Sharon C. Park

Diagnosing Moisture in Historic Buildings

Diagnosing Moisture in Historic Buildings was a symposium held in the Washington, DC area, May 6–8, 1996, which brought together practitioners in the field of historic preservation to wrestle with the issue of dealing with diagnosing, and ultimately controlling, unwanted moisture in buildings. Too often, hastily devised solutions are implemented, such as waterproofing foundations, which are expensive, can damage important archeological evidence, and can fail to solve the moisture problem if the real source of moisture is improperly diagnosed. Sixty registrants and 20 staff spent 3 days combining classroom lectures with on-site field exercises to develop a methodology for properly diagnosing moisture. The symposium was supported by a grant from the National Park Service, National Center for Preservation Technology and Training in Natchitoches, Louisiana and was co-sponsored by the Friends of Meridian Hill, the Friends of Great Falls Tavern, Gunston Hall Plantation, with co-operating support from the National Trust for Historic Preservation.

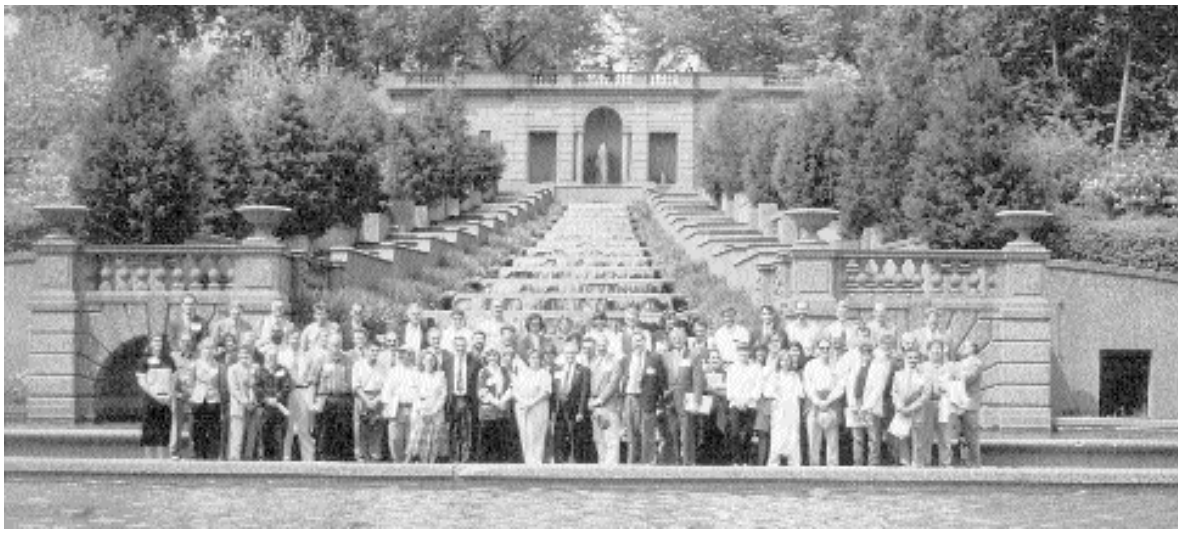
Symposium participants at Meridian Hill Park, Washington DC. Photo by Eric Avner, NPS.

The symposium was organized by Heritage Preservation Services of the National Park Service as technical training for architects, engineers, site managers, contractors, museum administrators, and property owners who deal with the impact of unwanted moisture in historic buildings. The goal of the symposium was to develop a model training program with a workbook for similar training at other sites. In addition, a new National Park Service Preservation Brief *Holding the Line: Controlling Unwanted Moisture in Historic Buildings* will be available in October which reflects the issues discussed during the symposium.

The format of the symposium combined classroom lectures in the mornings with field exercises at three sites in the afternoons. The classroom sessions looked at systematically diagnosing moisture from the outside of a building to the inside; understanding the sources and variables that affect moisture movement in historic materials and buildings (see sidebar A); developing guidelines for establishing a monitoring plan for complex moisture problems; and setting a preservation framework for controlling moisture, particularly from excessive roof run-off and saturated ground moisture. The field exercises gave the participants an opportunity to implement the multi-step methodology (see sidebar B) and to learn about survey and diagnostic instrumentation. Following is a brief summary of both the classroom discussions and the field exercises.

The five most common sources for moisture in historic or older buildings are:

1. above-grade penetration of moisture through the building envelope;
2. below-grade moisture entrance through foundation walls or through rising damp capillary action;
3. broken or leaking plumbing pipes and mechanical equipment;
4. interior moisture from household activities or from climate control systems; and
5. moisture generated from maintenance or rehabilitation construction.



The greatest source, perhaps 80% of the troublesome moisture, comes from improperly handled roof run-off and site drainage. Too often, deferred maintenance results in blocked gutters and downspouts, blocked or corroded subsurface drainage systems, and deteriorating exterior or foundation materials. Keeping buildings in good condition and maintaining water collection systems through cyclical maintenance can alleviate much of the troublesome moisture. For situations where corrective action is necessary, for example, repairing cracks in exterior walls, it is important to complete remedial treatments before repairing damaged finishes, such as interior plaster. Other sources discussed included water damage from broken or leaking pipes, poor ventilation of interior spaces where condensation or mold and mildew growth are occurring, and moisture from construction, such as replastering, that takes a long time to dry. An unsuspected source of moisture damage is from automatic landscape irrigation systems which, if placed too close to the building, can add tremendous amounts of water at the foundation or spray water directly onto exterior surfaces.

Symposium Planning Committee

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Hugh Miller, FAIA, Historical Architect and Preservation Consultant, Richmond, VA
William Rose, Research Architect, Building Research Council, University of Illinois, Champaign-Urbana
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The symposium also looked at how new climate control systems can affect historic buildings which have aging building envelopes. New humidified climate control systems must be designed in conjunction with tightening up the exterior envelopes of historic buildings, particularly wooden frame structures. These systems are often used in museum settings, although residential structures incorporate added humidity as well. When interior relative humidities cannot be contained within buildings, it is possible for moisture to migrate into building walls and cause extensive damage. If the collection needs a climate controlled environment, all options (climate controlled cases, zoned areas within a building, etc.) should be investigated to ensure that there is a balance between protecting the collection and the building. In many cases, the building is as much an artifact as the collection and altering the building to handle these systems can be very destructive to the resource.

A systematic approach to diagnosing moisture problems generally involves a monitoring plan. Surfaces must be identified which appear to have a problem, and then changes in that condition must be recorded over time. Because moisture can travel far from its original source, both the building and the site need to be evaluated, not just the wet location. Tracking the relative change in moisture level or the appearance of the wet areas, particularly every time it rains, can help determine the source of the moisture. There are a number of helpful tools to assist with this diagnosis, from hand-held moisture meters to complex computer data-logging equipment used by moisture specialists. But the use of diagnostic tools alone, it was stressed, cannot replace sound, thorough visual inspection, and evaluation of the variables. Too often, more data is collected than can effectively be used, and so designing a moisture monitoring plan should be done within useful parameters in terms of the scope and cost.

The classroom discussions were followed by field exercises to expose the participants to the diagnostic methodology. Meridian Hill, a National Historic Landmark, was the site for the first day. These cascading waterfalls and ponds are controlled from several early-20th-century pump rooms built of exposed aggregate reinforced concrete that are incorporated into the landscape. Unwanted moisture at this site is deteriorating significant concrete features. The object of the first day was to visually survey the site and identify areas of moisture decay using all five senses, plus intuition. This is always the first step in evaluating a site. The participants determined that much of the high humidity located in the pump rooms

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A. Variables That Affect Moisture Damage in Historic Buildings:

Complex Variables

A variety of simultaneously existing conditions contribute to moisture problems in old buildings. For recurring moisture problems, it may be necessary for the owner or preservation professional to address all of the following variables:

- Types of building materials and construction systems
- Building usage and moisture generated by occupancy
- Condition and absorption rates of materials
- Type, operation, and condition of heating, ventilating, cooling, humidification/dehumidification, and plumbing systems
- Type of soil, moisture content, and surface/subsurface water flow adjacent to building
- Type of roof drainage and its rate of discharge
- Daily and seasonal changes in sun, prevailing winds, rain, temperature, and relative humidity, inside and outside, as well as groundwater levels
- Unusual site conditions or irregularities of construction
- Conditions in affected wall cavities, temperature and relative humidity, dewpoints
- Amount of air infiltration present in a building

Preservation Briefs #39 "Holding the Line; Controlling Unwanted Moisture in Historic Buildings" will be available from the Government Printing Office in October, 1996. The order number is 024-005-01168-4, the cost is $1.25 and the mailing address is Superintendent of Documents, GPO, P.O. Box 371954, Pittsburgh, PA 15250-7954.

B. Methodology for Evaluating Moisture Problems

I. Identify problem areas: list obvious damage (eroded mortar joints, mold, bubbling plaster) as well as potential hazards (impending structural damage, moisture contact with wiring)
II. List possible causes: poor site drainage, deteriorated materials, poor interior ventilation, rising damp, blocked fan coil drainage pans, high relative humidity from climate control systems, etc.
III. Identify and obtain additional information needed: site plans, topography drawing, location of underground water storage features, building plans, absorbency rates of materials, etc.
IV. State your theory (hypothesis) of what is causing problem: for example, ground moisture is saturating foundation walls or downspouts discharge is too close to foundations, or damp crawl space is allowing humid air to migrate into habitable spaces, etc.
V. Test your theory: use a garden hose to simulate rain or take temporary steps to correct a problem, such as placing long extender tubes onto downspout discharge to divert water away from foundation, measure to see if situation improves.
VI. Implement appropriate treatment: If test was successful, implement a more permanent remedial treatment keeping in mind that treatments should not remove historic materials unnecessarily and should not damage historic character or appearance of the building. If the simulated test did not make a measurable difference, go back to step III and do more research to develop another theory.
VII. Undertake follow-up monitoring: record what treatment was used and make notations as to the success of the treatment. If moisture continues to be a problem elsewhere, be sure to evaluate the impact of the most recent treatment on the site. Correcting some moisture areas does not eliminate the possibility of related moisture damage occurring elsewhere.

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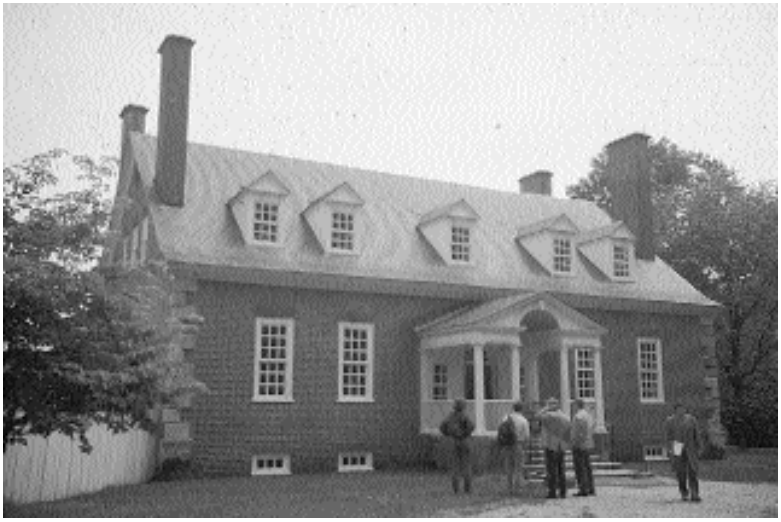
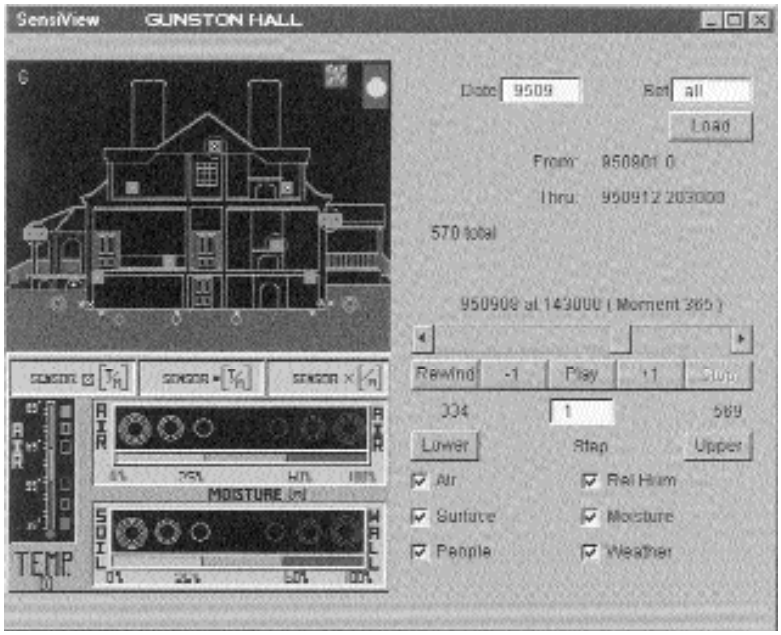
could be alleviated with the installation of humidistatically-controlled exhaust fans. The repair of cracks in upper level concrete which are allowing moisture to seep into the pump rooms will require the talents of masons specializing in matching the remarkable aggregate textures to avoid unsightly patches. Also, site drainage needs improvement to reduce the water that enters behind the concrete retaining walls and balustrades.

The second day was spent in Maryland at Great Falls Tavern on the C&O Canal, a 19th-century frame and masonry building that now serves as a National Park Service visitor center. The objectives were to become familiar with survey instruments, such as moisture meters, and to understand the variables that affect moisture problems. The participants, equipped with a set of survey instruments, learned how to use this equipment. Several stations were set up to demonstrate hand-held resistance meters, deep probe spikes for the ground to determine saturation levels, infrared sensors to record the amount of moisture present in building materials, and visual analysis of the functioning of gutters, downspouts, and site drainage. A demonstration was provided of the use of lime mortar rendering or coating for the interior surfaces of damp basement walls to protect them from the erosion of mortar. Again, it was determined that handling the run-off from gutters and downspouts and adjusting drainage patterns from terraces and planted areas would go a long way to dry out this building.

Gunston Hall Plantation, site of the third day of the symposium. Photo by Elizabeth Sasser.



Computer program recording data from Gunston Hall. Image by Bryan Blundell.



The third day was spent at Gunston Hall Plantation the National Historic Landmark home of George Mason. This 18th-century brick and sandstone building is used as a house museum and diagnostic instrumentation has been in place for some time. Earlier ground moisture problems had been addressed about 10 years ago with the introduction of a shallow subsurface perimeter drainage system about 4' away from the foundation walls. This positive drainage had a remarkable effect in eliminating standing water in the basement. With the forthcoming installation of an upgraded climate control system, the museum staff wanted to ensure that there would be no additional moisture related problems. A computer logging system uses probes to record moisture, temperature, and humidity levels and can compare local weather data. There are about 15 stations set up on 3 levels of the house to measure moisture in the air, in the walls, on surfaces, and in the ground.

Overall, the symposium was a great success. The range of disciplines brought insight from differing perspectives. The need for greater scientific understanding was recognized while still respecting the knowledge of the long-term practitioner. The forthcoming Preservation Brief builds upon the discussions at the moisture symposium and will look at a range of treatment options primarily that capture and dispose of exterior rainwater and improve air circulation in interiors. As the title of the new brief indicates, holding the line against moisture problems requires constant vigilance, a staff trained to understand how the building and mechanical systems function, and cyclical maintenance to keep the building and mechanical systems in good working order.

Sharon C. Park, AIA, is the Senior Historical Architect of Heritage Preservation Services, NPS. She was the Chair for the Moisture Symposium and is the author of the forthcoming Preservation Brief #39 Holding the Line: Controlling Unwanted Moisture in Historic Buildings.