

Tech Notes

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



EXTERIOR WOODWORK

NUMBER 1

Proper Painting And Surface Preparation

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“OLE JIM” GALLAUDET COLLEGE Washington, D.C.

“Ole Jim,” completed in 1881, was the first gymnasium constructed for Gallaudet College, a National Historic Landmark. The building is distinguished by its Tudor Revival style, imitating the half-timbered structures of Elizabethan England. The upper floor is framed in heavy timber post and beam construction while the first floor (which originally housed a swimming pool) is of masonry. In 1940 the building ceased to function as a gymnasium and was converted first to a print shop and later to a warehouse. The building was slated for demolition when the college decided to rehabilitate it in 1980 for use as alumni offices and dining facilities.

Between the heavy timber framing on the second floor, the exterior

wall is faced with tongue and groove siding made of Southern yellow pine. There are also ornamental “half-timbers” applied over the siding, resulting in horizontal ledges and angled pockets which have a tendency to catch and hold water.

As early as 1910, the second floor wall surfaces were covered with stucco in an attempt to reduce water damage. The most dramatic aspect of the 1980 rehabilitation was the removal of the applied stucco and restoration of the painted half-timbered wooden exterior, much of it still intact (see figure 1). Old paint was removed down to bare wood and a new primer and two topcoats were applied. However, the newly applied paint on the wooden surfaces started failing within a year. By 1984, with the paint blistering and peeling, the college realized that the entire exterior wooden surface once again needed major work.

Proper surface preparation, elimination of moisture problems, and appropriate paint system selection are essential for effective protection of exterior woodwork.

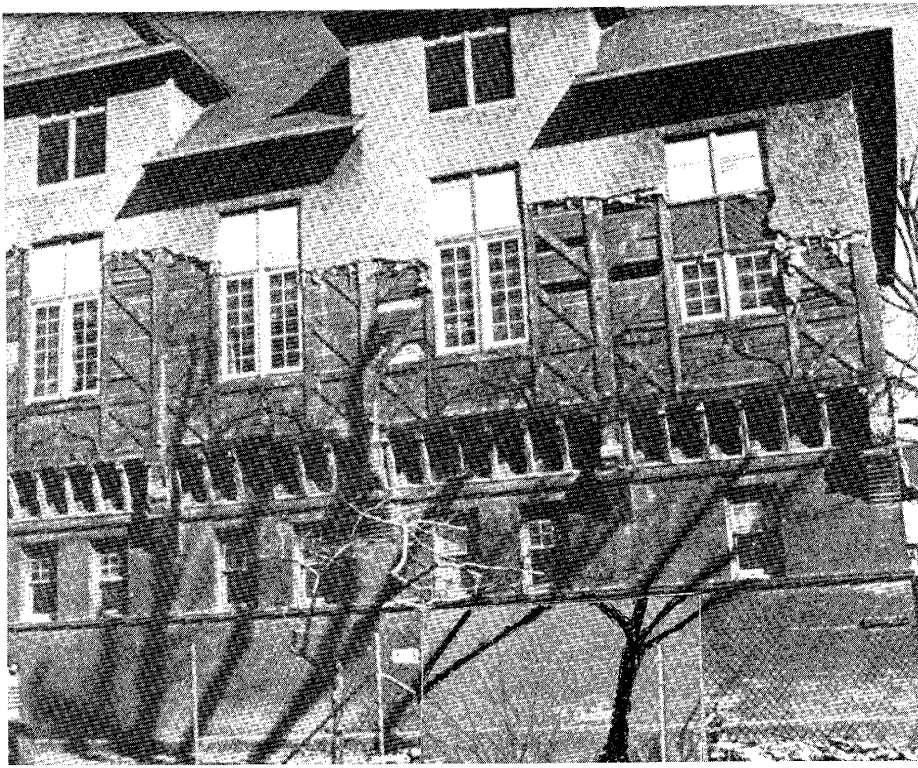


Figure 1. The stucco, applied circa 1910, is shown here being removed as part of the 1980 restoration. The wooden siding and "half-timbering" was largely intact underneath. Photo: Courtesy of Gallaudet College

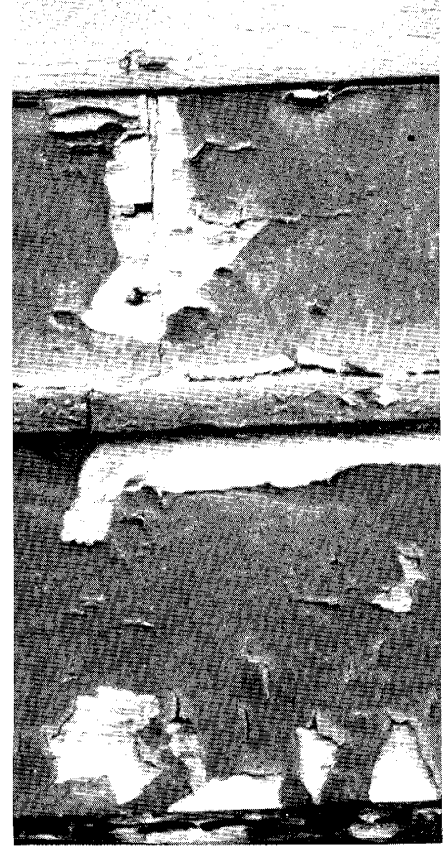


Figure 2. Paint applied in 1980 started to peel within a year, and by 1984 extensive failure had occurred. Photo: Sharon Park, AIA

Problem

A preservation architect was hired to investigate the reasons for the failure of the 1980 paint coating and to recommend appropriate remedial treatments. The college was particularly interested in having new paint work last in excess of 7 years.

Paint peeling off the wooden surface indicated that the prime coat had not adequately bonded to the wood (see figure 2). A close inspection using a "cherry picker" revealed three areas of serious deterioration. First it was apparent that moisture was getting behind the "half-timbering" where it covered the tongue and groove siding, and was rotting the wood. Secondly, the joint where the recessed tongue and groove siding abutted the heavy timber posts and lintels was equally difficult to keep sealed once the paint had failed. And finally, extensive dry rot had occurred at the intersection of the structural column and sill plate (see figure 3). The extensive paint failure, together with the deteriorated wood, indicated a serious moisture problem.

Paint Failure Based on the physical evidence and on an examination of records from the 1980 work, it was possible to attribute the paint failure to a combination of factors: excessive wall moisture, selection of an incorrect paint system, and painting in cold weather (see figure 4).

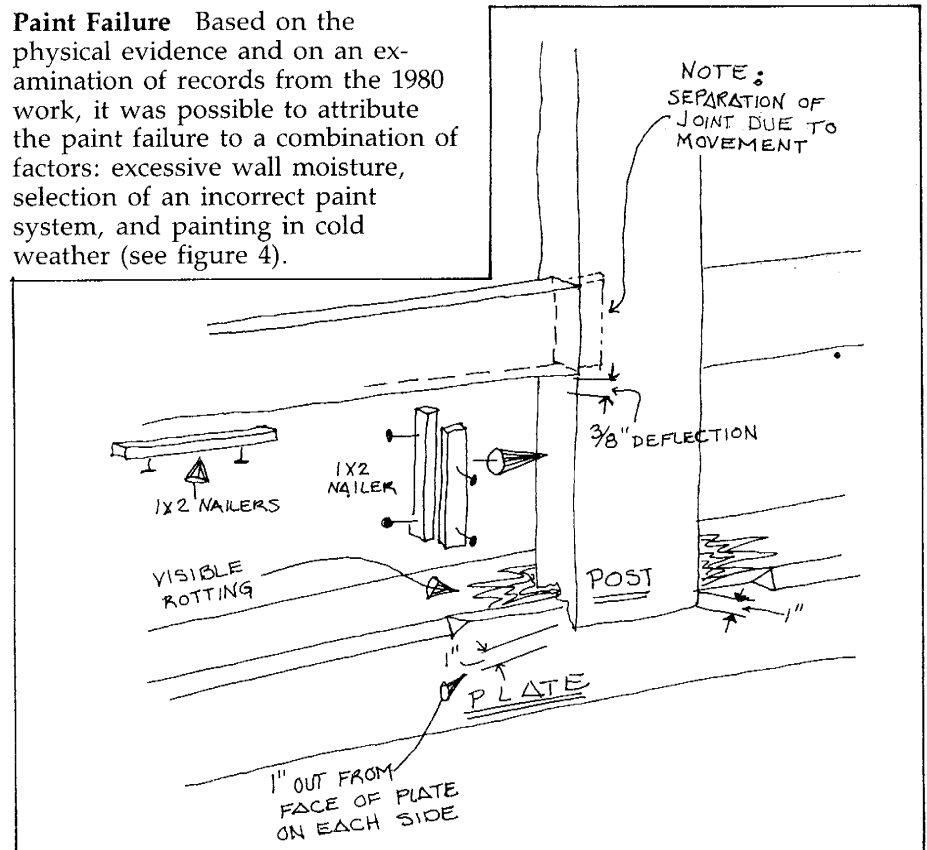


Figure 3. Areas of wood deterioration included the horizontal sill plate at the structural post connection as shown in this sketch made on site in 1985. Drawing: Dell Corporation.

During the 1980 restoration, a steam pipe had burst, saturating a large section of the exterior wooden wall in the gymnasium. Readings taken after the accident showed a moisture level in the wood as high as 43%. Apparently, the walls were not adequately dried out before batt insulation was installed and the wall surfaces painted, thereby contributing to the paint failure.

The paint selected for the 1980 exterior work was a fire-retardant marine grade epoxy (pigmented polyamide epoxy). The paint had been chosen partly because it contained fire-retardant agents and was therefore consistent with the college's fire safety concerns. Local codes required a fire-retardant coating on the interior wooden surfaces, and the local fire officials had recommended its application on the exterior as well. In addition, the paint was selected because it was supposed to help waterproof the exterior and seal the many troublesome wood joints.



Figure 4. Flaking paint was the result of painting moisture-laden wood, using an inappropriate paint system, and undertaking the work during cold weather. Photo: Baird Smith, AIA

This impervious paint only compounded the problem. Residual moisture trapped in the walls from the broken steam line could not easily escape once the epoxy paint was applied. Furthermore, the paint turned out to be hygroscopic, or moisture absorbing, because of the salts used in the fire-retardant formulation. Once exposed to moisture, the paint swelled and, due to poor surface bonding, blistered off. Records also showed that the painting occurred during weather below 40°F, creating the possibility that the paint had frozen before drying or, at a minimum, that the prime coat had not properly bonded to the wood. As a result of all these factors, there was widespread paint failure, exposing bare wood to further water damage and ultra-violet degradation.

The only way to solve the problem was to remove all the paint, properly prepare the wood surface, and repaint.



Figure 5. Some internal core deterioration was masked by sound surface wood. Water entering the connection of the post and beam framing rotted out the mortise and tenon pockets. These areas were consolidated and filled with epoxy. Photo: Baird Smith, AIA

Wood Deterioration The architect determined that prior to repainting, the deteriorated wood would have to be replaced or consolidated in order to provide a sound painting surface. While surface deterioration was readily evident in areas, further investigation revealed the rotting of the timbers at the tenon pockets (see figure 5).

The deterioration of the timber joints was from long-term decay probably dating back to the turn of the century. Fortunately, the surfaces of the structural timbers were in good condition; the rotted tenon pockets in the structural members could be consolidated and filled with epoxy resins rather than be replaced. About 10% of these timber joints were in need of such repair.



Figure 6. Sound pieces of wood salvaged from elsewhere on the building are being used to replace this deteriorated tongue and groove panel. In most cases, deteriorated wood trim, sills, and paneling were replaced with redwood that was back primed. Photo: Bryan Blundell

Solution

The architect directed an experienced contractor to help with both the condition evaluation as well as the actual repair work. The contractor computed that overall there was 8,000 square feet of wooden surface including siding, trim, gables, fascias, soffits and rafter ends. Careful documentation of specific areas of deterioration helped the owner understand the extent of the problem.

Repair and repainting was scheduled in the following order:

1. Removal of the fire-retardant epoxy paint;
2. Immediate priming of exposed surfaces;
3. Epoxy consolidation and epoxy infill of about 10% of the structural members;
4. Replacement of moderately deteriorated wood sills, paneling, and decorative trim (approximately 20%);
5. Painting with a second prime coat;

6. Caulking joints and open seams with an elastomeric polyurethane sealant;
7. Addition of molding trim to improve water drainage from horizontal surfaces and corners;
8. Painting with two top coats of high quality exterior paint.

Carried out on a time and materials basis by the contractor, work started first on the more intricate front elevation. The College would be able to more accurately estimate the overall cost once work on the front elevation was completed. The scope of work could be modified for the less significant elevations if adequate funds were not available.

Surface Preparation And Repainting

Since the key to a long-lasting paint job is good surface preparation, a systematic approach was developed which involved the careful removal of the paint, protection of the wooden surfaces while repairs were underway, and the use of two prime and two top coats of paint, with sanding between prime coats. To extend the life of the paint job and to provide long-term ease of maintenance, all joints were caulked and molding trim added to reduce areas where water could stand on horizontal surfaces or penetrate corners. While the extra care in sanding and the second prime coat added 20% to the overall painting cost, the contractor estimated that two to three years will be added to the life of the new paint job.

Paint Removal The first step was to strip off the old paint. Heat plates were used even though it was very difficult to raise the temperature of the fire-retardant

paint to the point where it could be scraped off without scorching the wood. Extreme care was taken; the work was carefully supervised and only workmen trained in this type of paint removal were employed. Work was scheduled to finish early in the day to allow at least three hours before the construction crew left the site, thereby providing time to detect any hidden smoldering of wood. (Smoke detectors wired to a caretaker's quarters or a central alarm are always a good back-up safety feature for any project involving thermal paint removal). No open flames were used on this job because of the high fire risks and the unavoidable damage they do to historic woodwork.

Upon removing the paint, it was evident that the wood, saturated by moisture at the time of the 1980 restoration, had dried out naturally, and in some cases was excessively dried out due to ultraviolet degradation from exposure to sunlight. To protect the wood surfaces, once the paint was removed, the walls were draped with tarpaulins to shed rain water.

*No open flames were used
... because of high fire
risks ...*

Priming After the old paint was stripped off, the wood surfaces were sanded, generally on the same day. Orbital sanders with #120 grit (medium grade) sandpaper were used on flat surfaces and flexible sanding blocks on the curved jack rafters and in tight corners. Moisture meter readings were taken of the wood prior to priming to ensure that the moisture content in the wood did not exceed a reading of 14%. As work progressed the exposed wood was primed with an oil-alkyd primer cut by 20% with mineral spirits. An oil-alkyd primer was selected for its good ability to bond to wood surfaces. The primer was thinned with a solvent to increase the depth of

penetration at the recommendation of the architect, following consultation with the paint manufacturer. The extra depth of primer penetration helped to rejuvenate the dried wood and ensure that the paint would bond to a strong substrate surface. In some cases, it was several weeks before repairs were completed, and the prime coat also prevented newly exposed nails from rusting and kept water from penetrating back into the wood.

*... the extra depth of
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Wood Repair and Replacement

Repair or replacement of damaged wood was the next step. This phase involved epoxy consolidation and epoxy infill of damaged structural members and the selective replacement of moderately deteriorated trim and sills. When wood was replaced, primed redwood was used since today's yellow pine is less durable than the heartwood yellow pine originally used on the building. Approximately 20% of the applied decorative trim (diagonals and ogee boards) were replaced along with five panels of tongue and groove paneling (see figure 6). Good sections salvaged from the wood panels were reused for small repairs elsewhere on the building.

When wood was consolidated and filled with epoxy resins, the strength of the epoxy fill was formulated to match the strength of the wood as closely as possible. The major areas of deterioration were mortise and tenon pockets of the vertical and horizontal structural members. With the surface wood of these members in generally good condition, only the punky areas of the beam or post had to be dug out. The remaining shell forming the tenon pocket was consolidated as a precaution to stop any future deterioration. The hollow was filled with epoxy resins

to stabilize the joint.

Prior to selecting epoxy consolidation as a means to repair structural members, the project team had taken into consideration the lack of consensus among professionals regarding the effectiveness of epoxy over the long-term. The natural wood fibers could continue to deteriorate behind the patch or adversely affect the area, possibly contributing to patch failure. However, while epoxies in this context have been in use probably less than 20 years, there does not appear to be serious problems if care is taken in formulating the fill material, surfaces are properly prepared, and the paint surface is maintained. The contractor, who was experienced in epoxy consolidation and repair, specially formulated the epoxy fill and primed both the epoxy treated wood and adjacent wood surfaces with an oil-alkyd primer. Based on his experience, the epoxy treated wood did not need special preparation other than priming and should hold the paint as well as the adjacent wood surfaces. Since the building owner is committed to a scheduled maintenance program, the potential problem was not considered serious.

Second Priming As the repair work was completed, the wooden surfaces were sanded lightly to remove any accumulated dirt, grease or dust, then primed with a second coat of oil-alkyd primer at the full strength, tinted slightly to ensure total coverage. The architect specified two prime coats for the building both because of the need to undertake several weeks of repair work following removal of the old paint and due to the history of bad paint performance on the building.

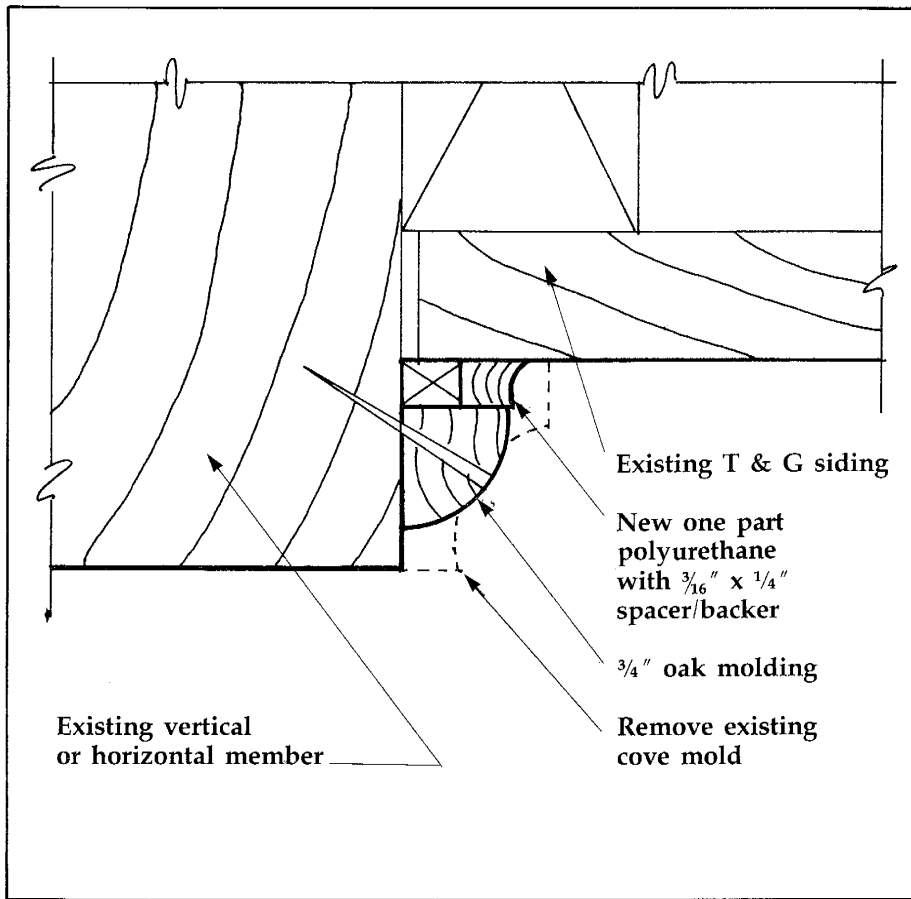


Figure 7. A molding detail was developed to seal the vertical and horizontal reveals. The additional backing strip for the molding provided a channel for a caulking or sealant bead. Drawing: Geier Brown Renfrow, Architects

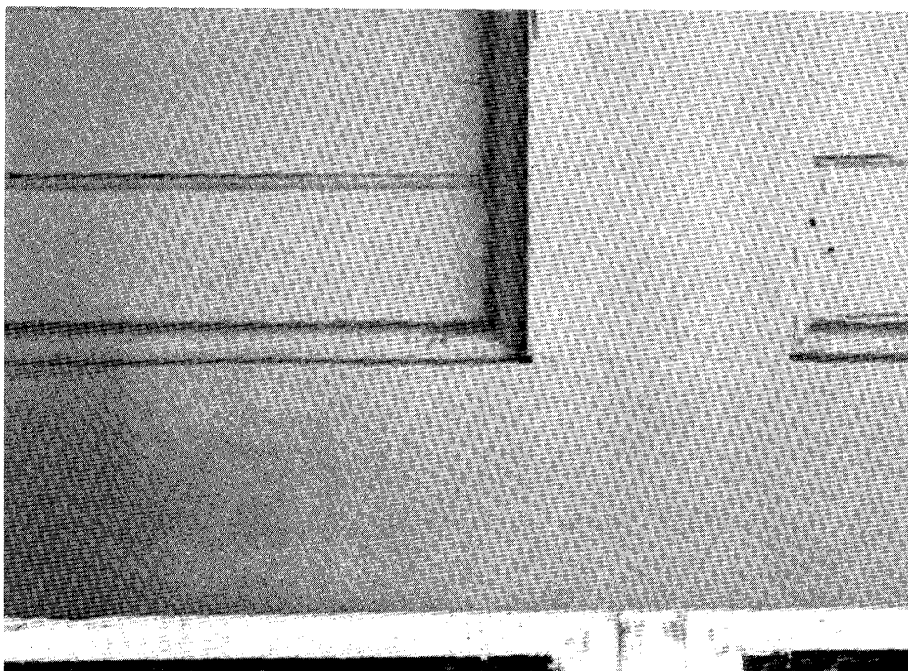


Figure 8. The molding strips blended with the horizontal and vertical boards and in combination with caulking should effectively keep moisture from penetrating behind the recessed paneling. Photos: Sharon Park, AIA

Caulking and Applying Molding Strips With the wood repaired and primed, the next step was to close the joints, seams and cracks on the surfaces where water could penetrate the wall. Areas of particular concern were the ledges on the horizontal beams or sill plates created by the recessed wood panels and the crevices created by the diagonally applied "half-timbered" trim.

In the 1980 restoration, a cove molding had been added where the recessed panels abutted the structural posts and beams. The joints, however, were not caulked and water penetrated behind the molding once the paint began to fail. The architect for the remedial work developed a new detail using a combination of a 3/4" quarter-round piece of oak with a 1/4" x 3/16" pine backing (see figure 7). The new wood was back-primed and edge-grain primed prior to installation. The reason for the backing piece was to create a channel to receive a 1/4" bead of caulking/sealant. Without this channel, there was no guarantee that the sealant would hold firm. This detail should allow for an effective seal at the joint—a chronic source of water penetration over the years (see figure 8).

The sealant selected for caulking was a long-lasting pre-mixed one-part polyurethane. This is a high-quality sealant applied with a caulking gun and is recommended for use on exterior wood. Areas caulked included open seams where horizontal and vertical boards intersected, joints around window openings, and along the new oak molding strips. The sealant takes paint very well after curing and should last at least as long as the paint.

Painting Proper painting procedures were followed throughout the project. The priming immediately after paint removal and then the repriming when wood repairs were completed showed the strong emphasis placed on development of a sound paint coating. Prior to applying the two top paint coats, the semi-gloss finish left by the second priming was roughed up using sandpaper and the surfaces were wiped down in order to remove any dust which had accumulated.

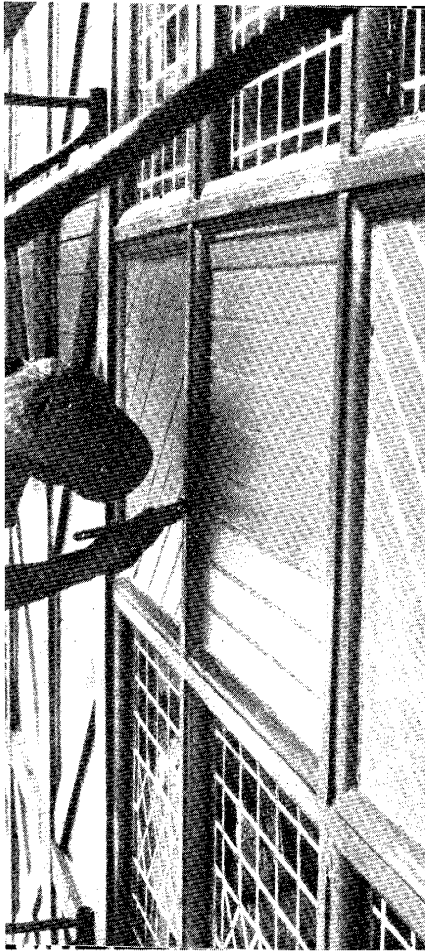


Figure 9. The building was painted with two coats of oil-alkyd primer and two top coats of acrylic latex.
Photo: Bryan Blundell

Acrylic latex paint, with its good color stability, was selected for the two top coats primarily for its durability and "breathability" (see figure 9). Compatible with the manufacturer's oil-alkyd primer, the acrylic latex also has flexibility of movement. This is an important quality since wood naturally expands and contracts.

Project Costs

Approximately 8,000 square feet of wooden surface area were stripped, repaired and repainted. The labor costs associated with stripping and repainting were \$32,000 and \$52,000, respectively. The labor cost for installing 2,400 linear feet of oak molding and caulking was \$10,000, and an additional \$11,500 covered the labor for wood replacement and

general caulking. Approximately 1,800 hours (average cost \$18/hr. or \$4.00 per square foot) were spent to strip the fire-retardant paint and to sand the wooden surfaces. It took approximately 2,400 hours (average cost \$22/hr. or \$6.50 per square foot) to paint the building using a four-coat three-color paint system with sanding between prime coats. The 4 coats of paint used a total of 85 gallons which averaged just under the 400 square feet to the gallon of coverage recommended by the manufacturer.

Project Evaluation

The need to undertake this remedial work so soon after the 1980 restoration shows how crucial it is to eliminate moisture problems before repainting, to select the proper paint system, and to follow correct painting procedures. The owner had to spend money twice within 4 years for the same job, and also incurred the additional expense for the repair of wood damaged directly as a result of the earlier work.

The project also shows the careful surface preparation that must be taken to ensure the proper bonding of paint to the wood as well as bonding between the different layers. Too often, considerable time and expense go into removing paint, but not enough time is put into surface preparation or proper application following manufacturer's recommendations. Then, too, there are frequent instances where inappropriate paints are used or an inferior quality is selected to cut costs. The results are the same—the necessity for more frequent repainting, serious paint failure or both.

For "Ole Jim," a 7-year life is expected from the new paint job before repainting will be necessary. Under normal conditions, 7 years is the commonly recognized life span for paint applied to bare wood which has been properly prepared. Future repainting should be much easier and cheaper due to the addition of trim pieces and thorough caulking to eliminate pockets where water collected. The owner is committed to regular inspection of the building and the correction of any problems as soon as they are apparent (see figure 10).



Figure 10. The college will inspect the building on a regular basis to ensure that any problems are immediately corrected. Photo: Charles Fisher

PROJECT DATA:

Building:

"Ole Jim"
Gallaudet College
Washington, D.C.

Owner:

Gallaudet College
Washington, D.C.

Project Dates:

Spring-Fall, 1985

Preservation Architect:

Baird M. Smith, AIA
Geier Brown Renfrow Architects
Washington, D.C.

Wood Specialist and General

Contractor:

Bryan Blundell, President
Dell Corporation
Rockville, Maryland

Owner's Project Manager:

John Dunn
Contract Agent
Gallaudet College

Paint Consultant:

Wayne Seymour
Technical Advisor
Duron Paint
Beltsville, Maryland

Project Costs:

Costs are for labor and exclude scaffolding and epoxy consolidation.

Paint Removal (8,000 SF @ \$4 per SF)	\$32,000
Repainting (4 coats) (8,000 SF @ \$6.50 per SF)	\$52,000
Wood Replacement and Caulking	\$11,500
Installation of Oak Trim and Caulking (2400 linear feet)	\$10,000

This PRESERVATION TECH NOTE was prepared by the National Park Service. Charles E. Fisher, Preservation Assistance Division, National Park Service serves as Technical Coordinator for the PRESERVATION TECH NOTES. Special thanks go to the project architect, Baird Smith, AIA, and the general contractor, Bryan Blundell, for their generous assistance in providing information concerning the work on "Ole Jim." The following Preservation Assistance Division staff contributed to the production of this Tech Note: Michael J. Auer, Brenda Siler, and Theresa Robinson. Historic Cover Photo: Courtesy of Gallaudet College.

PRESERVATION TECH NOTES are designed to provide practical information on practices and innovative techniques for successfully maintaining and preserving our 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 directs 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.

Comments on the usefulness of this information are welcomed and should be addressed to PRESERVATION TECH NOTES, Preservation Assistance Division-424, National Park Service, P.O. Box 37127, Washington, D.C. 20013-7127.