitol. The original plaster surface was extremely nubbly, making combination solvent and tool work impossible. A totally chemical method was necessary, which we identified as a solution of ammonium bicarbonate raised to a high Ph and applied with cotton balls. Because the mixture selectively removed the immediate overpaints but spared the target layer, we were able to fully document the stencils as well as to see the intact surface of the historic paint.

Decorative Exposures at the Treasury Department

In 1990 we did work which required extensive surveying for and exposure of decorative paint schemes in the Salmon P. Chase suite in the Treasury Department Building in Washington, D.C. This project serves to illustrate typical problems and solutions, as well as several atypical aspects of such work. In the largest of the three rooms, the one-time Secretary's Reception Room, there was evidence for three successive decorative schemes. There had been an original treatment for which wall but not ceiling evidence survived. Our best and most complete evidence survived for the second scheme, that finally chosen for reproduction. The third scheme incorporated the ceiling treatment of the second, employing a stenciled frieze as its only new decorative work apart from the polychroming of architectural elements. Our goal was to uncover and record all three schemes.

The third frieze treatment presented little technical challenge, but might have escaped detection in a more cursory search. Very little early plaster and therefore early evidence survives in the room. An extremely thick accretion of oil wall paints has, over the years, oxidized and shrunk, detaching its plaster substrate and leading to extensive replastering. There were only three limited areas in which to test. We needed those areas to provide information for the complete description of (at that time) an unknown number of schemes, and also to provide undisturbed spots of preserved evidence. The first test area, that between the two western windows of the south wall, showed the second frieze as the most recent decorative work. It also gave the first indications of the original frieze. But, probably because of the installation of a pier mirror or other large object, it showed no trace of the third treatment. Had we made the decision to go through the exposed second treatment in this spot in our study of the first, and to have left both other areas undisturbed, we might have missed the third frieze altogether. Rather, we decided to do preliminary tests on both of the other areas of early plaster, and to uncover the original frieze on an interior wall (where, of course, we were obliged to destroy evidence for the second frieze to reach the earlier material). We then found the last (third) frieze which we were able to uncover adequately with 5F5, a commercial stripper manufactured by Sterling, Clark, Lurton of Medford, Massachusetts.

The exposure of the second frieze, of which we had a good period photograph, was more of a technical than a chemical challenge. The immediate overpaint was quite soluble in several materials. Because it was the cheapest, most accessible and relatively least toxic, we used acetone, sprayed on the surface and wiped with

cotton. A thickened acetone gel would also have worked, and might have been our choice had we needed to uncover a larger area. As stated above, the thick accretion of oil paints had detached and caused the loss of large wall areas in the room. Had the process been allowed to continue, this might have been the next area to go. The plaster finish coat was delaminating over most of our test area, being held in place only by a few non-detached spots, by the friction of the neighboring plaster plates and, ironically, by the very same paints that had caused the problem. Unfortunately, it is not uncommon to encounter this sort of situation in which decay threatens the recovery of a decorative treatment. While this problem was in the plaster, we sometimes encounter like problems in the flaking or lifting of the paints themselves. It may be necessary to readhere and otherwise conserve the paints or plaster before any exposure can begin. (The range of possible solutions to these problems is beyond the scope of present paper.) In this case I was able to expose the decoration without plaster readhesion by operating on the surface with extreme care.

The second scheme's subtle wall stencils were challenging to identify and isolate due to the very low contrast between figure and field. (See the discussion on photographic evidence below.) Once the upper overpaints had been removed careful application of n-butyl amine diluted with water allowed their exposure.

The ceiling decoration which completed the second scheme had been varnished before being overpainted. This offered an easy stopping point, and allowed rough exposure with 5F5. The varnish was extremely discolored, obscuring the period paints and distorting their colors. Fortunately, it was soluble in lacquer thinner (a very strong combination of solvents including xylene, toluene, etc.), allowing us to have an unobstructed look at the true palette. However, this solvent was very hard on the bronze powder line which bordered all elements of the central foliate design. Had this not been the case entire retrieval of the ceiling paints might have been economically feasible.

Evidence for the Reception Room's first decorative scheme survived only in part, given that the ceiling treatment, probably done in water soluble distempers, had been lost entirely. We did, however, have intact if limited evidence for a full wall treatment from painted dado to frieze. This scheme, especially in its frieze, was the most difficult exposure in the room. The paints were quite soft and were not particularly well adhered. The overpaints were much stronger and were well bonded to the original work. Further, they offered no clear solubility difference that we could exploit. Briefly, it seemed that we would not be able to describe the scheme completely without opening up too great a length of its short extent, allowing an inadequate sample to be left intact for future research.

As we would approach a bit of the original paint, the overpaints would pull off the surface taking the target layer with them. Sometimes under such circumstances it is possible to cut the upper layers away using fresh scalpel blades under a field microscope. Even this very time consuming approach did not work. We finally settled on an approach whereby we got as near as we dared to the layer with chemicals, then sanded the surface very carefully with fine sandpaper. We then had a thin residue of the overpaint over a patch of the original which we removed chemically. As stated, there was no solvent which would both dissolve this residue and not attack the soft underlying paints. With great care we were able to apply a solvent (the ammonium bicarbonate mixture described above) with swabs in tiny localized areas, stopping the action with water and cotton before the original paints were entirely destroyed. Much of the early work was lost, both because of the imprecision of the technique and because of the failed tests that had preceded it. However, in part because the repeat was short, we were able to piece together enough lines from different parts of the exposed area to faithfully reconstruct the scheme in a completely non-speculative manner.

The other major room of the Salmon P. Chase Suite is the corner office, twice in the past the office of the Secretary of the Treasury. Presumably this room, too, had had three decorative schemes, but evidence for the first (which would have been contemporary with the frieze described immediately above) was entirely absent. The second scheme was related to the second scheme of the Reception Room, sharing identical wall stencils though distributing them differently. The third treatment left the ceiling

decoration of the second intact but repainted its field to match new wall paints and accompany a new polychrome cornice treatment. Its frieze was also reworked in an arabesque pattern in colors matched to the surviving ceiling foliate design.

Because the wall stencil treatment of the second decorative scheme used the same stencils already described in the Reception Room, and because the figure and field contrast was great, it was a relatively simple task to work down evenly through the layers and reveal the dark green stencil paint with 5F5 paint stripper. But there was difficulty in the interpretation of the evidence uncovered. As stated above, the Reception Room ceiling had narrow stripes painted in a bronze paint. Parts of the stripes remained gold in color while the greater part had degraded to a very similar dark green. (It is possible that the protective varnish helped retain the gold color in those few spots.) The stencil's dark green was also similar to colors seen on painted furniture when bronze paints degrade. Under the microscope it became clear that the paint was composed of bright bronze specks in a semi-translucent green oil matrix. We saw no independent green pigment particles. Because of the somewhat acidic nature of drying oils, it seemed possible that any corrosion might have been accelerated, possibly causing the migration of corrosion products into the matrix, and hastening the conversion of a possibly golden finish into a deep green one. The question therefore became: was the green of the matrix original and intentional or was it a corrosion product which should not be copied in restoration? We sent a sample to the Fogg laboratory for analysis. They found in the matrix a copper component unrelated to a corrosion product, therefore indicating that the intended original effect was that of a sparkling, translucent green.

Intact Exposure of a Ceiling at the Treasury Department

The most interesting and ultimately the most productive exposure in the suite was that of the Secretary's Office ceiling. Some years ago, a worker preparing the ceiling for painting had seen some paint chip off and noticed a color difference below. He began to scrape with a putty knife and discovered two female allegorical figures, one on each end of the central shallow ceiling arch. Although we have no surviving chips of the overpaints, it is likely that these paintings were thickly varnished, allowing the easy mechanical exposure. No other area of this central arch or either of the two flanking arches was amenable to the same technique. A few years before our work in the room exposure tests on additional areas were done, revealing a very sophisticated foliate design with, in the extreme ends of each of the full outer arches, trompe l'oeil Treasury Department shields. These tests had been done with commercial strippers and a blade, going down evenly through the layers in the manner described above. Unfortunately, this technique could not produce undamaged results as the work had been done with very full bodied paints which had been applied thickly in areas of highlights and accents, producing a surface with pronounced relief. Therefore any chemical and blade removal which stopped short of cutting off the high point of the paints left large amounts of overpaint in the valleys, and any which removed most or all of the overpaints necessarily sliced through and sacrificed the thickest areas of the decorative work.

Our preliminary tests discovered some very useful information. While the first overpaint, (that applied after the room's third decorative treatment, obscuring the allegorical figures, the foliate decorative work, and the scheme's second field) was a well bound layer, the subsequent ceiling paint was very weak, and could be selectively dissolved by a number of solvents. This allowed us to reach evenly a level exactly one layer away from the decoration. We further discovered that, although the target layer was also soluble, it was a bit more tenaciously bound than the first overpaint, suggesting that we might be able to remove it with little damage to the lower layer if we controlled our dwell time carefully. The remaining difficulty was in the surface relief which prevented effective knife work. Our solution was to dissolve and remove the first overpaint not with a tool, but with a fabric, allowing its total removal without endangering the raise highlights of the decoration. The results were surprising. The test areas were exposed virtually intact, suddenly

raising the exciting possibility that the actual historic paints might be retrieved rather than replicated. The Treasury Department requested and accepted our proposal to do just this.

Our steps were as follows. We first removed the bulk overpaints with commercial stripper. Two difficulties emerged during the work. One was the partial spot delamination of the paint accretion down to lower levels. To accommodate this condition we were forced to apply our materials around these shallow craters until their level was reached. The second major difficulty was the delamination of the plaster surface along the lowest edges of the arches for reasons of paint thickness and shrinkage as described above. To correct this completely unacceptable condition we injected adhesives into the shallow voids and stabilized the surface. To accommodate this unexpected but necessary work within time and budget constraints, we decided not to expose the solid color field areas, but rather to repaint them.

When we had evenly reached the level of the second overpaint we sprayed on denatured alcohol, one of several possible solvents, rubbing each area with rags to reach the first overpaint. With carefully monitored dwell time, we applied 5F5, removing it with a dull blade just at the point when the overpaint was loosened through most but not all of its thickness. When cleared this allowed a ghost of the decorative paint to show through. We then applied the 5F5 again, controlling dwell time even more carefully as it also had the ability to dissolve the target layer. When the overpaint residue was thoroughly weakened, but before the target layer had been attacked, we vigorously rubbed the chemical and paint residue off with rough pieces of burlap. The burlap functioned in two ways. It was just rough enough to act as a mild abrasive, loosening the softened upper paint, but without the strength to damaged the decorative work. Because of its loose weave it also had the ability to absorb large amounts of material. When this step was completed we cleared the surface with mineral spirits to stop any residual solvent action and to remove any traces of the wax additives of the 5F5 which could interfere with later coatings. Thus, unexpectedly, we were able to expose the period decorative work using exactly the same sort of solvent which had proven inadequate previously by using it in an unconventional fashion.

As stated, this campaign of work did not expose the central field areas which were repainted in the subsequent restoration of the room. Preferring a ceiling whose paints were entirely exposed, the Treasury asked us to return and to remove the new field paints and surviving period overpaints to bring the fields to the same level as the surrounding decorative work. This phase of work presented technical difficulties in the form of shifted solubilities in the paint layers. In sum, the problem developed in the following way: In our earlier work in the room, we had used solvents to remove the paints above the first overpaint. The apparent action of these solvents was to soften the layers which we subsequently removed with tool and fabric. In fact, there was a deeper solvent penetration into the underlying layers. That is, portions of the solvents actually moved farther into the paints than their upper softened portion would suggest. Those more deeply penetrating fractions dissolved and at least partially removed the most soluble portions of the lower paints. Therefore, once the layers had dried completely, they had in effect been changed, retaining their less soluble materials while their more soluble ones had been removed to a significant degree. In this way we had actually reformulated the paints, causing them to be more insoluble than they had originally been, and preventing the familiar techniques that had allowed such exceptional exposure on the neighboring areas to be repeated to similar effect in the fields. (It is possible that our naphtha removal of the modern alkyds applied during restoration also aggravated this condition.)

We have come to realize that a caution on solubility shifts must be factored into any chemical paint removal work. While a short lag in time will not endanger an effort, too long a delay before returning to a surface that has undergone extensive exposure to solvents may alter the film's behavior in vexing ways.

Gold Leaf

Areas of gold leaf pose a perennial problem in the exposure of decorative schemes. While it might be thought that a material which is

elemental and incorruptible would easily stop a solvent and survive well, in practice this is rarely the case. When the gold is confined to striping or bordering, the areas of its use may be predictable, and its elusiveness may not be a great problem. But when it forms a more complex part of a decorative scheme it may present a serious challenge. This was the case in the description of a wide decorative frieze in the Collector's Appointment Room of the United States Customs House at Bowling Green in New York City. Repeating winged caduceus designs in large circular medallions had been done in stenciled gold leaf. The complex feathers patterns of the wings and those of the twining snakes were extremely elusive. Too aggressive work with solvents destroyed them easily, leaving undifferentiated field areas. Less aggressive work exposed them only in a spotty fashion, offering little help in describing borders.

Our final successful reconstruction of the pattern took advantage of the fortuitous behavior of the very tough, dark overpaint immediately above the target decoration. By approaching the layer closely with commercial stripper, then wiping with lacquer thinner (one of several solvents which gave this effect) we were able to leave the dark layer intact over field and non-gilded figure areas but to somewhat clear the gold. This may have been due to the paint's reduced ability to bond over the gold. This created an effect which had never existed, i.e., gold elements appearing on a field which was actually the subsequent paint treatment. Using this technique, which was far from totally effective, We were able to describe the pattern by exposing three of probably eleven medallions and comparing them. Because the patterns were largely bisymmetrical, this gave us six test areas. Systematic overlays of acetate tracings of them finally produced an accurate reconstruction. (There was one minor area at the point where the wings meet the upper circle whose final outline included a small bit of speculation.)

Photographic Evidence

Occasionally we are lucky to have period photographs showing intact interior treatments. While these are an enormous help in recreations, providing information that sometimes can be had in no other way, their use in the reconstruction of decorative paint schemes can be limited. The first limitation, of course, is in color, which is not faithfully reflected on early orthochromatic films. The second limitation is in detail which is often too small or grainy to allow the accurate reconstruction of a design's subtleties. Clearly, we will continue to use photographs as an aid in the study of decorative painting. But we must recognize their limitations, and realize that they cannot be a substitute for physical investigation in those cases for which the evidence survives.

The Treasury Department work illustrates an additional possible defect in photographic evidence. While working on the wall field area of the Reception Room mentioned above, my first indication of decoration came in the form of a distinct paint ridge of the sort that usually indicates obscured stenciling. Confident that I would soon come upon it, I continued removing layers until I came to plaster and realized that, whatever it was, I had missed it. I went back again very carefully and still saw nothing, at which point I brought in my microscope and began to approach it in other ways. What I finally discovered was that there had indeed been a wall stencil, that it had accompanied the frieze pattern shown in the photograph and already uncovered, and that its field and figure colors had been so close, creating a scheme of wonderful subtlety, that neither rough chemical work nor microscopic investigation under field conditions caught it easily. Having proven that this treatment existed, I returned to the photograph which should have shown it. Outside of a possible mottling, it simply had not been recorded

Polychromed Woodwork

Woodwork features in early houses were occasionally picked out in different colors. While this is not a classic decorative treatment like graining or stenciling, it is, properly, decorative work, and must be described to enable faithful recreation. There may be no way to predict its presence in a given room, therefore it is important to do testing which is extensive enough to discover any which may have been

done. We encountered some simple woodwork polychrome in recent work in a chamber of the Clafin House owned by the Wenham Museum in Wenham, Massachusetts. The paneled chimney wall showed a light green as its second finish treatment, the period that changes in the room suggested as its interpretive date. On several members just around the fireplace opening, a deep red could be found. It covered the two vertical quarter round moldings adjacent to the opening and the lower quarter round and flat face of the contiguous horizontal rail, but not its upper quarter round. While extremely simple, not to replicate it would have been to restore the room incorrectly.

There are also instances in which a monochromatic paint treatment ends at a given point. To show a space correctly such termination points must be described. The methods by which we describe them are the same as those discussed above for the description of decorative schemes. The stair hall of the mid-eighteenth century Bates-Scofield House owned by the Darien, Connecticut Historical Society will illustrate. The greater part of the woodwork of the hall had been given a Prussian blue base coat and a translucent verdigris glaze, a common fancy treatment of the period. The stair treads, however, showed evidence of having remained unpainted during this period. We could see that the tread's side nosings, which faced the entry, had been painted. The question arose of how the painted areas met the unpainted treads. Chemical study revealed that the glazed blue was taken about two inches onto both the treads and risers, making an unbroken line which descended down the flight at the point of the balusters.

The recovery of early polychrome schemes may depend not only on distinguishing areas of differing paints, but also in the proper description of their colors. Recently we were asked to look at an elaborate early eighteenth century corner cupboard taken from the Jaffrey House in Portsmouth, New Hampshire and now in the collection of the Museum of Fine Arts in Boston. Our investigation showed that the interior of the cupboard had been exuberantly picked out in bright colors, most of which survived well. Our first look at the paint of the curving rear wall of the cupboard, however, showed a darkish khaki color, not unlike the actual exterior color of the cupboard. Because some eighteenth century pigments are notorious for degradation and change of color, we looked more carefully and were able to find a well protected speck of non-degraded paint which proved that the original color of this feature had been a light green. Not to have faithfully reproduced this green would have led to an egregious misreading of the cupboard's true period appearance.

First Period Decoration (to c. 1720)

In recent years we have increasingly come to realize that decorative treatments were not uncommon in first period houses. The exuberance that they could express is well illustrated by a set of decorated ceiling boards which have come to light only recently. The field color is a pink on which broad, expressionistic waves, chevrons and lines were painted in strokes of white. Distributed over the remaining surface were comma-like "sponge paint" strokes which had originally been light green. Unfortunately, very few first period houses survive, and many of those that do have been restored in a style which caused most of their woodwork to be stripped. When evidence does remain it can be very difficult to read, as the paints tended to be weak distempers, gouaches or whitewashes which often survive only in small part. We were tantalized recently by the discovery of a roughly one foot long section of wall sheathing with intact early paints in the 1656 Whipple House owned by the Ipswich Historical Society in Ipswich, Massachusetts. Preliminary study suggests that it preserves the remains of early decoration, possibly "sponge painting" and picked out vertical moldings. Further investigation has not yet been done.

Because of the tendency of these fragile early paints to survive only in part, we can be presented with chimeras which appear to be decorative treatments but are in fact not. When, a few years ago, work was done on SPNEA's first period Perkins House, also in Ipswich, it appeared that a decorative treatment had been discovered on the paneling of its stair hall. Merged colors suggested a primitive marbleizing which was very beautiful. In reality it was a

chance co-mingling of fragmentary layers, successive paints having been applied over incrementally failing surfaces.

Dangers

The danger of phantom decoration is not confined to the first period. We were recently called in to examine window trim in the main stairhall of the Boston Public Library where painters believed that they had discovered a decorative glaze. On examination we found that the very inaccessible element it was thought to be on had been painted infrequently, and had become very dirty before the original treatment had been painted out. The shallow brushmarks of the surface had preserved enough dirt that, on uncovering, it had the appearance of a striated glaze. Our judgement was very simple. We removed it with soap.

There is an opposite danger that decorative work can be missed altogether. We were asked to visit the Congregational Church in Barkhampstead, Connecticut to comment on the proper matching of an assumed original gray paint that had been uncovered by members of the congregation. In fact, the gray was the second finish treatment, the first having been a tight grained faux bois in colors so similar to the actual broad grained base wood that it was extremely difficult to detect. All the wainscot and the greater part of the pews had received this treatment which has since been reproduced.

Toxicity

The exposure of lost period decorative work can be both challenging and rewarding. It can also be toxic, and certain cautions must be observed. Virtually all thick accretions of old paint contain lead. The worker must be very careful to avoid ingesting lead, to contain all lead-bearing residues and remove them from the job site, and to dispose of wastes properly. Virtually all solvents used in the chemical exposure process are potentially harmful. Exposure by both inhalation and skin contact should be avoided by the use of well fitting masks with fresh organic vapor cartridges, chemically resistant gloves and outer wear, and eye protection.

Conclusion

As I hope is clear from the above discussion, we are making progress in the development of field techniques to enable the description and even entire retrieval of obscured historic painted decoration. We have incrementally built a repertoire of approaches, but have not yet come so far that an element of invention is not often necessary. With further work and with future technological help, it is our hope that the exposure of decorative paint schemes will become increasingly affordable and commonplace, and that greater parts of our lost decorative heritage can be reclaimed.

* * *

Whitewash and Calcimine: Paints that Ain't

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Talk about paint and most people think of coatings based on a natural drying oil, one that carries the pigments used for opacity and color and that "dries" to a shiny, semisolid film. Indeed, drying vegetable oils and some fish oils have been used as paint vehicles for centuries, and linseed oil pressed from flax seed has been the lifeblood of ready-mixed paint from the industrial revolution until very recently.

Not every historic paint made use of drying oils, however. The hand-manufacturing process of pre-industrial paint, the expense of oils, and the custom of do-it-yourself painting that was set early in the colonial period made some interesting non-oil alternatives common. Milk or "Farmer's Paint," for instance, mixed simple pigments and lime with milk, the protein in which served as a binder. Perhaps most widely used were two closely related, site-mixed, water-based paints, whitewash and calcimine. Both these coatings have a history and character that makes them uniquely appropriate for period interiors, yet their home-spun nature means they require working methods apart from ordinary paint.

Whitewash

In all of its countless formulas and compositions, whitewash is still largely water and lime. When mixed to a thin paste and applied with a brush, it forms a film of calcium carbonate--essentially plaster--that provides a white, opaque coating. Until well into this century whitewash was made with slaked quicklime (produced by calcining limestone, oyster shells or similar raw material in a kiln). In fact, early recipes often recommend mixing and using whitewash while the lime is still hot from the slaking reaction in order to improve adhesion. Today, hydrated limes that require a minimum of slaking have replaced quicklime for most purposes, and any one of these products will make whitewash.

The list of other possible ingredients is long. Most are binders, organic and otherwise, mixed in to improve the durability and chalking resistance of the basic lime-and-water blend. Salt is the across-the-board favorite, but others that pop up are sugar, flour (rice, wheat, rye, or buckwheat--but never corn), starch, varnish, glue, skim milk (unspoiled), whiting, brown sugar, vegetable oil plasticizer, casein, formaldehyde, borax and sulphate of zinc. Alum was often advocated as a hardener that would keep the coating from rubbing off, and adding carbolic acid made "sanitary" whitewash. Indigo and common bluing are popular for counteracting the tendency of some binders to yellow. Bluing also has the same effect on a finished whitewash job as it does for laundry linens: making white look whiter.

Whitewash was not always white either. Adding lampblack produced whitewash in light to dark shades of gray. It was also commonly tinted with earth pigments such as Spanish brown for a dull pink, ochre for a cream color, ochre and lampblack for a stone color, or umber and lampblack for a fawn color. Brick dust, charcoal dust, and similar crude colorants might also find their way in. However, greens made by combining colors, chrome yellow, and other pigments destroyed by the lime were notoriously impractical.

Historical Use

Whitewash has long been popular for many surfaces because it is versatile, easy-to-make, non-yellowing and, above all, cheap. Tom Sawyer immortalized its application on fences, and it has been used outdoors on cottages, barns, stables, chicken coops, icehouses (to reflect heat), and outbuildings in general for generations. Unique roles for whitewash--such as protecting the trunks of fruit trees from frost and insects--abound, and in the 1840s the federal government even standardized its own formula of lighthouse whitewash for painting these aids to navigation.

Interior use of whitewash dates to the 17th century, when it was one of the few finishes available to early Americans. Colonial homeowners seem to have done their own whitewashing even when plasterers--whose trade often included whitewash--or painters were available. Whitewash might be found in the kitchens, pantrys, or the "public" walls and ceilings of houses. There is also evidence it saw use in grander buildings, such as the private stairway in the governor's Palace in Williamsburg, Virginia. By the 1887, one writer summed up whitewash as "a healthy and wholesome finish" for plaster walls that could be made "no less... agreeable to the eye by being tinted with dry color."

In the last century, whitewash gained an additional reputation for having some specific advantages (still including cost) over other finishes that made its use more specialized. First, whitewash held up well over masonry--not suprising given the lime content. Second, it was considered a "sanitary" coating appropriate for areas where food or livestock were kept or to retard the decay of wood. Mixes sometimes included carbolic acid to supplement the "disinfectant" quality of the lime. Though still good for wood surfaces, these advantages meant whitewash was regularly advocated for basements, underground rooms, and passages. Cellars, in particular, were often whitewashed yearly to keep them "sweet" and prevent stores from spoiling as well as to brighten the room. In this century, whitewash in thick coats has even been touted as a moderately effective fire retardant and thermal insulator.

Application

There are many antique recipes for whitewash. All require the use of slaked quicklime and most add two or more (occasionally cumbersome) other ingredients. The following interior mix from 1879 is typical:

Slake about one peck of lime in hot water, keeping it covered during the slaking process. Strain and add one-half peck salt dissolved in water, one and a half pounds ground rice put in boiling water and boiled to a thin paste, one-quarter pound powdered whiting, and one-half pound clear glue, dissolved in warm water. Mix well together; let it stand for several days and apply hot. Color to suit.

As noted, most historical additives are an attempt to counteract the tendency of whitewash to chalk or wash off; it is the lime that supplies the basic appearance and texture. Two mixes recommended in one form or another since the 1930s are easy to make, durable, and still provide the classic flat white whitewash look:

I. *Make lime paste by soaking 50 lbs. of hydrated lime in 6 gallons of fresh, clean water. Dissolve 15 lbs. of salt OR 5 lbs. dry calcium chloride in 5 gallons of water, then combine with 8 gallons of lime paste, mixing thoroughly. If necessary, thin with fresh water.*

This recipe is good for general woodwork and has substantial adhesion and chalk resistance in the calcium chloride version. The wash can stand covered for several days after mixing.

II. *In dry form combine 25 lbs. hydrated lime with 25 lbs. white portland cement, then add about 8 gallons of fresh, clean water. Mix thoroughly. A dollop of white casein glue (Elmer's brand glue) may be added per working batch. The wash should start out as a thick slurry, which is further diluted to the consistency of heavy cream.*

This formula works well on stone, brick, and other masonry. Don't mix more than can be used in a few hours.

Whitewash adheres best to rough surfaces and is less successful on smooth or non-porous

materials. Surfaces to be whitewashed must be clean and stable; dirt, dead whitewash scale, and other loose material should be scraped off first. Because there is no oil-based film to saponify with a caustic or penetrate and lift with a solvent, old-but-tenacious whitewash can be difficult to remove. Still, saturating the surface with vinegar or dilute hydrochloric acid usually speeds the work. (A test for whitewash is observing if sample fragments dissolve when immersed in acid.)

Fresh whitewash should be applied to a dampened surface so it dries slowly for improved adhesion and limited chalking. Best results are obtained with two or more thin coats, especially on masonry. The wash will go on like milk and be almost translucent, but will dry opaque and can then be recoated. The time-honored whitewash brush is wide and stiff with plant-fiber bristles such as tampico that are lime-resistant. Spraying with a pump and hose has been popular in the past for large surfaces. The watchword on modern tints is to mix them in carefully to avoid spotty coloring and to use lime-fast pigments (available at masonry supply houses).

Calcimine

Closely akin to whitewash, yet significantly different in aspects of its history and use, is calcimine. Also known as kalsomine or distemper, calcimine is a simple water-based paint that employs whiting (ground chalk) as the primary pigment. When the powder is mixed with a glue size binder and water, it can be spread with a brush much like whitewash or fresco decorating. Early calcimine was mixed on the job by the painter or homeowner from dry whiting that was bolted (sifted through a fine silk cloth) and flake white glue, but it was later available in a dry-mixed prepared form. Zinc white was sometimes substituted for whiting before 1900, particularly in high quality work, and manufacturers of prepared calcimine might include casein along with the glue.

Calcimine was originally popular in its pure, white form but in time it was realized that the coating took colors well. Tinting with dry distemper colors ground in glue was common until matte-finish oil and latex paints took over after 1940, and variety of black, green, Venetian red, lake, ochre, brown, and blue pigments.

Historical Use

Throughout the 19th century and well into the 20th century calcimine was used to whiten walls and ceilings in all levels of housing. It was inexpensive and easy to apply, making it ideal for use by homeowners and semi-skilled painters. It was also fashionable, with an "artistic," absolutely flat, soft pastel look and velvety texture that was unobtainable with the linseed oil paints of the era. White calcimine was well-suited to ceilings and when tinted was popular for walls. In the late 1800s some tastemakers held that calcimining parlors, sitting rooms, and bedrooms in "cold colors" was to be avoided in favor of "delicate or warm neutral tints." However, the dark, strong hues of reddish brown, maroon, olive, steel-blue, or green were acceptable for halls, dining rooms, and libraries.

On the practical side, calcimine covered less-than-smooth plaster well and, being water-based, it could provide quick color to walls in new construction before the plaster cured fully--a weeks-long process. It had its limits, however. The simple nature of calcimine meant it did not stand up well to abrasion, moisture, or other domestic wear, and it was often used down to a wainscot or other durable surface that covered the real traffic area. Because calcimine could not be washed, it was customary in most households to recoat the surface every two years or so as it soiled or aged. Since a second coat of calcimine tends to dissolve the glue and lift the first coat, ceilings and walls were normally washed clean before applying the new job. Water and elbow grease were the main solvents, but adding a little washing soda or vinegar to the bucket helped. In its day, the impermanent character of calcimine was even promoted as an advantage, making it easier to "redecorate" than wallpaper or textiles.

Application

Making "old fashioned" calcimine from raw ingredients involves breaking up and thoroughly blending the masses of whiting and glue and

letting them soak overnight--a chore that was largely obsolete by the 1930s. Prepared calcimine, though, is simply mixed with water in a galvanized or plastic pail according to the manufacturer's directions. Typically this means adding enough warm or cool water to make a paste, then straining this mixture through a cloth. The calcimine is then allowed to sit for at least 30 minutes, after which it is thinned with cold water just enough to be workable.

Unlike whitewash, calcimine is applied heavy in one single coat, flowing on the mix rather than brushing it. Though it is not intended to take subsequent coats because the glue resoftens, at one time part of a skilled painter's bag of tricks was being able to lightly "top over" a first coat with a deft hand if more calcimine was necessary. Wide brushes are used for calcimine, traditionally with stiff Russian or Chinese natural bristles. Surfaces need to be very clean, free from oil, and are usually sized to produce a uniform job. Since calcimine is quick-drying, it has to be applied rapidly to maintain a wet edge, avoiding drafts or very warm conditions in the room. Conversely, working in a cold, damp building could cause the calcimine to sag.

Tinting calcimine requires attention too. Colors are mixed with water, then the pre-strained calcimine paste, in order to obtain an even blend. Combinations of colors are first mixed dry, then wetted and added. It is important to test tints first on paper or the wall itself to judge the color, as they dry lighter than their wet appearance. Stippling with brushes or sponges was also a favorite effect.

Calcimine is still a highly appropriate and obtainable finish for many historic interiors. Evidence of existing calcimine is easy to confirm; if the finish dissolves with water, it's calcimine. Determining original colors is simple as well. Archival records or wall samples tend to be remarkably reliable because the lack of an oil binder means they are unaffected by yellowing.

Indeed, calcimine probably causes the most problems when it is encountered unexpectedly. After calcimine had seen its heyday, the walls and--most notoriously--the ceilings of many a building were overcoated with oil-base paint. Since these paints contain no water, the calcimine usually holds up and may be recoated many times. However, once high moisture levels are present or a latex paint coat is added, the calcimine often softens, causing all the subsequent paint jobs to peel.

When this situation occurs, the best solution is removing all paint down to the original calcimine. This is never an easy proposition and inevitably requires much handwork. Washing with solutions of TSP (trisodium phosphate) or wallpaper paste remover and water helps, as do the vinegar or washing soda methods. Another approach worth trying is steam from a wallpaper removing rig or other source. Remarkably, applying wallpaper paste to a paint-over-calcimine surface is also a good trick because the drying paste tends to stress the layers, causing them to peel further and often drop right off.

Prepared Dutch Kalsomine is still manufactured by the Muralo Company of Bayonne, New Jersey, and is available retail through the Johnson Paint Company (355 Newbury St, Boston, MA 02115; 617-536-4838).

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Covering/Encapsulating Decorative Wall Treatments to Ensure Long-Term Preservation Options

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The following describes some cleaning techniques and several methods of covering and encapsulation that have been used, in the past, to protect original decorations, or perhaps used merely to cover unsightly cracks on ceilings and walls.

Perhaps you may agree with me that conservators, in the United States, have only recently became involved with the conservation and restoration of large-scale ceiling and wall decorations. In the process, their contributions are largely responsible for making decorative painters, architects, and curators of historic properties aware of the importance of reversible materials, and the need to respect the original decorated painted surfaces.

However, one of the problems associated with conservation materials (such as "Magna Colours" for example) is, that they are neither adaptable nor practical, nor suitable for large-scale painted areas. These materials are delicate, easily dissolved, and do not brush out well on a large surface, nor stand up to the wear and tear of every day abuse in a functional building.

Cleaning

In the traditional decorative trade, probably the best form of preservation was defined as a "wash finish," and today, it may be termed as "maintenance." It was common practice for a church decorator, to simply wash the ceiling and walls, using a mild ammoniated detergent, observing elementary procedures, such as working from bottom to top, in order to avoid unsightly detergent streaks from running down and dwelling for any length of time on the unwashed surface below. After an appropriate dwell time of the detergent, the surface would be rinsed thoroughly with water, then wiped with a chamois leather. This "wash finish" is no longer practiced, but instead, the ceiling and walls are painted over with a modern day latex paint.

Likewise, when a varnished surface over a painted decoration becomes discolored or yellowed, today, the varnish is no longer cleaned off, but painted over in an Off-White or "colour of the month," resulting in the obliteration of what was a well-planned, and harmonious scheme. This repainting, due to the nature of the paint, must be repeated every ten years or so.

Contrast painting over the varnish, with the traditional decorator's method for removing discolored and yellowed varnish over decorative paint. The methods are similar to those used by a fine arts conservator. Conservators working on a canvas painting, would roll a cotton swab, saturated with an appropriate solvent, and work over the surface of the painting approximately a square inch at a time. A decorative painter would use a 9" Lambs Wool roller, saturated with appropriate solvents, and work over the surface of a ceiling or wall a square yard at a time, dissolving the old varnish which can then be removed with a clean cloth saturated with solvent using the minimum amount of abrasion

on the original decorated finish. After which, it would receive a "wash finish," described previously. Then the decorator would in-paint or repaint the damaged areas with oil paint and re-varnish.

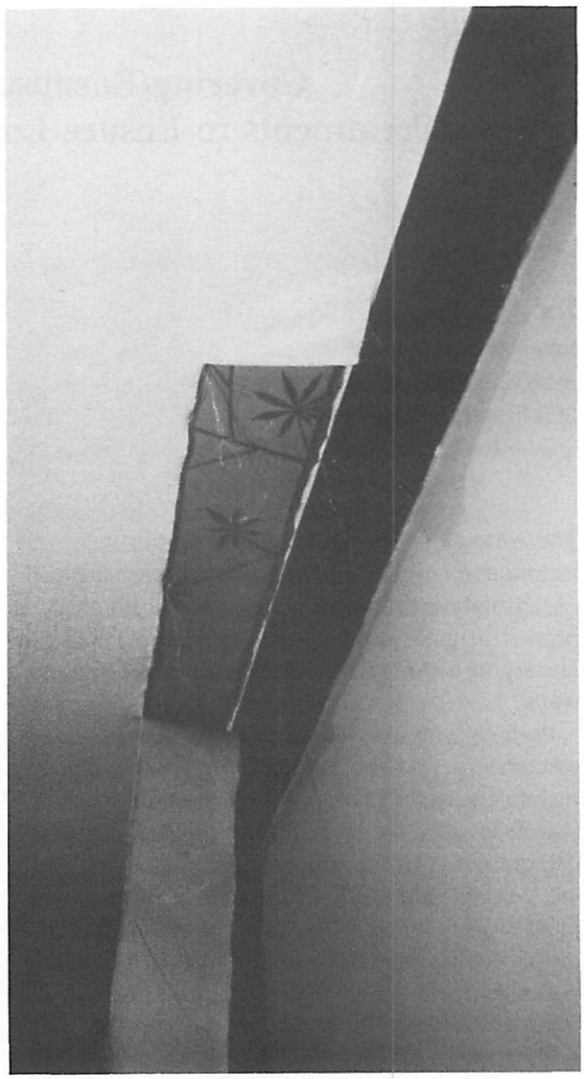
Oil base paint, by its nature, discolors over a period of time, creating what would appear to be a mismatch of colors. Oil paint, perfectly matched in the past, would appear today as if the decorator did not possess the necessary skills to match colors. At the present day, we would, of course, use an acrylic or more stable medium for touching up, avoiding fugitive colors, and then re-varnish with a non-yellowing reversible acrylic varnish.

Several methods, which have been employed in the past by decorators, in covering and encapsulating decorative ceilings and walls, include stretched canvas, applied canvas directly to the surface, and a thin (skim) coat of taping compound over the wall decoration.

Stretched Canvas

From the 1890s until the late 1940s, a common practice in the treatment of cracked ceilings (Figure 1) was to stretch a canvas over the area (this was the forerunner of the modern-day dropped ceiling). A strip of wood strapping 1/4" X 1/2", was anchored to the walls around the perimeter of the room, 1" to 3" below the ceiling line. A second strip was then anchored below, and butted against the first. If the room had a plaster cornice, the wood strapping was anchored to a member of the cornice, approximately 1" to 3" below the ceiling line, and applied around the center rose or light fixture, if one existed. Had a wooden cornice existed, the wood strapping would, obviously, not be necessary (this would of course alter the profile of the cornice).

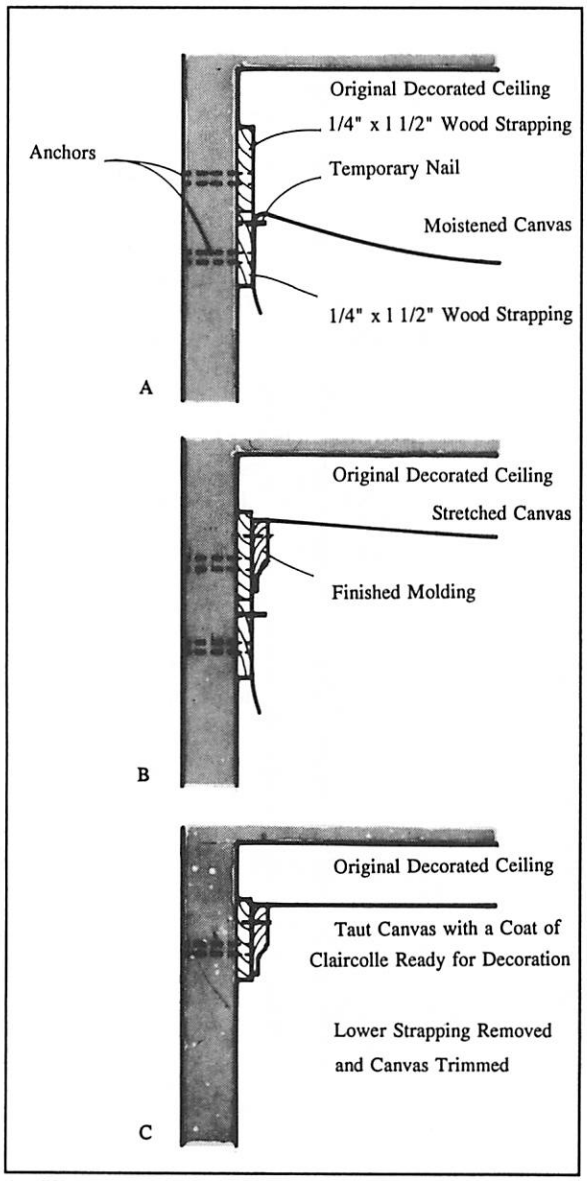
The canvas was cut and sewn together whenever necessary in order to cover the ceiling in one piece. The canvas was pre-sized, and moistened with water before hanging. Starting on one side of the room, while the canvas was still damp, the canvas would be temporarily nailed to the lower strapping. In the same manner, the canvas was nailed to the opposite wall and the remaining two walls (Figure 2a). When the canvas was stretched as evenly as



1. Stretched canvas over decorated ceiling. This method of covering ceilings to hide cracks and other defects was used from the 1890s until the late 1940s.

possible using 3" clamp-nose pliers to grip the canvas and adjusting the temporary nails to accommodate the stretching, it was allowed to dry and tighten.

A finished wood molding, the same size as the wood strapping, was nailed to the upper wooden strapping taking up the slack and stretched the canvas even tighter (Figure 2b). Once the molding was firmly secured in place around the room, the canvas was trimmed below the molding and the lower wood strapping was removed. With a 7 inch-8oz distemper brush, a coat of claircolle (a mixture of size and whiting with a drop of alum) was applied. When dried,



2. Historic method of stretching a canvas over a ceiling.

the canvas became taut (Figure 2c). The ceiling was then ready to receive decoration with distemper paints.

When a build up of distemper occurs, or if the canvas becomes water damaged, distemper can be removed by applying hot water to the surface, which will soften the distemper. It then can be scraped off with a large soup spoon (no sharp edges). After stripping, the canvas can be sized and decorated again. The benefit of a canvas ceiling is that it can be successfully maintained, while preserving the original decorated ceiling 1" to 2" above the canvas.

The client would have a ceiling without unsightly cracks. The question is then raised: was this an intentional covering to preserve the original decoration, or was it just to remedy an unsightly cracked ceiling? If it was done merely to remedy the cracks why not plaster over the entire ceiling?

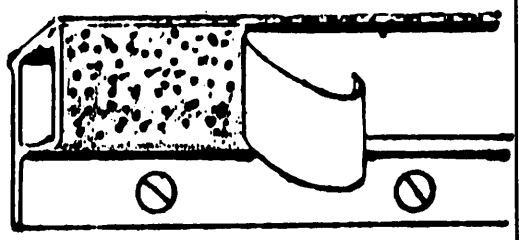
There are modern methods on the market which allow you to hang canvas in this manner. They consist of a plastic track anchored to the wall as in wood strapping. This plastic track has an adhesive strip which holds the canvas in place until it is pulled taut and tucked into a locking channel by using a special tool. No molding is required, because the canvas butts to the wall and covers the plastic track (Figure 3).

Canvas Applied Directly to the Surface

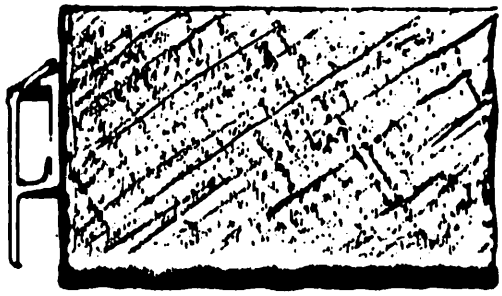
Prior to a canvas being applied to the ceiling or walls, the plaster must be examined and, if necessary, reattached and consolidated. Then an isolating coat of varnish is applied to the decorated surface. With the appropriate adhesives, linen canvas or vinyl canvas can then be applied directly to the surface.

Conservators are wary about adhesive products, unless they have "conservation" stamped all over them, or have been accepted by the "conservation community." Yet there are perfectly good reversible products in the construction industry that have stood the test of time, which in my opinion, are far easier to handle and less expensive. These materials, such as "Professional Strippable Vinyl Adhesive" by Roman Adhesive, Inc., are non-bleeding, mildew-resistant, do not pull away from the substrate, and have great adhesion properties. Yet they can be removed dry without any stress on the substrate.

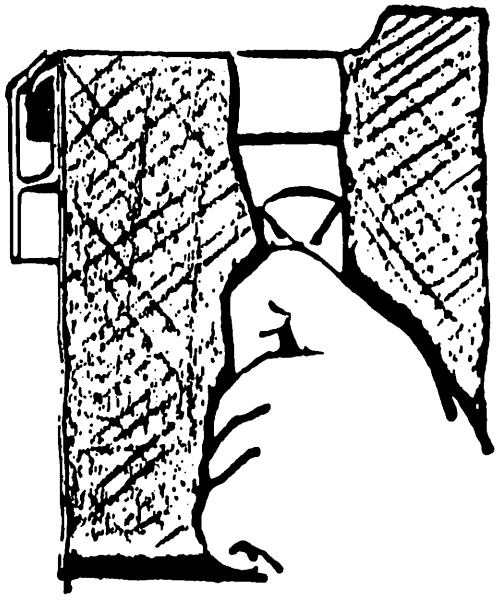
Any adhesive residue left on the surface can be removed with a drop of dishwashing detergent or wallpaper remover in water. These two solutions will prevent the water evaporating from the surface. This method would permit it to dwell longer. The water solution can be sprayed onto the surface, allowed to dwell for approximately 10 minutes, and sprayed again as many times as necessary until the adhesive becomes soft. It can then be agitated with a soft brush and wiped clean.



A. Adhesive Strip



B. Canvas Held in Place with Adhesive Strip



C. Canvas Pulled Taut and Tucked into the Locking Channel

3. Modern plastic track method for installing stretched canvas.

Linen canvas, after applied directly to the surface, should be treated with a coat of size (with carbolic added to stop deterioration of the size and the fabric), before oil painting. The size will insulate the fabric from direct contact with the oil. Size is generally regarded as a very unsatisfactory material to be applied under paint, although in this case it performs a useful and legitimate function of protecting the fabric from the oxidizing effects of the oil, which would eventually cause the fibers to become brittle and friable (a modern day substitute for size would be an acrylic primer or acrylic gesso). A canvas that has been painted in the studio can be installed successfully by applying the adhesive to the back of the canvas, then applying it to the wall or installed with the dry method of applying the adhesive to the wall. Once it has reached a certain tack the canvas can be applied dry onto the adhesive.

Vinyl canvas can be applied in the same manner as linen canvas. One of the advantages of vinyl is that it requires no size or gesso, but can be painted directly on the surface. Seams butt together perfectly, and when painted, are undetectable. Both linen and vinyl canvas can be easily removed when the proper adhesive is used. Both materials and methods have been used successfully in the past.

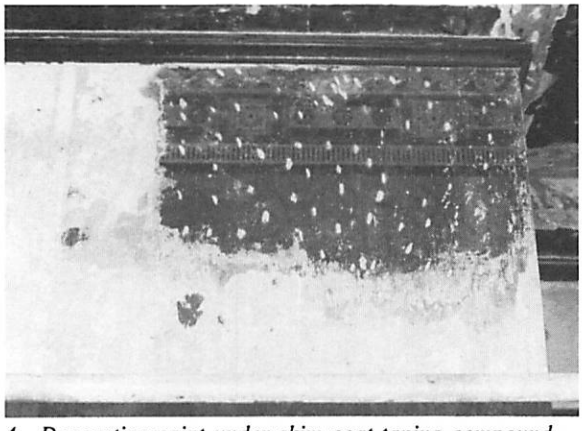
The approach of using canvas as a method of covering original decoration serves three purposes:

1. In the future, the present day decoration, which is being applied over the canvas, will become an integral part of the building's history, and should be respected as such and protected. The use of canvas on the walls with reversible adhesive, as opposed to painting directly over isolating varnish, will serve this purpose.
2. If, in the future, scholars have research to do on original paintings, the canvas could be carefully removed, and reinstalled without damage to the present decoration.
3. If the walls should develop cracks or have water damage, the canvas could be removed, the wall repaired, and the canvas reinstalled without damage to the present decoration.

Thin (Skim) Coat of Taping Compound

Researchers, however, sometimes overlook it. after removing outer layers of paint, they reach a skim coat of taping compound and misinterpret this layer as the original substrate. In fact, the original decorative ceiling may be intact behind this protective covering (Figure 4). Prior to applying the compound, as mentioned before, the plaster must be examined and if necessary, reattached and consolidated. An isolating coat of varnish is first applied to the surface, then a coat of latex bonding agent is applied over the varnish.

The traditional tools of a plasterer, the "hawk" and "trowel," can be used to apply a skim coat of compound. Taping was at one time considered the purview of the plaster trade.



4. Decorative paint under skim coat taping compound.

Today it falls under the jurisdiction of the painter, who uses putty knives ranging from 4" to 10" in width to apply the compound.

Skim coats of compound are usually applied in a three-coat process, unlike skim coats of plaster. The first compound coat is applied vertically, the second coat horizontally and the third coat vertically. The craftsman sands in between coats with a sanding pole with a 3" by 10" pad on the end, which allows the surface to be sanded uniformly. The finish coat is then very lightly sanded (a good taping job should require very little sanding).

The advantage of a skim coat taping compound is that is produces a brand new wall surface. The disadvantage is that the present day decoration is destroyed when removed. I have found that taping compound can be removed in the same manner as the canvas adhesive, and the bonding agent removed with denatured alcohol. There may be some compounds on the market that have an adhesive additive and are not removable with water. If this method is contemplated, a test for solubility should be conducted before application.

The question remains: were the earlier canvas applications deliberate attempts at preserving the original decorated painted surface or merely to remedy unsightly cracks? Although the use of stretched canvas, canvas applied directly to the surface, and skim coats of compounds are not standard conservation practices, they merit study as alternatives to covering original decoration with sheet rock.

* * *

28 PRESERVATION BRIEFS



Painting Historic Interiors

Sara B. Chase

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National Park Service
Cultural Resources
Preservation Assistance

The paint Americans used in the past is undeniably part of a technological and commercial record. But beyond that, the colors we have chosen and continue to select for our interior living and working spaces—bright and exuberant, purposefully somber, or a combination of hues—reflect our nation's cultural influences and our individual and collective spirit (see Figures 1, 2). Paint color is a simple, direct expression of the time, and of taste, values, and mood. To consider paint only as a protective coating is to misunderstand its meaning as an important aspect of America's heritage.

This Brief is about historic interior paints and choosing new paints for historic interiors if repainting is necessary or desirable. It addresses a variety of materials and features: plaster walls and ceilings; wooden doors, molding, and trim; and metal items such as radiators and railings. It provides background information about some of the types of paint which were used in the past, discusses the more common causes and effects of interior paint failure, and explains the principal factors guiding decisions about repainting, including what level of paint investigation may be appropriate. Careful thought should be given to each interior paint project, depending on the history of the building and its painted surfaces. Treatments may range from protecting extant decorative surfaces, to ordering custom-made paint that replicates the original paint color, to using today's paint straight off the shelf and out of the can.

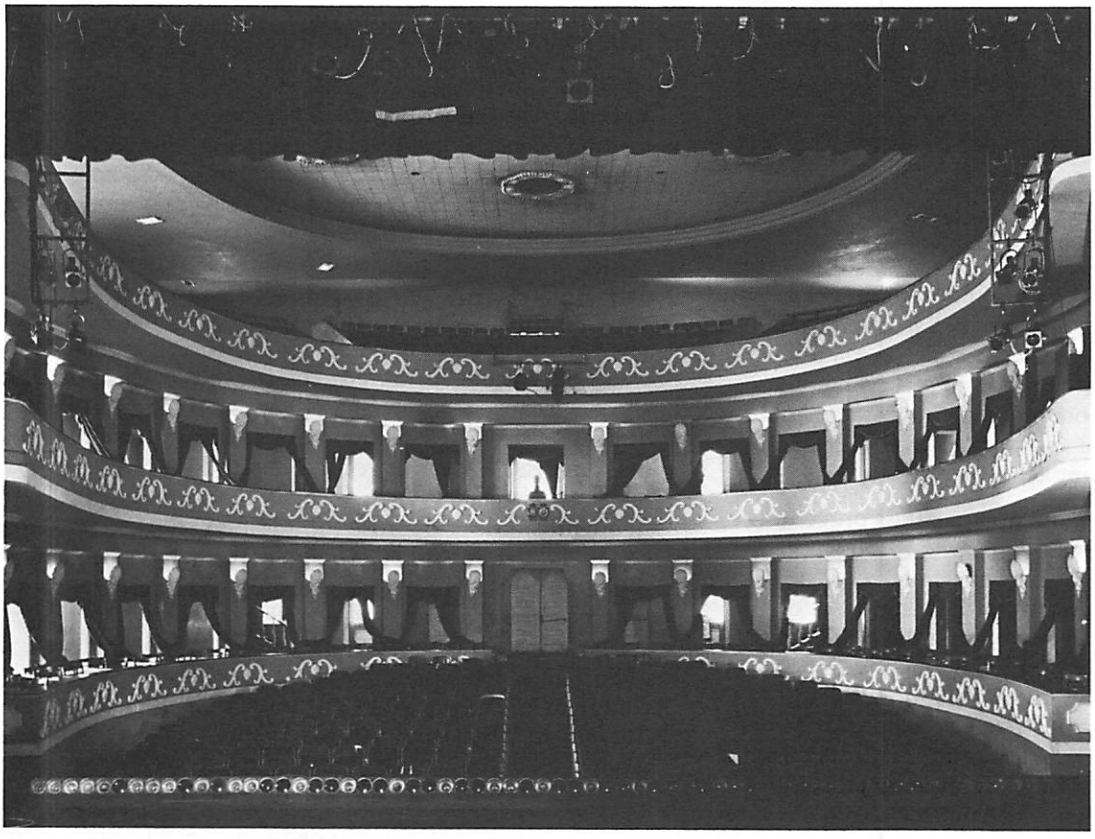
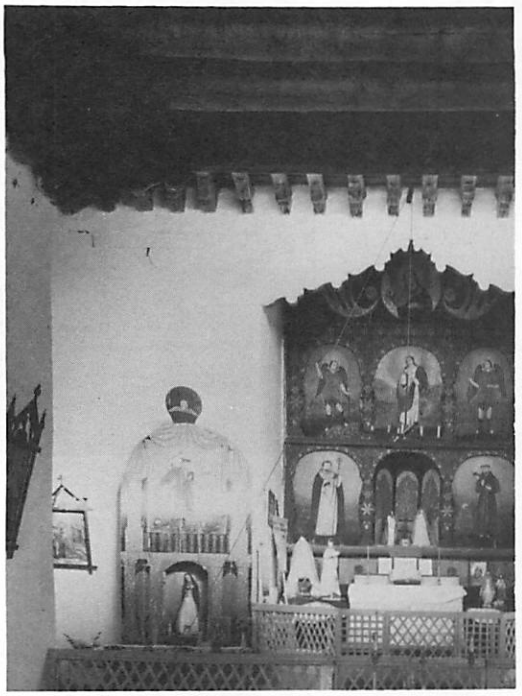


Figure 1. Researching the interior paint history is the key to a successful preservation or restoration project. The decorative detailing can be appreciated in this Puerto Rico theater primarily because of appropriate paint color and paint placement. Photo: Max Toro.

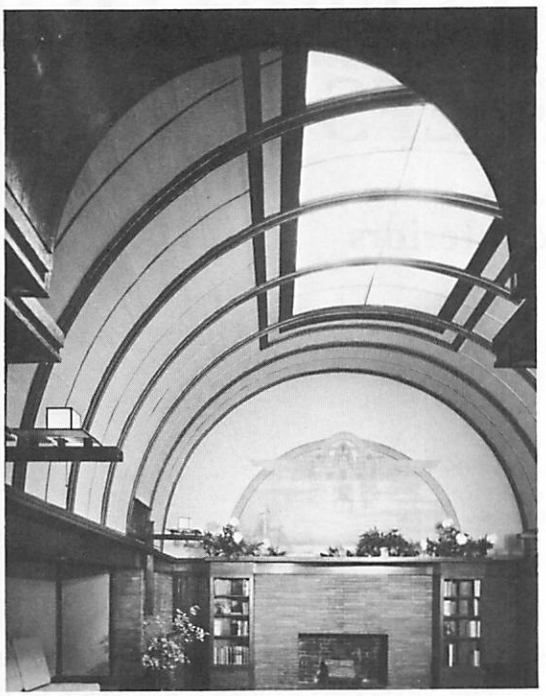
Finally, stripping old paints or applying new oil/alkyd paints poses serious health and safety concerns; the State Historic Preservation Officer should be contacted for current legal and technical information on removal, disposal, and health and safety precautions.

Constituents of Historic Paint: Pigment, Binder, and Vehicle

Paint is a dispersion of small solid particles, usually crystalline, in a liquid



A



B



C

Figure 2. Paints—plain and colored—have been used throughout our history to define and accent interior spaces. Three examples serve to illustrate a variety of geographical and cultural influences, building types and uses, and interior designs from the 18th to the 20th century. (a) San Jose de Gracia Church, Las Trampas, New Mexico (1760). Photo: Kirk Gittings. (b) Frank Lloyd Wright Home and Studio, Oak Park, Illinois (1889-98). Photo: Philip Turner for HABS. (c) U. S. Customs House, Trading Floor (1908), New York City. Photo: National Park Service files.

medium. Applied to a surface, this liquid has the special quality of becoming a solid, protective film when it dries. Paint also enhances the appearance of surfaces. A late Victorian writer observed that the coming of a painter to a house was cause for celebration. Indeed, these statements not only indicate the chemical and physical complexity of paint, but also its emotional impact.

Pigment. Pigment made the paint opaque, thus preventing deterioration of the substrate caused by ultra-violet light, and added color, thus making the paint attractive. White lead, a whitish corrosion product of lead, was most often used to provide opacity. The white pigment in a colored paint is often called the "hiding" pigment. In addition to preventing the sun's damaging rays from hitting the surface of the substrate, the white lead also helped prevent the growth of mold and mildew. Not until early in the 20th century was a successful substitute, titanium dioxide (TiO2), patented, and even then, it did not come into prevalent use by itself until the mid-20th century (earlier in the century, titanium oxide and white lead were often mixed). Zinc oxide was used briefly as a hiding pigment after 1850 (see Figure 3).

Early tinting pigments for house paints consisted of the earth pigments—ochres, siennas, umbers made from iron-oxide-containing clay—and a few synthesized colorants such as Prussian blue, or mercuric sulfide (crimson). From the early 1800s on more pigments were developed and used to offer a wider and brighter variety of hues.

Binder. The most common binder in interior paints was, and still is, oil. Chalk was sometimes added to water-based paints to help bind the pigment particles together. Other common binders included hide glue and gelatin.

Vehicle. The fluid component was termed the vehicle, or medium, because it carried the pigment. Historically, vehicles included turpentine in oil paints and water in water-based paints, but other vehicles were sometimes used, such as milk in casein paints.

Oil-Based and Water-Based Paints

The two major types of paint are termed oil-based and water-based. For *oil-based paints,* linseed oil was frequently chosen because it is a drying oil. When thinned with an organic solvent such as turpentine for easier spreading, its drying speed was enhanced. To make the drying even faster, drying agents such as cobalt compounds were frequently added. Because the addition of driers was most successfully done in hot or boiling oil, boiled linseed oil was preferable. The drying rate of linseed oil paints was relatively rapid at first, for several days immediately after application, and paint soon felt dry to the touch; it is important to remember, however, that linseed oil paint continues to dry—or more precisely, to cross-link—over decades and thus continues to a point of brittleness as the paint ages. Strong and durable with a surface sheen, oil-based paints were mainly used for wood trim and metal.

Whitewashes and distemper paints differed from oil paints in appearance primarily because the vehicle was water. *Water-based paints* were always flat, having no gloss of their own. Because the paint film dried to the touch as soon as

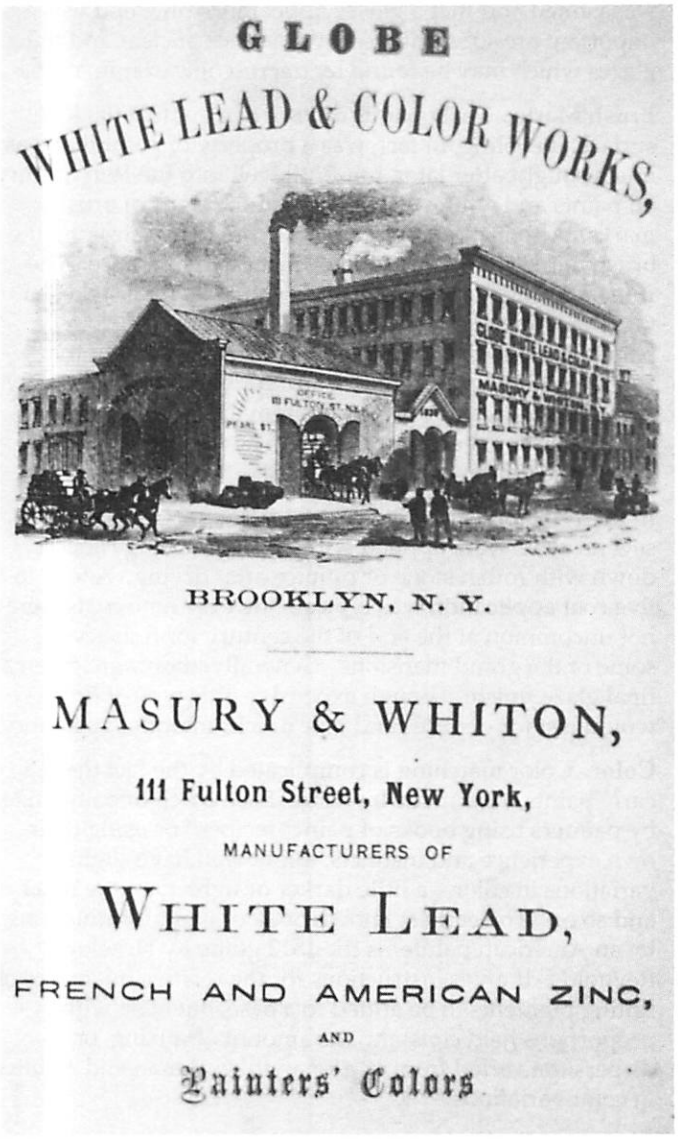


Figure 3. There were numerous companies producing white lead in the United States by mid-19th century. Shown is one manufacturer's trade flyer. Of note, production figures for white lead showed a marked increase after 1850, but a steady decline after 1880. This was, in part, due to a change of taste and style at the end of the 19th century—stains and clear finishes were preferred over opaque paints for interior decorative treatments.

the water evaporated, driers were not needed. Water-base paints were fairly strong, with the pigments well bound as in hide glue distempers, but they did not hold up to abrasion. Wood trim, therefore, was rarely painted with these types of paint historically, though interior plaster surfaces were frequently coated with whitewash and calcimine. Distemper paints were commonly used for decorative work.

Recent Changes to Paint Constituents. Until the mid-20th century, almost all paints used in America could be divided according to the type of binder each had. Chemists sought to improve paints, especially when the two world wars made traditional paint components scarce and expensive. Modern paints are far more complex chemically and physically than early paints. More ingredients have been added to the simple three-part system of pigment, binder, and vehicle. Fillers or extenders such as clay and chalk were put in to make oil paints flow better and to make them cheaper as well. Mildewcides and fungicides were prevalent and popular until their environmental hazards were seen to outweigh their benefits. New formulations which retard the growth of the mildew and fungi are being used. As noted, lead was eliminated after 1950. Most recently, volatile organic solvents in oil paint and thinners have been categorized as environmentally hazardous.

Types of Historic Paints



Historic paints were often made with what was available, rather than adhering to strict formulas. Recipes for successful formulas can be found in historic documents, such as newspapers, illustrating the combinations of ingredients which could be used to produce a paint.

Oil-based paints: Linseed oil, a volatile thinner such as turpentine; a hiding pigment (usually white lead) and coloring pigments.

Enamels: natural resin varnish was added to oil-based paint to provide a hard, more glossy surface.

Glaze: a translucent layer applied to protect the paint and to impart a more uniform gloss surface. Usually made from linseed oil with natural resin varnish added. Some glazes have small quantities of tinting pigments such as verdigris or Prussian blue; some had no pigments added.

Water-based paints: Water, pigment, and a binder, such as hide glue, other natural glues, or gums. Usually used on interior plaster surfaces.

Whitewash: often used on interior plaster surfaces in utilitarian spaces and, at times, used on interior beams; consisted of water, slaked lime, salt, and a variety of other materials. Occasionally a pigment (usually an ochre or other earth pigment) was added to provide tint or color.

Distemper: used for interior applications, were made from water, glues (one or more different natural glues, gelatine, and gums) with whiting as the basic white pigment to which other tinting pigments were added.

Calcimine, or kalsomine: often used on interior surfaces and is another common name for distemper.

Tempera: paint prepared with pigment, egg yolk or white and water; used almost exclusively for decorative treatments.

Gouache: a water-based paint made of whiting, pigment, water, and gum arabic as the binder; used almost exclusively for decorative treatments.

Milk-based paint:

Casein: also called milk paint, was made with hydrated (slaked) lime, pigment, and milk. Most often oil was added, making a strong emulsion paint. Various recipes call for a large variety of additives to increase durability. Casein paints were also used for exterior surfaces.

A major difference in modern paints is the change in binder from the use of natural boiled linseed oil to an alkyd oil which is generally derived from soybean or safflower oil. Use of synthetic resins, such as acrylics and epoxies, has become prevalent in paint manufacture in the last 30 years or so. Acrylic resin emulsions in latex paints, with water thinners, have also become common.

Pre-1875 Paints

Production and Appearance. How were paints made prior to the widespread use of factory-made paint after 1875? How did they look? The answers to these questions are provided more to underscore the differences between early paints and today's paints than for practical purposes. Duplicating the composition and appearance of historic paints, including the unevenness of color, the irregularity of surface texture, the depth provided by a glaze topcoat, and the directional lines of application, can be extremely challenging to a contemporary painter who is using modern materials.

The pigments used in early paints were coarsely and unevenly ground, and they were dispersed in the paint medium by hand; thus, there is a subtle unevenness of color across the surface of many pre-1875 paints (see Figure 4). The dry pigments had to be ground in oil to form a paste and the paste had to be successively thinned with more oil and turpentine before the paint was ready for application. The thickness of the oil medium produced the shiny surface desired in the 18th century. In combination with the cylindrical (or round) shaped brushes with wood handles and boar bristles, it also produced a paint film with a surface texture of brush strokes.

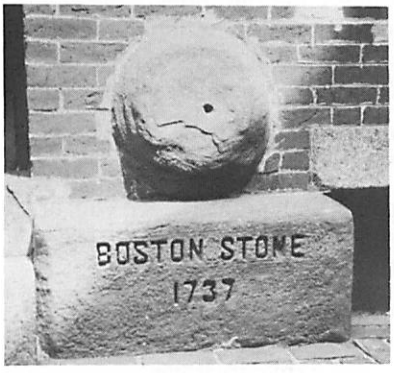


Figure 4. The Boston Stone (1737), a surviving relic of early paint production, was used for pigment grinding in the shop of Thomas Child of Boston, a London-trained painter and stainer. The early paint-grinding tool is the logo of the National Paint and Coatings Association. Photo: Courtesy, SPNEA.

Geographical Variation. The early churches and missions built by the French in Canada and the Spanish in the southwestern United States often had painted decoration on whitewashed plaster walls, done with early water-based paints. By the mid-17th century oil paint was applied to wood trim in many New England houses, and whitewash was applied to walls. These two types of paint, one capable of highly decorative effects such as imitating marble or expensive wood and the other cheap to make and relatively easy to apply, brightened and enhanced American interiors. In cities such as Boston, Philadelphia, New York, and later, Washington, painters and stainers who were trained guildsmen from England practiced their craft and instructed apprentices. The painter's palette of colors included black and white and grays, buffs and tans, ochre yellows and iron oxide reds, and greens (from copper compounds) as well as Prussian blue. That such painting was valued and that a glossy appearance on wood was important are substantiated by evidence of clear and tinted glazes which may be found by microscopic examination.

Brush Marks. Early paints did not dry out to a flat level surface. Leveling, in fact, was a property of paint that was much sought after later, but until well into the 19th century, oil paints and whitewashes showed the signs of brush marks. Application therefore was a matter of stroking the brush in the right direction for the best appearance. The rule of thumb was to draw the brush in its final stokes in the direction of the grain of the wood. Raised-field paneling, then, required that the painter first cover the surface with paint and afterward draw the brush carefully along the vertical areas from bottom to top and along the top and bottom bevels of the panel horizontally from one side to the other.

In the 19th and early 20th centuries, for very fine finishes, several coats were applied with each coat being rubbed down with rotten stone or pumice after drying. A four to five coat application was typical; however nine coats were not uncommon at the end of the century for finishes in some of the grand mansions. Generally, they were given a final glaze finish. Though expensive, this type of finish would last for decades and give a rich, smooth appearance.

Color. Color matching is complicated by the fact that all early paints were made by hand. Each batch of paint, made by painters using books of paint "recipes" or using their own experience and instincts, might well have slight variations in color—a little darker or lighter, a little bluer and so on. The earliest known book of paint formulations by an American painter is the 1812 guide by Hezekiah Reynolds. It gives instructions for the relative quantities of tinting pigments to be added to a base, but even with proportions held constant, the amount of mixing, or dispersion, varied from workman to workman and resulted in color variations.

Knowing all of the facts about early paints can aid in microscopic paint study. For example, finding very finely and evenly ground pigments, equally dispersed throughout the ground or vehicle, is an immediate clue that the paint was not made by hand but, rather, in a factory.

By the first decades of the 19th century more synthetic pigments were available—chrome yellow, chrome green, and shades of red. Discoveries of light, bright, clear colors in the plaster and mosaic decoration of dwellings at Pompeii caught the fancy of many Americans and came together with the technology of paint to make for a new palette of choice, with more delicacy than many of the somewhat greyed-down colors of the 18th century. Of course, the blues which could be produced with Prussian blue in the 18th and 19th centuries were originally often strong in hue. That pigment—as were a number of others—is fugitive, that is, it faded fairly quickly and thus softened in appearance. It should be remembered that high style houses from the mid-17th to late 19th centuries often had wallpaper rather than paint on the walls of the important rooms and hallways.

Glossy/Flat. Another paint innovation of the early 19th century was the use of flatter oil paints achieved by adding more turpentine to the oil, which thus both thinned and flatted them. By the 1830s the velvety look of flat paint was popular. Wherever decorative plaster was present, as it

frequently was during the height of the Federal period, distemper paints were the coating of choice. Being both thin and readily removable with hot water, they permitted the delicate plaster moldings and elaborate floral or botanical elements to be protected and tinted but not obscured by the buildup of many paint layers. (The use of water-based paints on ceilings continued through the Victorian years for the same reasons.)

Unfortunately, flat paints attract dirt, which is less likely to adhere to high gloss surfaces, and are thus harder to wash. Victorians tended to use high gloss clear (or tinted) finishes such as varnish or shellac on much of their wood trim and to use flat or oil paints on walls and ceilings.

Decorative Painting. In interiors, paint could be used creatively and imaginatively, most often to decorate rather than to protect. Decorative forms included stencilling, graining and marbleizing, and *trompe l'oeil* (see Figures 5, 6).

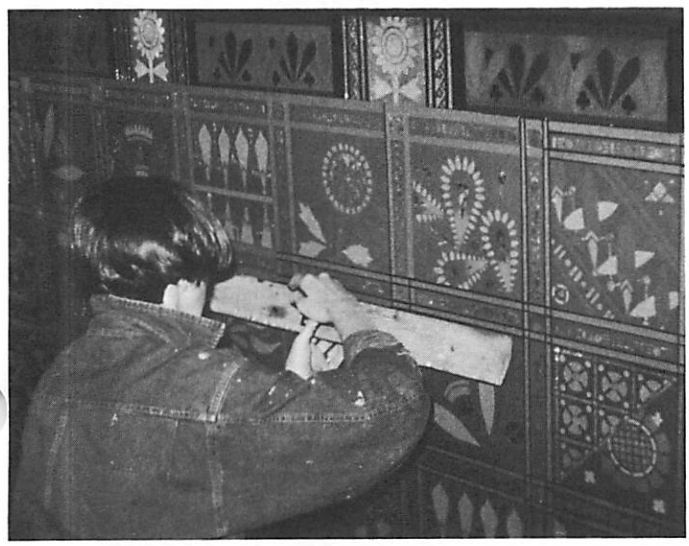


Figure 5. Owners of historic properties often find evidence of decorative painting on interior walls; however, the task of actually preserving or restoring decorative work, such as the complex stencilling pictured here, should only be undertaken by professionals who have specialized training and field experience. Photo: Courtesy, Alexis Elza.



Figure 6. Historic doors may have graining patterns or clear finishes under one or several coats of plain paint, such as these restored 18th and early 19th century doors. Graining may appear even on more vernacular doors of the pre-1850 vintage. Photo: Jack E. Boucher for HABS.

Stencilling. Stencilled designs on walls were often used in the first half of the 19th century in place of wallpaper. Old Sturbridge Village, in Massachusetts, has paintings showing the interiors of a (c. 1815-1820) farmhouse which has both stencilled walls—imitating wallpaper—and painted floors or oiled and painted floor cloths, imitating fine carpets. By 1850 and for the next 60 years thereafter, stencilled and freehand-painted decoration for walls and ceilings became a high as well as a humble art. Owen Jones' ***Grammar of Ornament,*** published in 1859, provided the source for painted decoration from Portland to Peoria, Savannah to San Francisco.

Graining and marbleizing. If floors, walls, and ceilings were decorated by paint in a variety of styles, the wood and stone trim of rooms was not omitted. The use of *faux bois,* that is, painting a plain or common wood such as pine to look like mahogany or some finer wood, or *faux marbre,* painting a wood or plaster surface to look like marble—realistically or fantastically—was common in larger homes of the 18th century. By the early 19th century, both stylized graining and marbleizing adorned the simple rural or small town houses as well. Often baseboards and stair risers were marbleized as were fireplace surrounds. Plain slate was painted to look like fine Italian marble. In many simple buildings, and, later, in the Victorian period, many prominent buildings such as town halls and churches, the wood trim was given a realistic graining to resemble quarter sawn oak, walnut, or a host of other exotic woods.

Trompe L'oeil. Churches, courthouses, and state capitols frequently received yet another remarkable use of paint: *trompe l'oeil* decoration. Applied by skilled artists and artisans, painted designs—most often using distemper paints or oils—could replicate three-dimensional architectural detailing such as ornate molded plaster moldings, medallions, panels, and more.

Factory-Made Paints after 1875

An enormous growth of the paint industry began in the 1860s, stimulated by the invention of a suitable marketing container—the paint can. The first factory-made paints in cans consisted of more finely ground pigments in an oil base; after purchase, additional oil was added to the contents of the can to make up the paint. Such paints saved the time of hand-grinding pigments, and were discussed at length by John Masury in his numerous books. After 1875, factory-made paints were available at a reasonable cost and, as a result, greater numbers of people painted and decorated more of their buildings, and more frequently. The new commercial market created by ready-mixed paint became the cornerstone of our modern paint industry (see Figure 7).

20th Century Paints

By the early decades of the 20th century, popular taste turned away from exuberant colors and decoration. Until the late 1920s both the Colonial Revival and Arts and Crafts styles tended toward more subdued colors and, in the case of Colonial Revival, a more limited palette. The use of *faux* finishes, however, continued. Residential architecture often featured stencilling, such as painted borders above wainscoting or at ceiling and wall edges to imitate decorative wallpaper. Institutional buildings in both cities

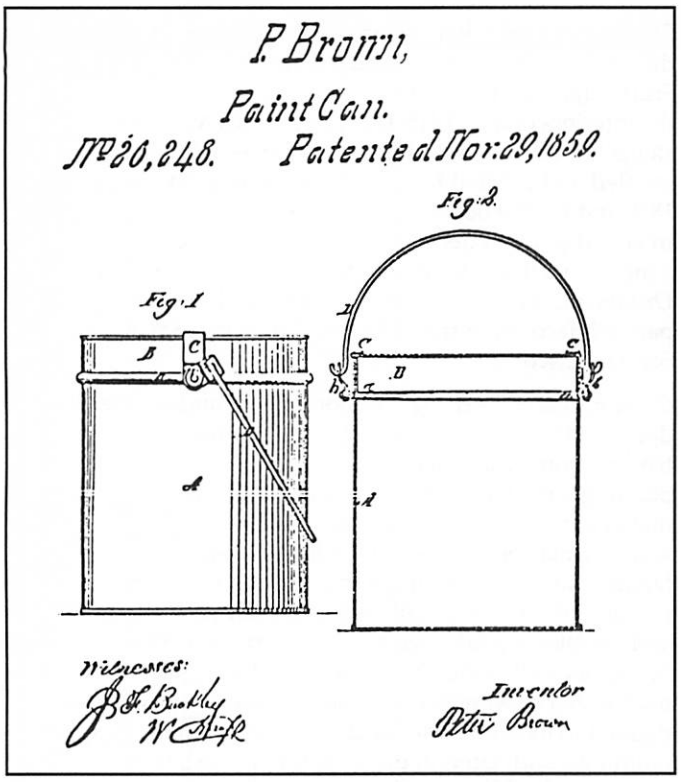


Figure 7. This 1857 patent drawing of a paint can invented by Peter Brown shows a remarkable similarity in design to today's containers. An airtight, carryable container allowed the sale of small amounts of paint. It helped revolutionize the paint industry for typical consumers in the late 19th century because paint was now essentially available to anyone who wanted it.

and small towns used wood graining on metal-clad doors, door and window frames, and staircases, and had stencilled ceilings as well. Many high style public buildings of the 1920s had painted ceilings which imitated the Spanish and Italian late medieval and Renaissance styles.

Although stenciling, gilding, and *faux* finishes can be found, they did not express the modern style of the time. On the other hand, glaze treatments were often used in the early 20th century to "antique" walls and trim that had been painted with neutral colors, especially in Spanish Colonial Revival and Mission architecture. The glazes were applied by ragging, sponging, and other techniques which gave an interesting and uneven surface appearance. Colored plasters were sometimes used, and air brushing employed to give a craftsmanlike appearance to walls, trim, and ceilings. During the same period, Williamsburg paint colors were produced and sold to people who wanted their houses to have a "historic Georgian look." Churches, country clubs, and many private buildings adopted the Williamsburg style from the late 20s onward.

Often decorated with simple molded plaster designs of the Art Deco and Art Moderne styles, interiors of the 1930s and 1940s were frequently accented with metal flake paints in a full range of metallic colors, from copper to bronze (see Figure 8). And enamels, deep but subdued hues, became popular. Paint technology had progressed and varying degrees of gloss were also available, including the mid-range enamels, variously called satin, semi-gloss, or eggshell. In contrast to Victorian paint treatments, this period was characterized by simplicity. To some extent, the



Figure 8. The lobby foyer of the Paramount Theater in Sacramento, California (1931) features painted plaster columns and cornices which have been finished in gold and silver leaf. The theater, a National Historic Landmark, is noted for its Art Deco style. Photo: Gabriel Moulin Studios.

Bauhaus aesthetic influenced taste in the 1950s; interior paints were frequently chosen from a palette limited to a few "earth" colors and a "nearly neutral" palette of off-whites and pale greys.

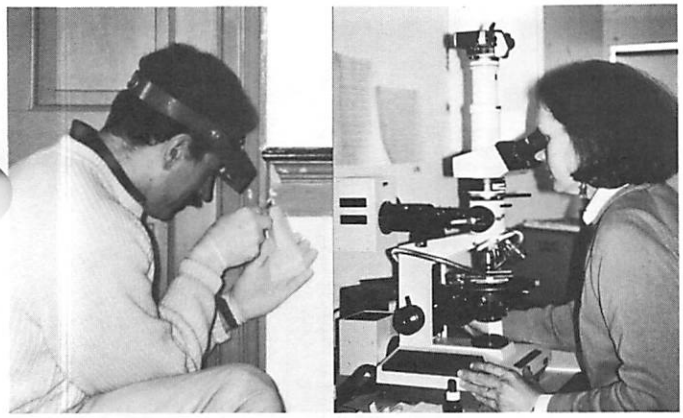
While the trend in colors and decorative treatments was defined by its simplicity, paint chemists were developing paints of increasing complexity. Experimentation had started early in the 20th century and accelerated greatly after World War II. Of greatest significance was the manufacture of the latex paints for consumer use. Synthetic resin emulsions carried in water offered advantages over the traditional oil paints, and even over the oil/alkyd paints: they did not yellow; they permitted water clean-up until dried; and they emitted no toxic or hazardous fumes from solvent evaporation.

Paint Investigation

Understanding each project's historic preservation goal and knowing what level of information needs to be collected to achieve that goal is an important responsibility of the purchaser of the service. Before someone is hired, the owner or manager needs to decide if a thorough investigation of painted surfaces is actually needed, and *how* to use the results when one is done.

Specialists with both training and field experience conduct paint investigations. These experts use sophisticated instruments and procedures such as field sampling, cross-section analysis, and fluorescent and chemical staining to learn about the components and behaviors of historic paints (see Figure 9). In addition, they utilize written documentation, verbal research, and visual information about past painting in the building in conjunction with findings in the field (Figure 10).

Paint investigation can make several contributions to a project. A complete analysis of the paint layers on surfaces within a structure can tell a great deal about the sequence of alterations that have occurred within a building, as well



A B

Figure 9. Conservators are shown in the two-part process of conducting a complete paint investigation: (a) Paint samples are carefully collected onsite. (b) In the laboratory, an ultra violet light microscope is used to identify pigment and binding media. Paint samples are photographed with the camera mounted on top of the microscope. (right). Photo left: Courtesy, Matthew J. Mosca; Photo right: Courtesy, Andrea M. Gilmore.

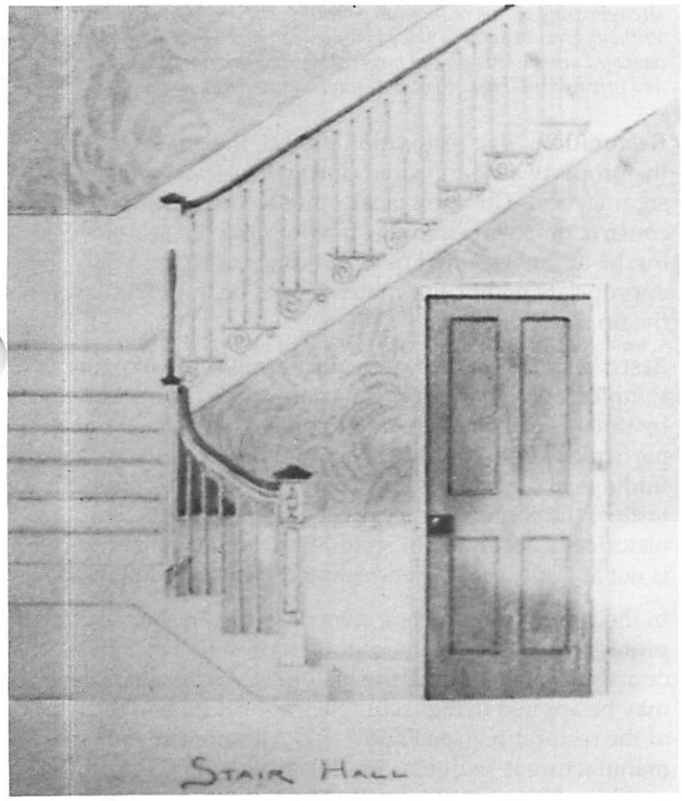


Figure 10. Written, oral, and pictorial documentation—such as this historical rendering—are combined with essential field research to provide the framework for sound historic preservation decisions. Photo: Courtesy, SPNEA.

as potentially providing ranges of dates for some of these changes. By establishing a full sequence of paint layers (termed a *chromochronology*), together with other research, alterations of various building spaces and features can be associated with specific paint layers. It is by establishing this association that the correct layer is identified; when the correct layer has been identified, the color may be matched.

In addition to its archeological value, paint analysis can determine the types and colors of paint on a given surface (identification of thin glazes, decorative paint schemes, binders and pigments). Beyond color identification, then, paint analysis is also recommended to diagnose causes of paint failure. Knowing a paint binder can often explain causes as well as guide appropriate preservation or conservation treatments.

Owners and managers should identify all of these needs before deciding on the extent of analysis. For example, a complete paint investigation is usually recommended as part of an historic structure report. For buildings with little documentation, additions and alterations can often be identified, and possibly dated, through analysis. Often the use of such seemingly expensive techniques can save money in the long run when determining the history of building change.

It is possible to do some analysis on site; this is a much simpler process that can be undertaken for less cost than the complex laboratory procedures described above. However, the usefulness of onsite analysis is limited and the results will not be as precise as results from samples that are analyzed in a laboratory with a good microscope. Any short-cut approaches to paint analysis that do not follow scientific procedures are generally not worth the expense. In summary, if preservation and restoration treatments are being undertaken, a complete investigation is recommended; for a rehabilitation project, onsite analysis and color matching may provide an adequate palette.

Choosing a Treatment

Most projects involve re-painting. It is the historic appearance of the interior and the visual impression that will be created by new paint treatments that must be considered before choosing a particular course of action. The type and colors of paint obviously depend on the type of building and the use and interpretation of its interior spaces (see Figure 11). A consistent approach is best.

Preservation. When the treatment goal is preservation, a building's existing historic features and finishes are maintained and repaired, saving as much of the historic paint as possible. Sometimes, cleaning and washing of



Figure 11. A dark layer can be seen beneath the flaking lighter paint on these raised field panels. Depending on the project work goal and the period of the building's history being interpreted, any one of the paint layers could be duplicated in repainting. National Park Service files.

painted surfaces is all that is needed. Or a coating may be applied to protect important examples of history or art (see Figure 12). If repainting is required, the new paint is matched to existing paint colors using the safer, modern formulations. Re-creating earlier surface colors and treatments is not an objective.

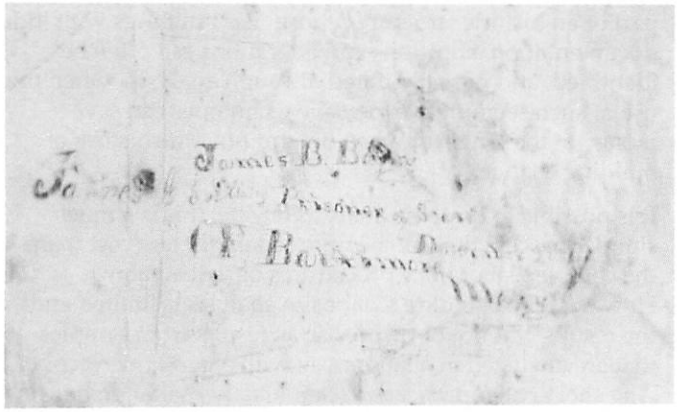


Figure 12. When discovered, important examples of history such as this pencilled Civil War graffiti should be preserved. A conservator can easily clean the area, then apply a protective coating. The history this hand-written message possesses is well worth the sacrifice of surface uniformity, even if it interrupts a freshly painted surface. Photo: Kaye Simonson.

Rehabilitation. In a typical rehabilitation, more latitude exists in choosing both the kind of new paint as well as color because the goal is the efficient re-use of interior spaces. Decisions about new paint often weigh factors such as economy and durability—use of a high quality standard paint from a local or national company and application by a qualified contractor. Color choices may be based on paint research reports prepared for interior rooms of comparable date and style. More often, though, current color values and taste are taken into account. Again, the safer paint formulations are used (see Figure 13).



Figure 13. Part of a historic freight depot, this is not a high-style room and its painted surfaces are obviously in poor condition from long-term neglect. Interior spaces that are being converted for a new use in rehabilitation projects can benefit from being repainted in historic period colors rather than a neutral off-white. Photo: National Park Service files.

Interiors of institutional buildings, such as university buildings, city halls, libraries, and churches often contain rich decorative detailing (Figure 14). During rehabilitation, careful choices should be made to retain or restore selected portions of the decorative work as well as match some of the earlier colors to evoke the historic sense of time and place. At the least, it is important to use period-typical paint color and paint placement.



Figure 14. Holes left by insertion of toggle bolts used in the structural strengthening of this ceiling can be seen in the decorative plaster work. Without great expense, a skilled painter can now clean and touch up the damaged areas. This type of targeted repair work can benefit both public and private buildings. Photo: National Park Service files.

Restoration. In a restoration project, the goal is to depict the property as it appeared during its period of greatest significance. This may or may not be the time of its original construction. For example, if a building dated from 1900 but historians deemed its significance to be the 1920s, the appropriate paint color match would be the 1920s layer, not the original 1900 layer.

Based on historical research, onsite collection of paint samples, and laboratory analysis, surface colors and treatments can be re-created to reflect the property at a particular period of time. It should be noted that scholarly findings may yield a color scheme that is not suited to the taste of the contemporary owner, but is nonetheless historically accurate. In restoration, personal taste in color is not at issue; the evidence should be strictly followed.

In the restoration process, colors are custom-matched by professionals to give an accurate representation. If an artist or artisan can be found, the historically replicated paint may be applied using techniques appropriate to the period of the restoration (see Figure 15). Although custom paint manufacture is seldom undertaken, color and glazing are capable of being customized. In some projects, paint may be custom-made using linseed oil and, if building code variances allow it, white lead. For example, the repainting of a number of rooms at Mount Vernon demonstrates that it is possible to replicate historic paints and applications in all aspects; however, as noted, replication of historic paint formulation is not practical for the majority of projects.

Identifying Deteriorated and Damaged Paint Surfaces

Because painted surfaces are subject to abrasion, soiling, water damage, sunlight, and application of incompatible paints they generally need to be repainted or at least reglazed appropriately from time to time.

Abrasion. From the baseboards up to a level of about six feet off the floor, wood trim is constantly subjected to wear

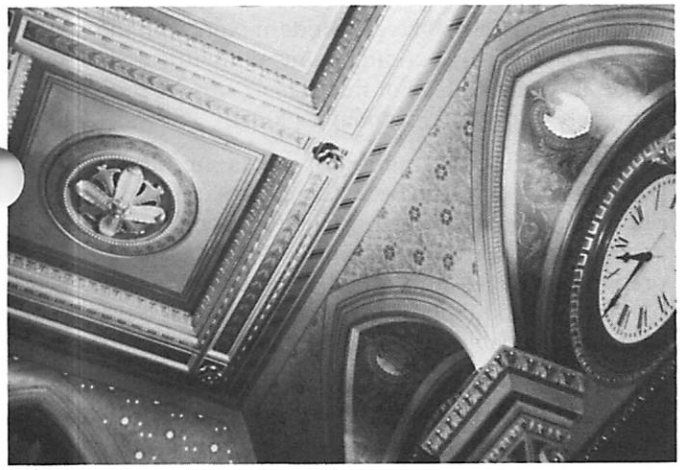


Figure 15. The decorative work on the walls and ceilings of the Senate Chamber, Providence, Rhode Island, City Hall (1875) is a rich combination of paint and gilding on ornate plaster features. It was carefully restored in 1975. Photo: Kate Gilliat. © Providence Preservation Society.

from being touched and inadvertently kicked, and from having furniture pushed against it (see Figure 16). Chair rails were in fact intended to take the wear of having chairs pushed back against them instead of against the more delicate plaster wall or expensive wallpaper. Doors in particular, sometimes beautifully grained, receive extensive handling. Baseboards get scraped by various cleaning devices, and the lower rails of windows, as well as window seats, take abuse. The paint in all of these areas tends to become abraded. Two things are important to bear in mind about areas of abraded paint. Samples taken to determine original paint colors and layer sequences will not be accurate except at undamaged edges. Also, dirt and oil or grease need to be removed before applying any new paint because new paint will not adhere to dirty, greasy surfaces.

Dirt. Soiling is another problem of interior paint (see Figure 17). Fireplaces smoked; early coal-fired furnaces put out oily black soot; gas lights and candles left dark smudges. Sometimes the dirt got deposited on plaster walls or ceilings in a way that makes the pattern of the lath behind the plaster quite clear. Another source of dirt was polluted outside air,



Figure 16. This residential door shows how scuffed and abraded interior painted surfaces can become over time, particularly if the feature is in a high-use area. In the preservation project, the door was simply cleaned and repainted the same color. Photo: Robert M. Smith, Jr.

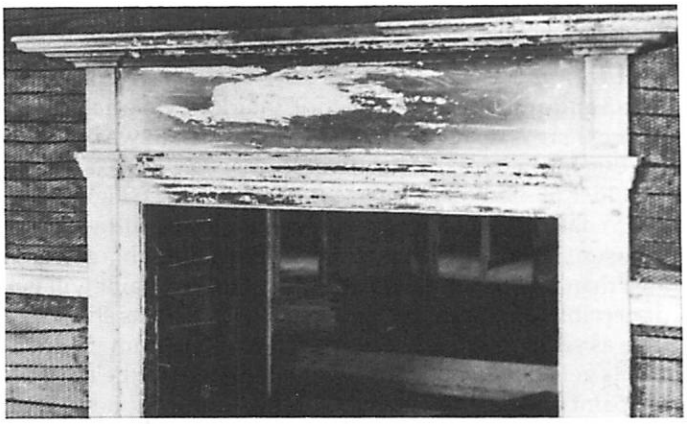


Figure 17. A Federal period fireplace needs careful preparation for repainting. While the soot must obviously be cleaned off, it is important to leave as much of the historic paint intact as possible. Photo: National Park Service files.

from factories or other industries, infiltrating houses and other nearby buildings. Until smokestacks became very high, most air pollution was caused by nearby sources.

In paint investigation, dirt on the surface of paint layers, as seen under the microscope, can be very useful in suggesting the length of time a given paint layer remained exposed, and in distinguishing a finish layer from a prime or undercoat layer. This kind of soiling can happen on any painted surface in a room, but may be slightly heavier in the recesses of moldings and on upward-facing horizontal edges. Using dirt as a sole measure, however, may be misleading if the surfaces have been cleaned. The fracture or bonding between paint layers is often used by professionals as a better means of indicating time differences between layers as well as indicating those layers that are part of a single decoration or painting.

Water. Water, the usual source of deterioration for many kinds of material, is also a prime cause of interior paint failure (see Figure 18). As a liquid, it can come from roof leaks, from faulty plumbing or steam heating systems, or from fire-suppression systems that have misfired. As a vapor, it may come from such human activities as breathing, showering, or cooking. Plaster walls sealed with unpigmented hide-glue are notably susceptible to water damage because it forms a water-soluble layer between the plaster and the paint. This can cause the paint to lose



Figure 18. The major crack along this cornice indicates that there has been long-term moisture problem in this room. Restoring the plaster work and repainting should be done only after the water problem is solved. Photo: Jack E. Boucher for HABS.

adhesion when even small amounts of moisture come into contact with the water-soluble sealer.

Age/Sunlight. Finally, in historic interiors, especially where there is heavy paint build-up, paint can weaken and fail due to chemical or mechanical reasons. For example, the older linseed oil is, the more brittle it is (see Figure 19). It also darkens when it is covered and gets no ultra-violet exposure. In rooms where there is more sunlight on one area than on others, the oil or even oil/alkyd paint will get discernibly darker in the less exposed areas in as short a time as six months. Painted over, the oil medium in older paints gets quite yellow-brown, thus changing the color of the paint. Prussian blue is one of the tinting pigments that is particularly vulnerable to fading.

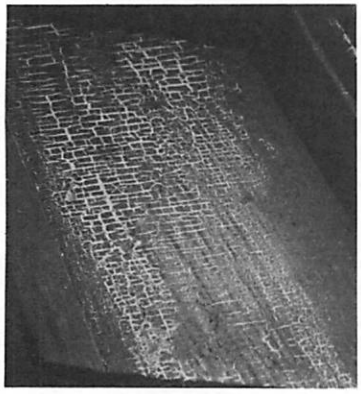


Figure 19. Sunlight typically causes paint deterioration on windows and window sills. This alligatored surface can make paint research difficult, as later paints may have "run in" under earlier ones. This surface should be stripped of all degraded paint prior to repainting. Photo: Richard Graber.

Incompatible Paints. Understanding some basic differences in the strength of various paints helps to explain certain paint problems. Paints that dry to a stronger film are incompatible with those which are weaker. Acrylic latex paints are stronger than oil/alkyd paints. Oil or oil/alkyd paint is stronger than water-based paint such as calcimine. When a stronger paint is applied over a weaker paint, it will tend to pull off any weaker paint which may have begun to lose its bond with its substrate. Thus, on many ceilings of older buildings where oil/alkyd paints have been applied over old calcimine, large strips of paint may be peeling.

Oil or varnish glazes over older paints become brittle with age, and can make removal of later paints rather easy. Sometimes it is possible to take advantage of this characteristic to reveal an earlier decorative treatment such as graining or marbleizing. Getting under the edge of the glaze with a scalpel blade can make the removal of later paints relatively simple, and relatively harmless to the fancier paint treatment. Sometimes, paints separate from each other simply due to poor surface preparation in the past or the hardening of the earlier surface paint. Use of alkaline paint strippers can cause paint to lose adhesion. When insufficiently neutralized, they leave salts in wood which cause oil or oil/alkyd paints to fail to adhere to the surface. If dirt or oily residues are not cleaned from the surfaces to be painted, new paint will not remain well adhered.

Surface Preparation

First, it is important to note that the earlier, linseed oil-based paints were penetrating type paints, forming a bond by absorption into the substrate. Often these thin oil coatings were slightly tinted with an iron-oxide pigment so coverage could be seen; the next coating applied would adhere to this first oil layer. Modern paints, on the other hand, are primarily bonding paints with little ability to penetrate a substrate. For this reason, surface preparation is extremely important for today's paints.

Before preparing the interior for repainting, all moisture penetration from failing roofs or gutters or from faulty plumbing or interior heating elements should be identified and corrected. A paint job is only as good as the preparation that goes before it. The surface to be painted, old or new, wood, plaster, masonry, or metal must be made sound and capable of taking the paint to be applied.

Scraping and Sanding. The first step in preparing interior wood and plaster surfaces which are coherent and sound is to remove any loose paint (see **Paint Hazards** sidebar). Careful hand scraping is always advisable for historic surfaces. Use of mechanical sanders usually leaves traces of the sander's edges, visible through the new paint film. Hand sanding is also necessary to feather the edges of the firmly adhering layers down to the bare areas so that shadow lines are avoided. Preparing previously painted interior masonry for new paint is basically similar to preparing plaster. Metals elements, such as radiators, valences, or firebacks are somewhat different (see Figure 20). In order to get a sound paint job on metal items, the work is primarily that of sanding to remove any rust before repainting. If the existing paint is well adhered over the entire metal surface, then it may be necessary only to sand lightly to roughen the existing paint, thus providing some "tooth" for the primer and new paint layer. On wood, garnet sanding papers work well. Aluminum oxide and silicon carbide sandpapers are effective on other surfaces as well as wood; emery papers should be used on metals.

Paint Removal. When should surfaces be completely stripped? Obviously, new paint is wasted when applied on

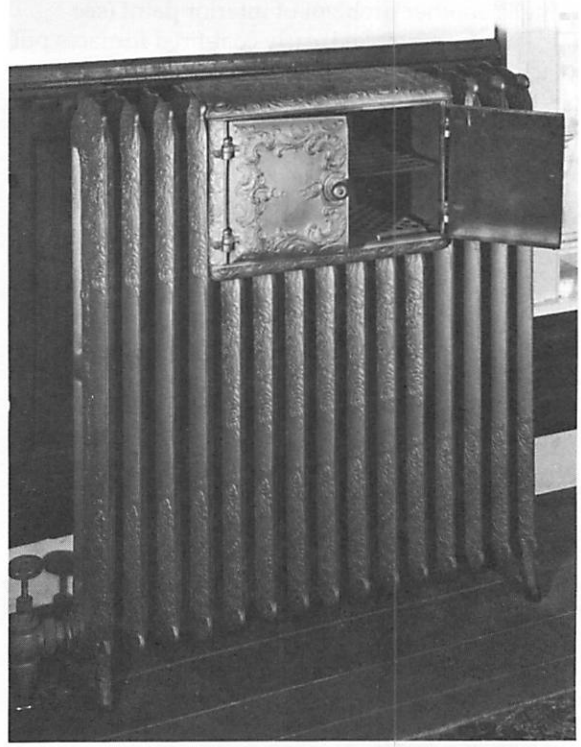


Figure 20. Historic metal components, such as this decorative cast-iron radiator, should be preserved during interior work. Following surface preparation, repainting with rust-inhibiting primer and finish coats is recommended. Photo: Jack E. Boucher for HABS.

old paint which is loose, that is, extensively damaged and deteriorated. Sometimes paint on an architectural feature needs to be removed if it obscures delicate detailing (see Figure 21). For the most part, however, if the surface is intact—and the presence of lead paint has been shown to present no health dangers to building occupants—the existing paint can be overpainted.

Well-adhered, intact paint layers (in at least one area of each room) should be covered with a sturdy protective tape, then painted over with the new paint and left in place to inform future research. The next owner may be interested in the building's past history, and methods of gleaning information from old paints grow more sophisticated all the time.

Heat/Scraping. Propane torches should never be used because they can damage historic wood features. Also, charred areas of wood will not hold the new paint. Use of a heat gun or heat plate may be relatively fast, but has both health and safety drawbacks. Heat oxidizes lead paint, causing poisonous fumes. And old walls may contain fine debris which acts like tinder and smolders when heated, bursting into flame hours after the stripping. (Heat methods are best limited to those interior elements that can be safely removed from the building for stripping and re-installed). Finally, scraping to remove heat-loosened paint may gouge and scar the wood or plaster substrate if not done carefully. Rotary wire brushes cut into wood and should be avoided altogether.

Chemical stripping. Removing paint from wood and plaster features can be done with either caustic strippers (potassium or sodium hydroxide) or solvent strippers (organic compounds such as methylene chloride, methanol, or toluol). Caustic strippers are fairly fast acting, but can weaken wood fibers if left on too long, causing them to raise and separate. They also leave alkaline residues which must be neutralized by an acidic wash (usually white vinegar which contains 4% acetic acid). It is difficult to make the neutralizing 100% effective and, when it is not, chemical reactions between the alkaline residues and the new paint may cause the paint to lose adhesion.

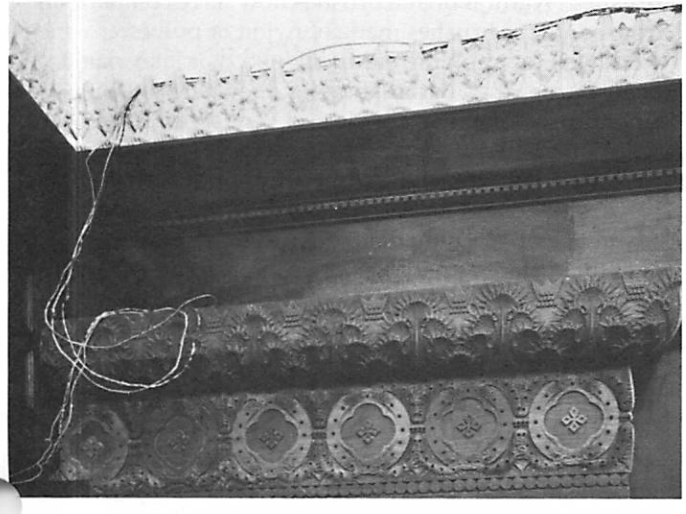


Figure 21. Stripping paint may sometimes be necessary to reveal the delicate detail of an elaborate piece of interior decoration such as this wood column capital. If total paint removal is deemed appropriate, all paint information should be carefully recorded. Photo: National Park Service files.

Methylene chloride and other organic compounds are as effective as caustic strippers, but their fumes may be both flammable and toxic. While they may leave wood and plaster surfaces free from harmful residue, the newly cleaned surface must be washed down with mineral spirits or denatured alcohol before priming in order to remove additives, such as wax, that were put in the stripper to retard its drying. All hazard warnings on the labels of chemical strippers should be heeded.

Detergent or vinegar and water. Water-based paints can usually be scrubbed off with hot water with a detergent added. Calcimine and whitewash are difficult to remove; because of the lime or whiting content (calcium carbonate), however, they can be broken down with acids. While strong acids may work quickly, they are very dangerous. Acetic acid in its most common form, vinegar, (4% acetic acid) is often used instead. In areas where any calcimine remains and is evident as chalk, the area can be coated with white shellac, which provides a stable surface for the new paint.

Air pressure. Air pressure of 200-500 psi is effective for flat surfaces if there is a weak substrate surface bond. A flat nozzle is inserted between the paint layer and substrate, and the air pressure simply lifts the loose paint up for easy removal. When used carefully, this method is fast and causes little damage.

Patching and Repair. Once the substrate and its surface are sound and clean, free from crumbling, loose material or dust, the next step is to undercut and fill any cracks in plaster surfaces. Plaster which has lost its key and is sagging should be re-attached or replaced. Friable plaster and punky wood need to be consolidated. Wood surfaces should be made as smooth as they were historically so that the paint film will cover a relatively uniform surface. Rotted wood must be removed and new wood carefully spliced in. Finally, gypsum plaster finishes can be painted as soon as the water has evaporated; a lime putty coat or traditional finish plaster can be primed almost immediately after drying as well, using alkali-resistant primers such as acrylic latex.

Priming. The importance of a primer can hardly be overstated. It is the intermediary material between the immediate substrate, which may be an old paint layer or may be bare wood, plaster, or metal (rarely stone, as around a fireplace opening), and the fresh paint itself. The primer must be capable of being absorbed to some extent by the material underneath while being compatible and cohesive with the paint to be applied on top. Most paint manufacturers will provide explicit instructions about which primers are most compatible with their paints. Those instructions should be followed.

The question of a primer for latex paint continues to be debated. Traditionalists recommend that the primer between an old oil paint and a new latex paint be an oil primer, but the improvements to latex paint in recent years have led many experts to the conclusion that today's top grade latex primers are best for latex finish paints. If a latex primer is selected, the label on the can should specify clearly that it is one which can bond to an older oil or oil/alkyd paint.

The most important general rule to remember is that softer or weaker paints should always go over harder and

stronger paints. For instance, because latex is stronger than oil, an oil or oil/alkyd paint can go over a well adhered latex, but the reverse will run the risk of failure. Using primer and finish paints by a single company is a good way to guarantee compatibility.

Choosing Modern Paint Types/Finish Coats

Most frequently today, the project goal is preservation or rehabilitation. Because of the impracticality of replicating historic paints, restoration is least often undertaken. Given current laws restricting the use of toxic ingredients, such as lead, solvents, and thinners, contemporary substitute paints using safer ingredients need to be used. Many paint companies make latex paints in colors that are close to historic colors as well as appropriate gloss levels, but contain no white lead and no hazardous volatile organic compounds.

Work on historic properties generally requires the services of a qualified paint contractor who has had at least five years of experience and who can list comparable jobs that a potential client can see. Then, too, getting a sample or a mock-up of any special work may be advisable before the job starts. While less experienced workers may be acceptable for preparing and priming, it is wise to have the most experienced painters on the finish work.

Oil-based/alkyd paints. Today's version of oil paint has a binder that usually contains some linseed oil (read the paint-can label), but also has one of the improved synthesized oils, frequently soy-based, known as alkyds. They dry hard, have flexibility, and discolor far less than linseed oil. They can also be manufactured to dry with a high sheen, and can take enough tinting pigment to create even the very deep Victorian period colors. However, they all contain volatile organic compounds, and thus are forbidden by law in some parts of the United States. They are also less simple and more dangerous to use, as cleaning up involves mineral spirits.

Acrylic water-borne paints (latex). Latex paints are synthetic resins carried in water. Before the paint dries or cross-links, it can be cleaned up with water. Early in the history of latex paints, some contained styrene/butadiene resins. Now nearly all top-grade latex paints contain acrylic resins, which are superior. Also, until fairly recently, the latex paints, while offering great strength, quick drying, and water clean-up, had some disadvantages for jobs which needed to have an historic look. Today, there are latex product lines with better gloss characteristics and more historic colors from which to choose. In addition, latex paints often have excellent color retention with very little fading. Still, it is always a good idea to buy a quart and "test paint" the color chosen for the job on site before making a total commitment.

Calcimine/whitewash. Modern water-based paints such as calcimine can be purchased today and have much the same appearance as the early ones. The same is true of modern whitewash, although today's whitewashes do not leave the same ropy surface texture as the early ones.

Glazes. Glazes were often part of historic paint treatments. Traditionally oil and turpentine, sometimes with a scant amount of pigment, today's glazes can be formulated with a water base and are relatively simple to apply by brush. An experienced decorative painter should be consulted before deciding whether to use a glaze coat rather than a high-gloss enamel. The glaze is capable of providing protection as well as a more accurate historic appearance that includes a greater depth to the finish.

Types of Modern Paint

Oil-based/alkyd: Non-volatile oils and resins, with thinners. (Alkyds are synthetic, gelatinous resins compounded from acids and alcohol.) Accept almost any type of coloring/hiding pigments. For use on interior wood and metal.

Acrylic water-borne paints (latex): Suspension of acrylic or polyvinyl resins in water, with other resins, plus hiding and coloring pigments and extenders. Dries by evaporation. Commercially produced acrylic or latex enamels are also available in a complete range of gloss levels which are produced with the addition of various acrylic polymers. Use on interior plaster especially.

Enamels: Modern alkyd paints are adjusted with the addition of synthetic varnishes to produce a complete range of gloss levels.

Metal finishes: Paints marketed for use on metals, can either be alkyd, latex, or epoxy based, or combinations. The primers used for metals are formulated with rust-inhibiting ingredients.

Special finishes: finishes such as urethane and epoxy-based paints, marketed for very high gloss surface treatments.

Epoxies/Urethane. These were not available until relatively recently and thus are not appropriate for replication of traditional finishes.

Applying Interior Paints

Because flat wall surfaces generally dominate an interior painting job, some flexibility in applicators is suggested below:

Brushes. Natural bristle brushes now have competition from synthetic brushes made of nylon or polyester which work well for applying either oil/alkyd or latex paints. Being harder than natural bristles, they tend to last longer. Since brushes come in a wide and very specific variety of types suited to different types of work, it is important to have a painter who will use the appropriate brush for the paint selected and for each portion of the job. One strong advantage of brushing paint on is that the paint is forced onto the surface and into all of its imperfections. Thus a good brushed-on paint job may last longer if the substrate is sound and the primer and finish coats are compatible and of top quality.

Rollers. There is no harm in using a roller, or even an airless sprayer, to apply a prime coat to a large flat area. Since all contemporary commercial paints dry with a smooth surface anyway, use of a roller or sprayer is acceptable for priming, and even for a first finish coat. However, to get paint well pushed into articulated surfaces and to add some texture to larger flat surfaces, a brush is best.

CAUTION: Before Painting/Know Paint Hazards and Take Action

Before undertaking any project involving paint removal, applicable State and Federal laws on lead paint abatement and disposal must be taken into account and carefully followed. State and Federal requirements may affect options available to owners on both paint removal and repainting. These laws, as well as any requirements prohibiting volatile organic compounds (VOCs), should be requested from the State Historic Preservation Officer in each State.

Below is a summary of the health hazards that owners, managers, and workers need to be aware of before removing paint and repainting:

Lead and other heavy metal compounds. In virtually all paints made before 1950, the white or "hiding" pigment was a lead compound, or more rarely, zinc oxide. Work to remove lead paint such as scraping and dry sanding releases the lead—a highly damaging heavy metal—in dust. Lead dust then enters the human system through pores of the skin and through the lungs. The use of heat for stripping also creates toxic lead fumes which can be inhaled.

To mitigate the hazards of lead paint ingestion, inhalation, or contact, it is extremely important to prevent the dust from circulating by masking room openings and removing all curtains, carpeting, and upholstered furniture. Drop cloths and masking containing lead dust should be carefully enclosed in tight plastic bags before removal. Workers and others in the room should wear High Efficiency Particulate Air (HEPA) filters for lead dust (fume filters if heat stripping is being used), change clothing just outside the room leaving the work clothes inside, and avoid any contact between bare skin (hands) and the paint being removed. Workers should also not eat, drink, or smoke where lead dust is present. Finally, anyone involved in lead paint removal should undergo periodic blood testing. After work, ordinary vacuuming is not enough to remove lead dust; special HEPA vacuums are essential. The surfaces of the room must also be given a final wash with a solution of trisodium phosphate and water, changing the washing solution often and rinsing well.

In addition to lead, early oil paints also had cobalt or other heavy metal compounds in them to accelerate drying. A small amount of mercury is also included in some latex paints to help prevent mildew and mold formation.

Volatile organic compounds (VOCs). Organic paint strippers, such as methylene chloride, and oil/alkyd paints have VOCs as their solvent base. Inhaling these fumes can lead to respiratory and other illnesses, and to cancer. Especially in closed spaces (but in the outdoor environment as well) these compounds pollute the air and can damage health.

Finally, decorative paint work in an historic interior—whether simple or high-style—is well worth preserving or restoring, and when such fancy work is being undertaken, traditional tools should always be used (see Figure 22). To simplify by using short-cut methods or rejecting painted decoration is indeed to dismiss or skew history as well as to lose the enjoyment of a true historic finish.



Figure 22. Traditional water-based paint and artists' brushes are being used to reproduce historic finishes within a restoration project. Photo: Courtesy, Alexis Elza.

Summary

First, it is most important to understand the range of approaches and treatments and to make choices with as much knowledge of the original and subsequent historic paints as possible, using the Secretary of the Interior's Standards for Historic Preservation Projects as a framework.

A paint's patina of age expresses decades or centuries of endurance in the face of changing climate and conditions. Documenting the sequence of interior paint layers and protecting this information for future investigation should be an integral part of any historic preservation project.

Except for the rare, scholarly restorations of historic interiors, most repainting jobs done today will employ modern paint formulations. Modern paints can recreate the appearance of historic colors, gloss and texture in varying degrees, but eliminate earlier toxic components such as white lead and volatile organic compounds.

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Organizations

National Paint and Coatings Association
1500 Rhode Island Ave. N.W.
Washington, D.C. 20005

Painting and Decorating Contractors of America
3913 Old Lee Highway, Suite 33B
Fairfax, VA 22030

Federation of Societies for Coatings Technology
492 Norristown Rd.
Blue Bell, PA 19422-2350

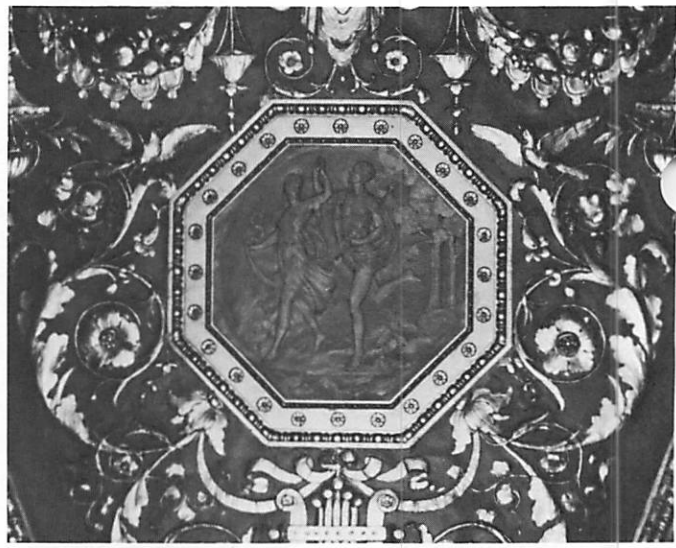


Photo: Matthew J. Mosca

Acknowledgements

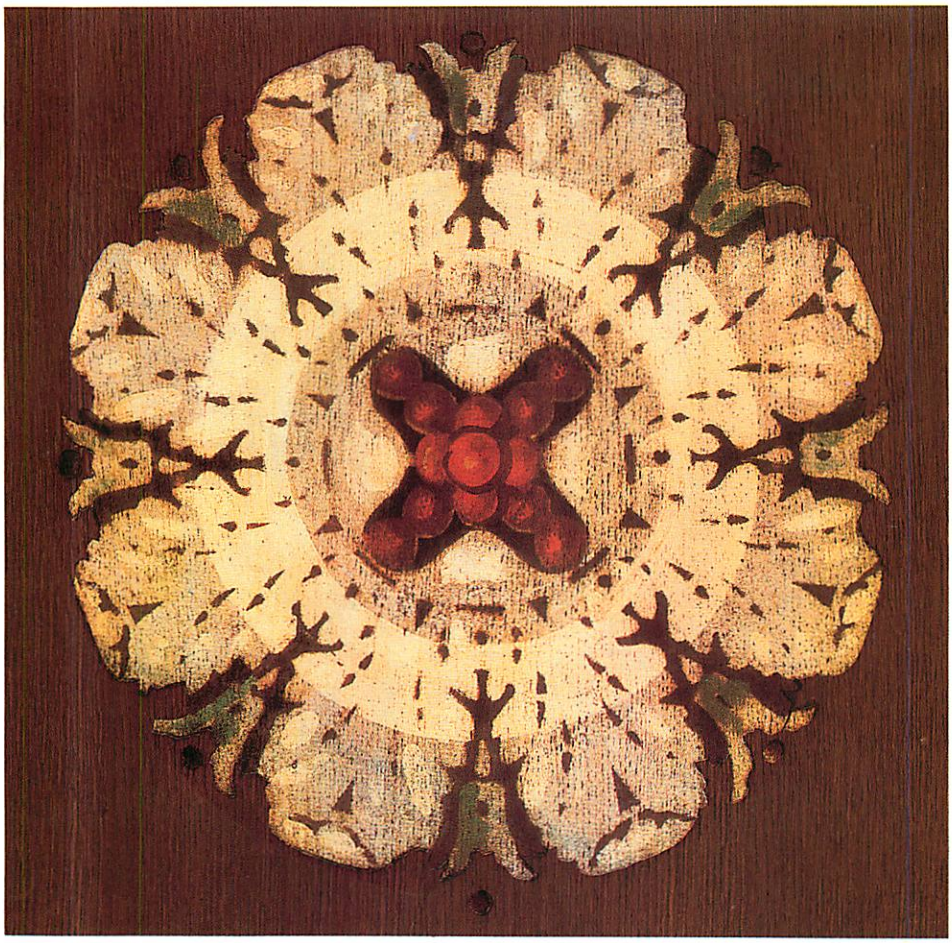
Thanks go to the technical experts in the field who reviewed the draft manuscript and made substantive contributions: Andrea M. Gilmore (Director, Architectural Services, Society for the Preservation of New England Antiquities), Andy Ladygo (Jefferson's Poplar Forest), and Matthew J. Mosca, Historic Paint Research. Insightful comments were also offered by E. Blaine Cliver, Chief, Preservation Assistance Division. In addition, Technical Preservation Services Branch staff members (H. Ward Jandl, Chief) and the NPS Regions provided valuable suggestions on both content and organization.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Comments on the usefulness of this publication may be directed to: Chief, Preservation Assistance Division, National Park Service, P.O. Box 37127, Washington, D.C. 20013-7127.

Kay D. Weeks served as project director and editor of the cooperative publication project.

June, 1992.

For sale by the U.S. Government Printing Office
Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328



PRESERVATION
Tech Notes
U.S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
WASHINGTON, D.C.

FINISHES:
NUMBER 1

Process-Printing Decals as a Substitute for Hand-Stencilled Ceiling Medallions

Sharon C. Park, AIA
Preservation Assistance Division
National Park Service

NATIONAL ARCHIVES
Washington, DC.

Completed in 1935, the National Archives was designed by John Russell Pope and is part of the Federal Triangle of monumental buildings in Washington, D.C. (*see figure 1*). As the repository for official Federal documents, including the Declaration of Independence and the United States Constitution, it is used daily by many visitors and researchers. The Central Search Room, the most ornate of the public research space, is a rectangular space paneled in "Gothic oak." Twenty-two feet above the floor is an imposing oak ceiling consisting of 105 coffered sections set within five large bays, separated by boxed beams. Decorative stencilling at the center of each coffered section consists of a 12″ diameter medallion of leaves curling around a grouping of red cherries. The shading and highlighting of the painted surface creates a trompe l'oeil effect of a carved wooden feature.

Problem

The coffered ceiling had been badly damaged in 1962 with the installation of fluorescent light fixtures (*see figure 2*). Forty of the coffers had been drilled with large holes to attach the light fixtures and the central medallions had been removed (*see figure 3*). In 1988, the General Services Administration (GSA) authorized a new sprinkler system in the Central Search Room. As part of the sprinkler project, the 1962 instrusive fluorescent lights were proposed for removal, with attendant enhancement of the desk level lighting. The two historic chandeliers were to be retained.

Using the ceiling openings created by removal of the modern light fixtures, 2″ diameter pipes were installed for the new sprinkler system. Because the intact historic panels were so tightly glued in place, it was difficult to remove them without damage. Therefore, the new sprinkler heads were located at the centers of the 40 replacement panels, which were evenly spaced across the ceiling. One historic panel was removed to serve as a model for the replacement panels.

At the beginning of the project, GSA

Substitute materials used to replace lost or damaged features or finishes should match the visual qualities of the historic elements without damage to the historic resource.

considered replacing the damaged panels with hand-painted stencils to recreate the medallions. While the craft techniques of stencilling are still practiced, in the end GSA preferred replacement panels that would appear to match the historic ones from the floor level, yet up close would not duplicate the original in every detail. This approach would both preserve the integrity of the historic work and set high standards for the fabrication of the replacement panels.

The historic ceiling, which had aged to a warm brown, would not be cleaned as part of the work, due to limited funds. Thus, in order to have the 40 new panels visually match the original, but uncleaned panels, the contractor would have to age the replacement panels artificially, permitting cleaning to take place in the future without creating a difference between the new and the original work. The treatment or solution used to "age" the new panels would have to be applied without obscuring the new decorative medallions. At the same time it had to be capable of being stripped later without damaging the new decorative work.



1. Completed in 1935, the National Archives is the repository for official Federal documents. Photo: Hugh Talman.

Historic Coffers

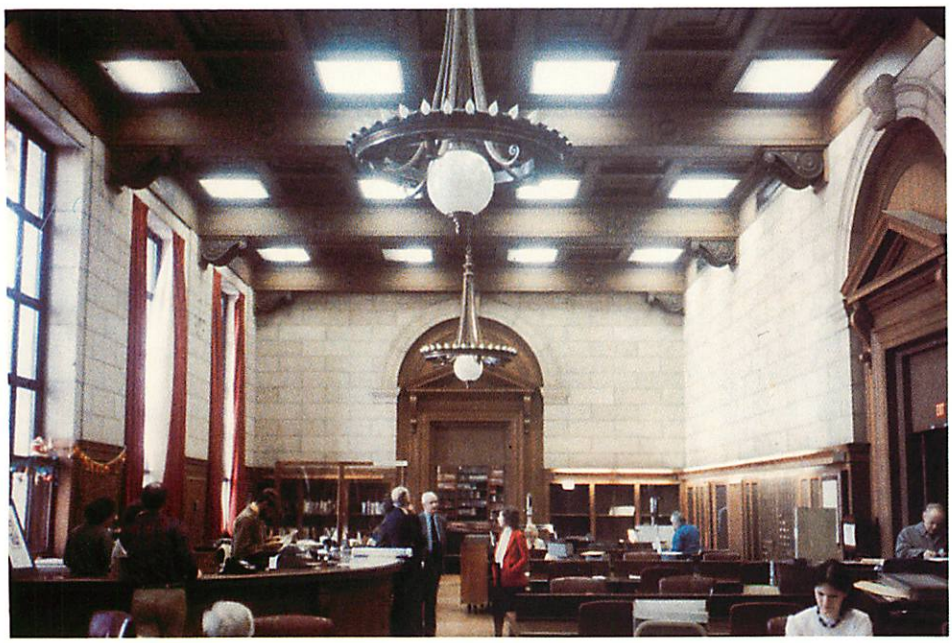
The original coffers were made of strips of white oak veneered onto plywood panels, approximately 16″ x 18″. The coffers were arranged in 5 bays of 21 coffers separated by boxed beams. Decorative egg and dart moldings, made of an early wood substitute known as "compo," trim the edges of each coffer. The hand-stencilled medallions, in the center of each panel, were individually shaded to highlight the curled leaves and cherries, giving a 3-dimensional effect. The colors had all aged to muted browns as a result of the darkening of the oil-based varnish overcoat.

Original medallions used as backing for access panels and shim pieces when the fluorescent lights were installed served as test panels for cleaning. Various chemicals were tested to find a treatment that would remove the old varnish without removing the paint. One entire undamaged panel was removed and cleaned, based on the test results, and served as the model for the replacement work. The varnish overcoat was removed using cotton swabs dipped in a solvent solution. It took 6 applications to carefully strip the varnish without removing the original brush marks. This was followed with up to 6 cleanings of the paint and highlights using a commercial stripper of toluene, acetone, and butyl-acetate. The result was that the original lighter tones of the white oak background were also revealed along with the bright colors of the original painted medallions (*see figure 4*).

Solution

Various options were investigated for replicating the visual appearance of the hand-stencilled medallions. These included painting the medallions and panels as well as printing and photographic reproduction techniques. Had traditional hand-stencilling been selected, varnishes and light-stable acrylic pigments would have been used to retard aging of the new paints.

Besides hand-stencilling, consideration was given to having lithograph prints made of the entire cleaned panel, wood graining included, and gluing them onto new plywood panels. The completed panel would then have received a protective varnish coat. Since the background wood panel would be printed along with the stencilled medallion, several original panels would need to be removed to use as models in order to keep the replacements from standing out due to a uniform appearance. This approach was rejected because of the difficulty of removing undamaged panels from the ceiling. A modified stencil was also considered; in this approach the stencilled medallions alone would be cut out and applied to oak veneered plywood panels. As the outer edges of



2. The 40 large visually obstrusive fluorescent lights, installed in 1962, damaged the coffered ceiling in the Central Search Room. Photo: Dell Corporation.



3. The light fixtures were carefully removed to permit installation of a sprinkler system behind the coffered ceiling and to restore the ceiling to its original appearance. It was necessary to reproduce 40 new panels for installation in the coffered ceiling, due to the damage resulting from the 1962 lighting work. Photo: Dell Corporation



4. A historic stencilled panel was removed and cleaned in order to have a model for the replacement panels. In this view, only half of the panel has been cleaned, revealing the difference between the aged and original appearance of the ceiling. Since the ceiling was not scheduled to be cleaned, a decision was made to reproduce the original panel appearance and then artificially age the replacement panels to blend in with the existing ceiling. Photo: Dell Corporation.

the medallion contain free-floating decorations, the paper backing would have to be carefully trimmed and the decorative elements separately applied in order for the natural wood background to be visible. This was a possible alternative, but would require careful handwork in the workshop.

A fourth option, and the one selected, involved creating a stencil on a clear background similar to decals used in model building. This water-release transfer decal would be placed directly onto the prepared plywood veneered panel. By having a transfer decal of the medallion on a clear background, the regularity of the pattern would be less noticeable, since portions of the different oak veneered panels would be visible. Slight hand shading of the medallion during the final varnish coating of the panels could affect highlights similar to the originals.

Process

The fabrication of the 40 new oak-veneer plywood panels used the same techniques as in 1935. The panels, however, were made slightly smaller as they had to be installed in the ceiling coffers from below, whereas originally they were seated from above the coffer. To match the oak, penetrating brown wiping stain was applied, followed by a non-linseed oil varnish. This produced

other projects when it is necessary to replace lost elements that originally were repetitive in appearance, polychromed, and viewed from a distance. It has the potential advantage over decorative painting of requiring less time at the site. It may be cheaper, especially where large numbers of repetitive patterns are involved. It should not be considered as a replacement for the still practiced craft of stenciling, but rather as a technique that can be effectively used where appropriate conditions exist along with budgetary constraints.

PROJECT DATA

Building:
The National Archives
9th and Constitution Avenue
Washington, D.C.

Owner:
U.S. Government
under the management of the
General Services Administration

Project Date:
1988

Project Manager:
Andrea Mones-O'Hara
General Services Administrator
National Capital Region
Washington, D.C.

Contractor:
Dell Corporation
J. Bryan Blundell, President
Rockville, MD

Cost:
The cost for photographing and printing 50 decals was $4,000. (For comparison, the cost of printing 200 decals would have been only $4,800, indicating considerable savings with larger quantities.)

This PRESERVATION TECH NOTE was prepared by the National Park Service. Charles E. Fisher, Preservation Assistance Division, National Park Service, serves as the Technical Editor of the series. Special thanks go to J. Bryan Blundell, President, Dell Corporation, for providing considerable information on the project work. Thanks also go to Andrea Mones-O'Hara, General Service Administration, for her review and comments on the draft and to Michael Auer, Preservation Assistance Division, National Park Service. Cover Photo: Dell Corporation.

PRESERVATION TECH NOTES are designed to provide practical information on innovative techniques and practices for successfully maintaining and preserving cultural resources. All techniques and practices described herein conform to established National Park Service policies, procedures and standards. This Tech Note was prepared pursuant to the National Historic Preservation Act Amendments of 1980, which direct the Secretary of the Interior to develop and make available to government agencies and individuals information concerning professional methods and techniques for the preservation of historic properties.

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ISSN:0741-9023 PTN-31 September 1990

the decals were printed in one day, and left to dry overnight (*see cover photo*).

At the contractor's workshop the finished decals were applied to the prepared panels by 2 people in a single day. The decals were transferred to the moistened surface of the panels and positioned around the fire sprinkler hole. Pressure from a squeegee blade was applied to affix the decal to remove any water or air bubbles. Upon drying overnight, two coats of clear acrylic were sprayed on to form an isolating layer over the decal. At this point, the new panels closely match the one original panel that had been cleaned.

Because the original panels were not to be cleaned at this time, the replacement panels were artificially aged to match the current appearance of the historic panels. To give an individual appearance to each medallion with a minimum amount of hand work, highlighting was done by rubbing a solvent soaked cotton swab over the tinted overcoats, removing some of the topcoat varnish in selected areas. A clear coat was sprayed over the tinted coat to provide a final protective layer (*see figure 5*).

Upon the completion of the sprinkler piping system, the finished panels were installed using 1 3/4″ long stainless steel pins to set the panels into the coffers (*see figure 6*). This side pinning (6 per panel) was necessary, as the panel had to fit around the sprinkler head and there was no room to manipulate the panel up into the small cavity space. The 40 panels were reinstalled over a one week period using a rolling scaffold and a crew of four. Upon completion, the replacement panels were virtually indistinguishable from the historic panels when viewed from below (*see figure 7*).



6. The finished panels were installed in the ceiling with new sprinkler heads located in the center of the cherry motif. Stainless steel pins were used to set the panels, since there was no room to lift the panels in place from above the ceiling once the wet piping system was in place. Photo: Dell Corporation.



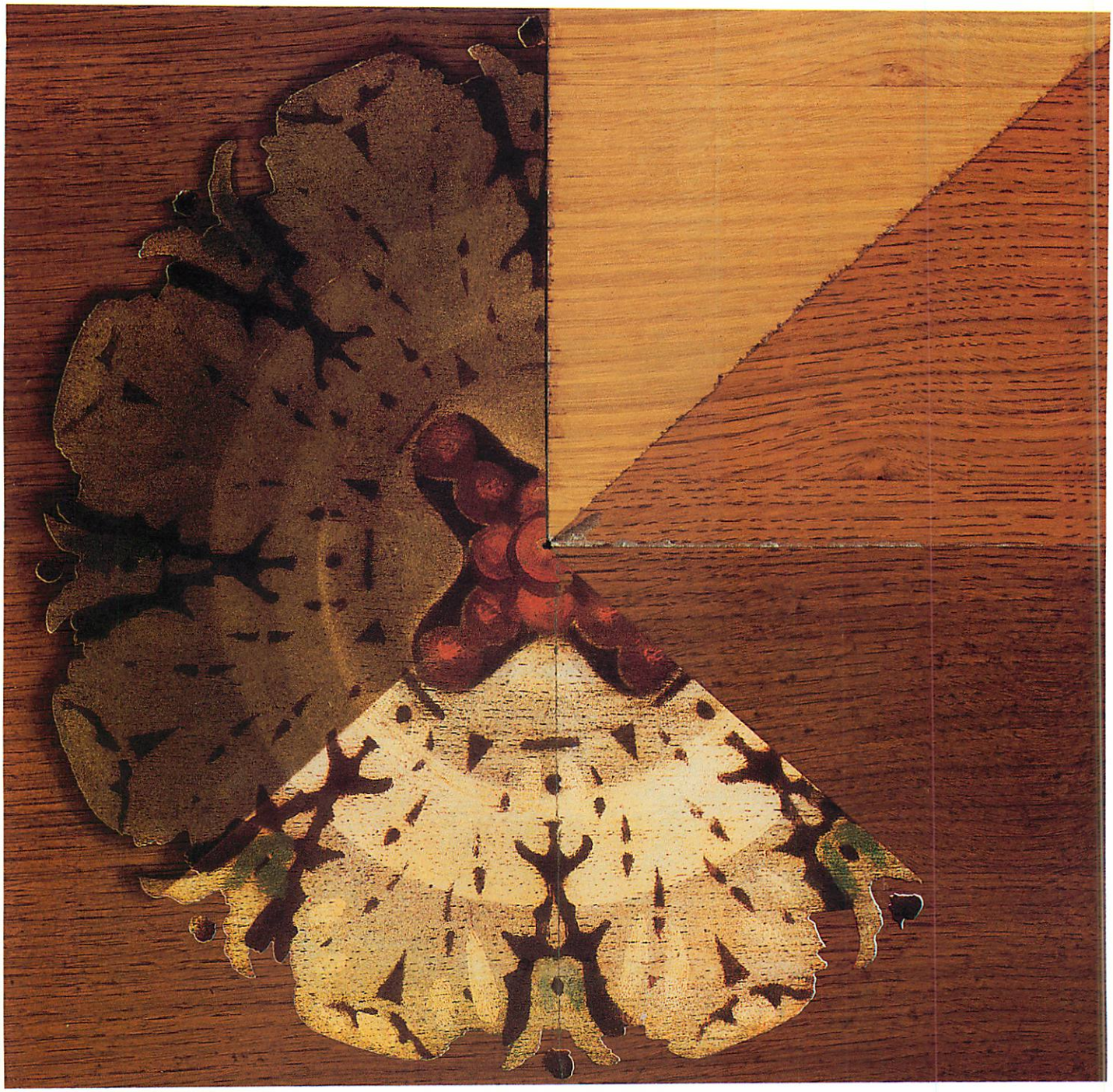
7. Following the work, the difference between the decal replacements and the historic stencilled panels is not discernible from the floor of the Central Search Room. Photo: Dell Corporation.

Conclusion

The use of the preprinted water-release decals on the prepared panels took less time than artisans working within the studio recreating the original technique. Traditionally, each color was hand-stencilled separately, allowing time between color applications for drying. While the cost of the decals was less than that of artisans doing the actual stenciling, it was difficult to determine exactly how much saving was realized on this job. The research and development time offset some of the potential cost savings that would be realized in a subsequent project of this type. For jobs involving larger quantities of mass-produced decals, the unit cost would be substantially reduced.

The challenge to find a cost-effective technique that could substantially recreate the appearance of a historic decorative detail was met—without resorting to the historic method of hand-stencilling. The high ceiling partly accounted for the successful use of this technique, since the differences with the original stenciling are not apparent from the public view. To the casual observer, the replacement panels are not discernible. To the trained observer, it is clear what is genuinely historic and what is replacement.

Application of this technique to other projects must be evaluated in terms of the impact on surviving historic material, and in terms of whether the new feature will be seen up close or at a distance. This fabrication technique may have applicability to



5. This demonstration model shows the various stages involved in finishing the ceiling panel. Starting with the raw wood panel in the upper right corner (1) and moving clockwise, a penetrating stain was applied (2) that matched the historic stain. A tinted varnish, or sealer, (3) was then applied to ready the backing panel to receive the decal (4). Two coats of acrylic sealer were used to protect this "cleaned" condition. The next 3 steps (5, 6, 7) produced the "aged" appearance with tinted varnish layers sprayed on using cardboard masks to produce the proper tones. A top coat of clear varnish (8) provided the final protective layer. Photo: Dell Corporation.

darkening within the grain, without obscuring the wood itself. A non-yellowing, light-stable oil varnish was used to seal the panel and to receive the medallion decal.

The decals were made using a photograph transparency of the original cleaned medallion. The decals were a water-release type printed with light-stable ink colors. The process-printing technique takes the photographic positive and with the use of a computer makes color separation negatives. Quality control is obtained by using a gray scale and color bar. Inks are not solid films of color, but rather transparent dots of color laid out in a pattern of 180 dots per inch. The variation in colors in the final product is achieved by printing the three primary colors (red, blue, yellow) and all the other resulting colors are from the overlapping of the color dot negatives. This way, as few as three screens with inks and a fourth screen of black for shading and depth are used. Each medallion decal required 7 runs through the printer (clear base, white background, 3 colors, black, clear top coat). Thus, it was critical to have precision registration to avoid blurred detail or a shift in color. Once the printing process was perfected, all