DRAYTON HALL
Charleston South Carolina

A CONSERVATION ASSESSMENT
AND TREATMENT PROJECT

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A view of Drayton Hall from the road facade. (UPenn 2002)

PROJECT BACKGROUND

Site History

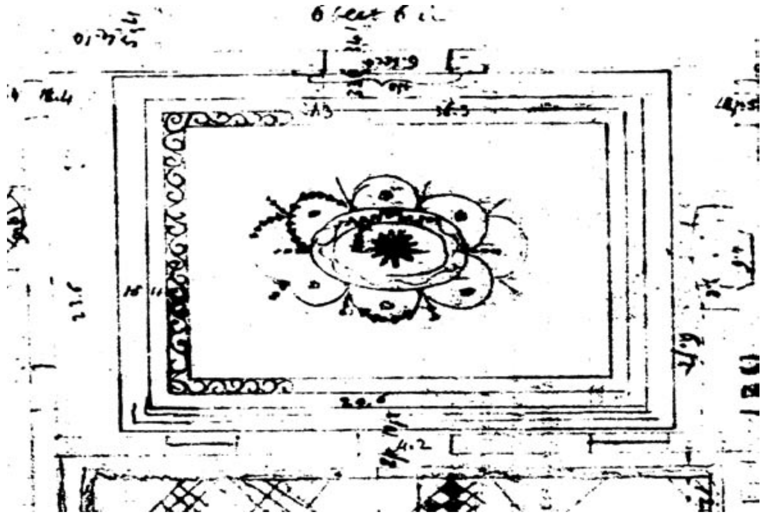
Drayton Hall is well known as one of the earliest and certainly one of the finest examples of Georgian Palladian architecture in the United States. From the time of its construction until the period of the American Civil War, it served as the principle residence and symbolic seat of the descendants of John Drayton, a family of major influence and achievement in the history of the colony and state of South Carolina.

Following the Civil War, Drayton Hall endured twenty years of decline and depredation. That the building survived the War at all, avoiding the fate of nearly all the neighboring plantations on the Ashley River, adds to its significance. The survival of Drayton Hall to the present can be attributed to a mixture of good fortune, to the building's inherent solidity, and in no small measure to the devotion of the Drayton family.

After the National Trust for Historic Preservation acquired the property from the family in 1974, a period of intense evaluation of the condition of the house began. Areas of deterioration were repaired or stabilized as needed over a period of several years. Preservation rather than restoration was prescribed in recognition of the high architectural integrity of the house and its lack of furnishings.

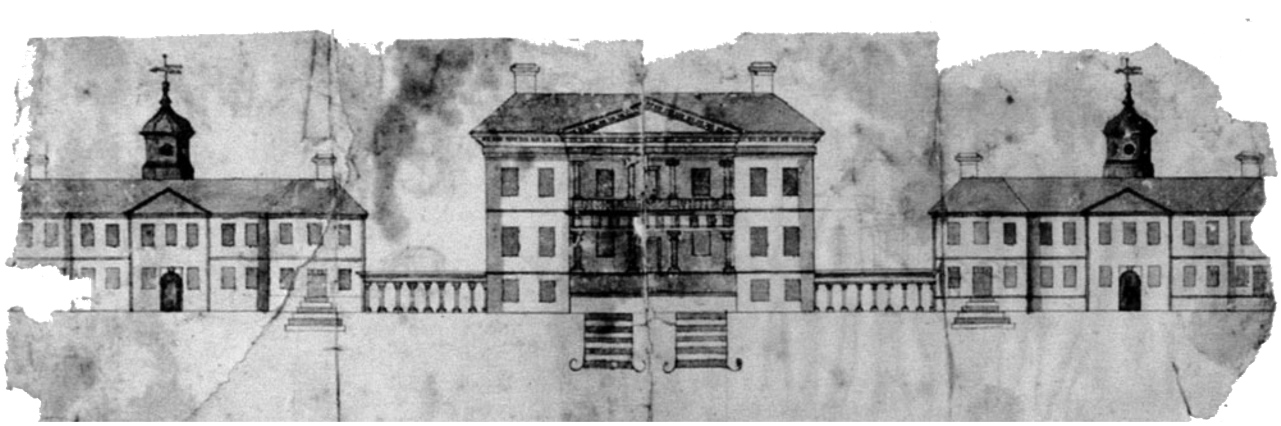
The Great Hall with its decorative ceiling and woodwork. (F. B. Johnston 1930)

Soon a desire to open Drayton Hall to visitation necessitated an evaluation of the live load capacities of the various structural systems throughout the house. In 1977, a structural analysis of the building identified several deficiencies including the ceiling framing of the Great Hall. The distance spanned by the joists was found to be excessive for their dimensions with a live load capacity of only 14.2 pounds per square foot for the floor, inadequate by modern standards to safely support the load of large groups of visitors. In addition, it was believed that the large span-to-depth ratios of the undersized joists resulted in excessive deflections of the floor in the second floor Great Hall and subsequent cracking of the plaster ceiling below.

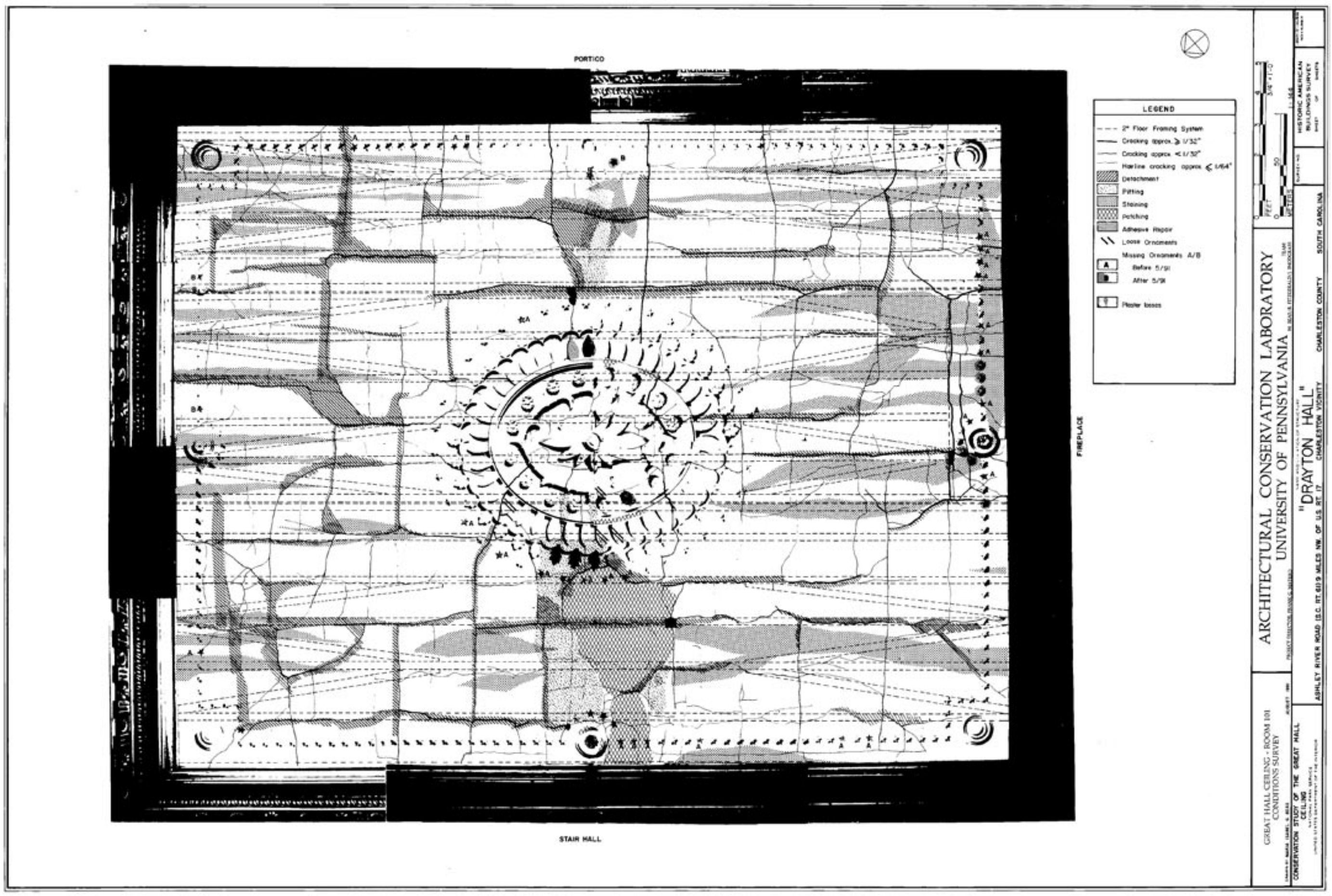


A drawing from Lewis Reeve Gibbes' sketchbook of the Federalist style ceiling which preceeded the present ceiling in the Great hall. (1845)

The present ceiling in the Great Hall is believed to be its third, probably installed in the 1860's in response to the need to relieve load from the summer beams that were originally located at the third points in the room. The original eighteenth century faming of the ceiling appears to have been a three bay system with the joists spanning approximately ten feet to summer beams, whose dimensions were approximately 11" x 11". While the design of the original ceiling cannot be determined from any surviving physical evidence, it is clear that the Georgian ceiling was at least 1" to 3" lower than the current ceiling.



A fragment of what is believed to be an 18th-century design elevation of Drayton Hall. The flanker building were not built as shown. The original image is in the collection of the Historic Charleston Foundation.



The completed condition survey from 1991. (UPenn 1991)

Recent Conservation

The 1991 and 2001-02 studies of the plaster ceiling and its supporting structure were executed by the University of Pennsylvania Architectural Conservation Laboratory using non-destructive techniques wherever possible. The architectural fabric was thoroughly examined in order to determine whether specific elements might exhibit evidence indicative of alteration. This was also done to correlate the structural behavior and failure of the various materials and assemblies in association with each other (*e.g.*, framing, plaster, and previous stabilization systems). A conditions assessment of the plaster ceiling was conducted primarily through visual examination. The following conditions were identified and graphically recorded on a rectified photomontage: *cracking, detachment, patching, adhesive repair, pitting, staining, missing ornaments, and plaster loss.* In 1991 areas of blind detachment were also identified through percussive testing. Annotated drawings of existing conditions of the framing system, joist by joist, and the plaster ceiling were prepared as well.

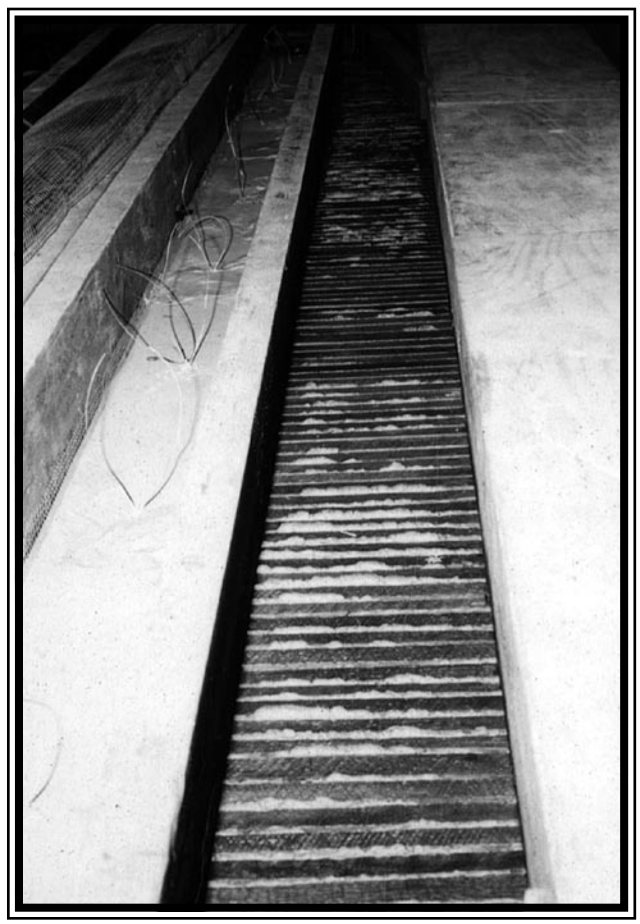
Steel and aluminum angle introduced to the joist system of the ceiling added approximately 4500 aditional pounds the the dead load of the ceiling. (UPenn 1991)

suggested that, while ultimate strength was improved, vibrational stiffness was not. Moreover, the steel reinforcement had added approximately 4500 pounds of additional dead load to the existing ceiling system. This had certainly increased the deflections of the joists through creep since their installation and had probably enlarged the existing cracks. This alone may be the source of the observed "worsening" of the ceiling reported after the repairs.

Current Program

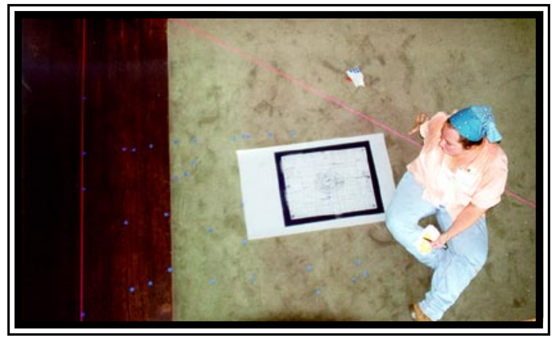
In additional to structural analysis and conditions survey, analyses of the wood, plaster, and mortars were undertaken in 1991 and 2001 to assist in the dating and diagnosing the condition of the framing and plaster ceiling. Wood species were identified, and mortars and plasters were chemically analyzed.

An initial review of past reports and documentation of the building focusing on the Great Hall was undertaken to gather as much available information about the ceiling and to help in the early process of interpreting the causes of the ceiling deterioration. This review revealed a consistent belief that deflection of undersized joists was the primary cause for cracking, with vibration contributing to secondary detachment. More recent hypotheses added the possibility of keying failure, lath detachment, and thermal movement to explain what had been considered random crack patterns. Opinions also varied on the success of the 1978 structural retrofit and plaster stabilization. Theoretical calculations



A view of the damaged keying as seen before the plaster was poured between the joists. (J.M. Garrison 1978)

Since 1991, several coordinated technical studies have been pursued at Drayton Hall to develop sensitive solutions for stabilizing the interior fabric of the house including structural, material and environmental intervention. As part of this effort, the ACL returned to implement treatments to the Great Hall ceiling. The 2001 plaster ceiling conservation project addressed both condition reassessment and treatment and included four primary tasks:



Collecting data. (UPenn 2002)

1) Condition Reassessment

To resurvey the ceiling using the data from 1991 and identify any changes since the earlier survey. Additionally, all data including the 1991 survey was incorporated into digital drawings using AutoCAD® and CAD overlay®. An experimental program of analysis utilizing a Geographic Information System (GIS) was also independently developed as part of this task to verify the validity of the collective assumptions about the ceiling conditions, causes of failure, and the validity of intervention strategies.

Installing temporary stabilization. (UPenn 2002)

A broken medallion fitted back together. (UPenn 2002)

2) Temporary Stabilization

To protect and support sensitive areas of the ceiling during the installation of the structural retrofit and reinstallation of the wooden floor above.

3) Treatment Design and Evaluation

To design and conduct a treatment testing program to determine the most appropriate method for reattaching delaminated sections of the ceiling. Using standards developed by

Applying the acrylic emulsion for reattachment. (UPenn 2002)

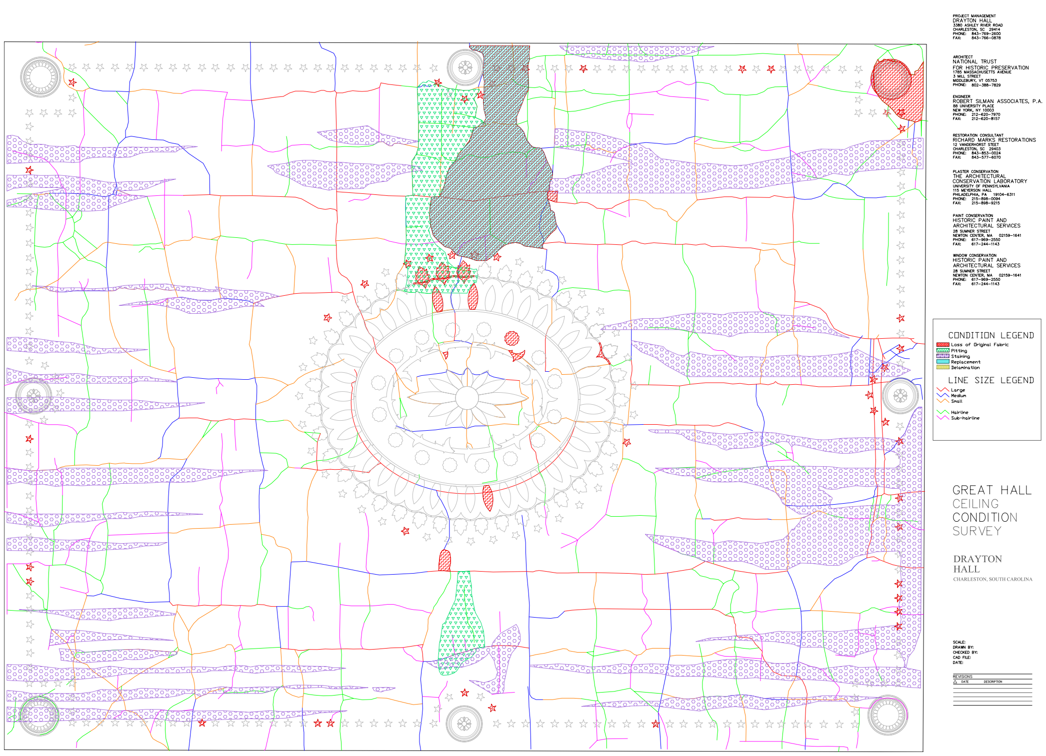
RILEM and ASTM, tests were conducted to provide comparative data on the treatments selected for testing.

4) Priority Treatment Implementation

To implement plaster conservation treatments to areas where failure was identified as existing or immanent. This was greatly influenced by the GIS analysis which afforded better modeling of the collective conditions posing real and potential threats to the stability of the ceiling. As a result of this analysis, the original location of the structural retrofit and visitor access above was reconfigured.

Data Collection

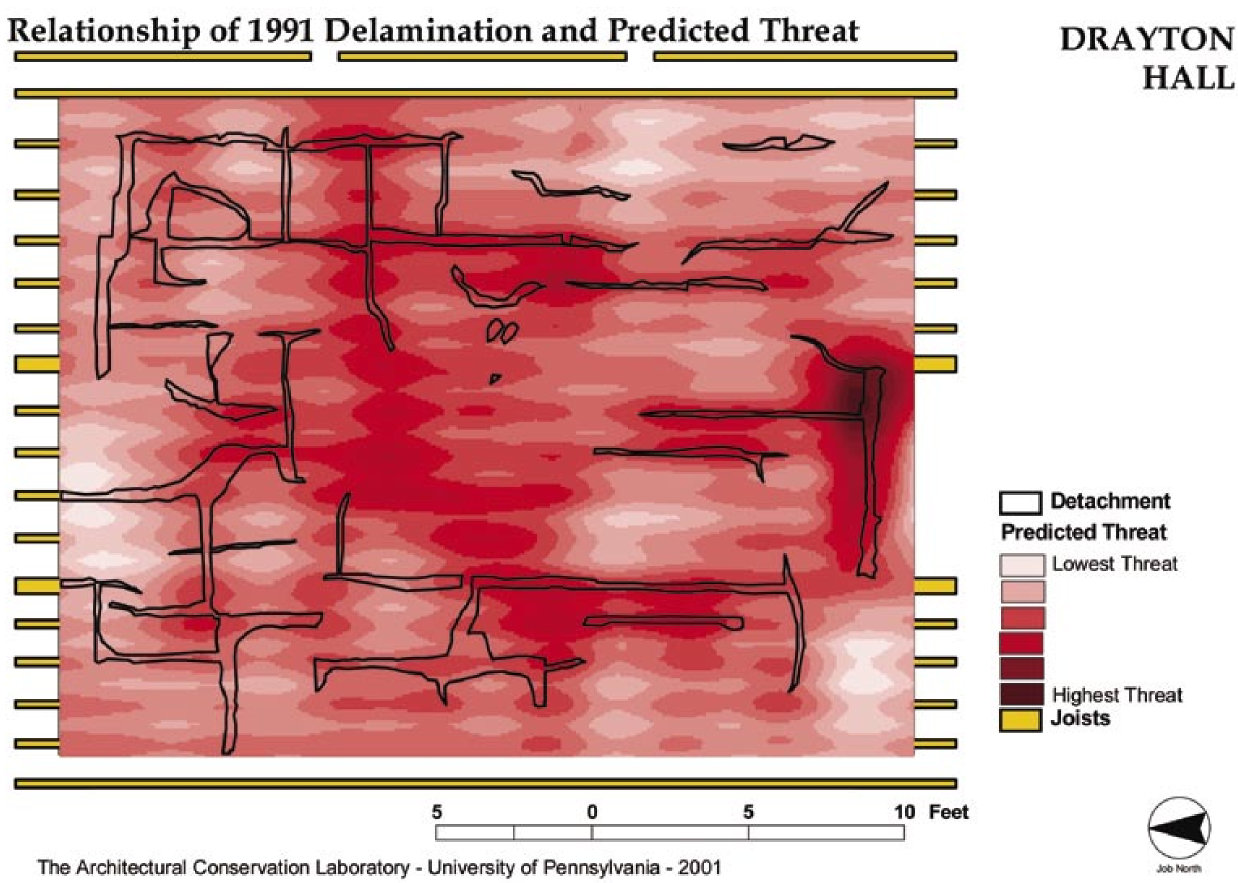
Phase One of the 2001/02 project began with a site visit providing an opportunity to execute a complete condition survey of the ceiling plaster. While the initial plan was to complete a new condition survey using the same format as the 1991 survey, it was decided that enhancing that existing survey could serve a greater function. Data was collected which focused closely on the existing visible cracking pattern in the ceiling. Often problems arise in condition surveys, which result from human error. Conditions often need to be identified through an intuitive rather than empirical approach and then translated onto a sheet for later reference resulting in variation from the actual. The choice to focus primarily on the cracks was made because they



The completed condition survey from 2002. (UPenn 2002)

were visible features, which can be easily identified and plotted on a map. These visible cracks, which had been recorded in the 1991 survey, were in direct contrast to the areas of detachment, also recorded in 1991, which were not visible and therefore much more subjective in their location and extent. The surveyors from 1991 located the cracks through observation, translating what they saw to paper without using a measured approach as was done in 2001. The cracks were then used as “locators” for each of the other conditions both visible as well as hidden. Each condition was placed on the map “relative” to the cracks.

In order to locate the cracks in the 2001 survey, all of the existing intersections were identified through the use of a plumb line. Intersections were plumbed to the floor where they were measured using triangulation from two set datum points. All intersection points were then entered into a CAD drawing based on these measurements resulting in a map that was accurate to 1/8 inch. The focus on “level of accuracy” for the 2001 map was not intended to diminish the significance of the 1991 data, which had been executed for a different



A color scaled representation of threatened areas executed in ArcView 3.2. (UPenn 2002)

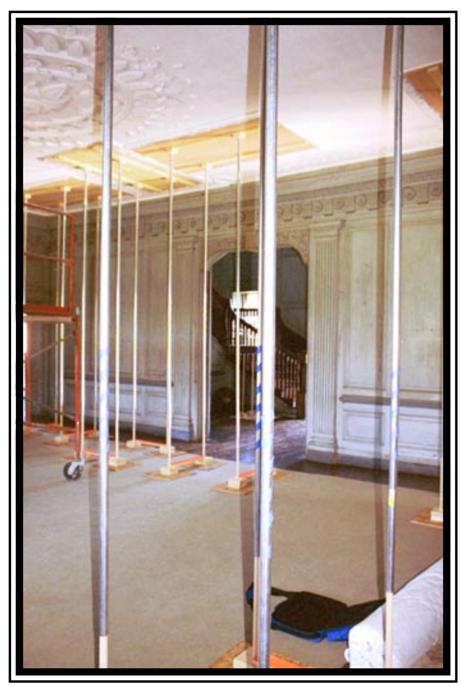
Cutting foam padding for the top surface of the temporary stabilization. (UPenn 2002)

function. The 1991 survey was intended to provide percentages of existing conditions to determine if the ceiling needed further attention, and as such was extremely successful. The 2001 survey required a greater level of accuracy because it needed to identify the exact location of the treatment. Exact locations for treatment need to be identified in order to reduce the possibility of unnecessary treatment.

The new map created in AutoCAD was used to do a comparative analysis. All of the data collected from these surveys was compiled together to create predictive modeling using Geographic Information System computer technology. From the CAD drawing, a GIS was used to develop raster representations of the ceiling in map formats that were used to help explain the problems associated with the cracking and detachment, without any further destructive manner and expensive tests. The GIS was used to integrate, analyze, and display data, extending the traditional conditions survey as part of our comprehensive conservation program.

Temporary Stabilization

Following the condition survey and the review of the existing literature, temporary stabilization needed to be installed which would allow for the reinstallation of the wood flooring above without causing additional damage to the decorative surface we were trying to repair. A complex system existed between the first and second floor Great Halls. The joists, to which the flooring was directly attached, held up the floor as well as prevented the ceiling from falling. What affected the floor above also affects the ceiling below. With this



Temporary stabilization platforms installed to protect the plaster from damage as the floor boards are reinstalled. (UPenn 2002)

The padding applied to the surface of the platforms protected the decorative features. (UPenn 2002)

fact in mind an approach was taken which needed to comply with certain parameters:

1. Allow visitors to still experience the space.
2. Be cost-effective, easily constructed, easily installed and removed.
3. Be minimally intrusive to the ceiling.
4. Minimize potentially damaging vibrations associated with the flooring reinstallation.
5. Prevent future detachment during floor installation.

The last issue was the most significant and allowed for a simpler, lighter design since the supports did not need to function structurally. The flexing of beams had been known to be problematic, associated with excessive weight carried by under-sized joisting, however there was not immediate threat of cataclysmic failure of the plaster surface resulting from failure of the existing structural system. The larger and more immediate threat was vibration resulting from various activities, including the use of power tools as well as percussive tools (hammers, drills) during the reinstallation taking place in the room above.

Nine support units were installed distributed over the surface of the ceiling. The supports were not needed over the entire surface of the ceiling but instead were placed in areas where the greatest potential for additional damage had been determined based on the condition assessment and GIS analysis. From the floor up, each unit consisted of four 16” X 16” platform bases with four feet of vertical one inch doweling. Each dowel was inserted into 10 feet of one inch rigid electrical conduit that connected to the upper platform—the top platform was a 4’ X 6’ sheet of luaun plywood strengthened with 1” X 4” pine running the length of the sheet. The top of the platform was then padded with 1” of foam covered with Tyvek paper intended to reduce the potential for staining associated with the moist environment of Charleston. Since the doweling had an outer diameter of 1” and the conduit had an inner diameter of 1”, the combination allowed for a telescoping effect that provided for simple minor adjusting. The combination of dowel within tube allowed for the platforms to conform to the irregularities of the space, ensuring uniform contact with the ceiling. Each unit was raised by means of the telescoping into contact with the ceiling without being forced too tight which could have added new variables to the already sensitive ceiling. A certain amount of flex between ceiling and floor was expected as a result of the undersized joists and therefore the foam was needed both as a method for absorbing the vibrations as well as allowing for this flex.

Since the schedule for the floor reinstallation was uncertain, these installed plywood pads could remain in place indefinitely functioning as shock absorbers to reduce the possibility of additional detachment; however they also functioned as a retainer to keep any potential detached parts from becoming irretrievably damaged, misaligned, or lost had sections of the plaster become fully detached. If plaster did become separated, it would remain in its location and orientation until the panel was lowered allowing for proper reattachment.

Treatment Design

Having identified the areas of greatest threat based on the mapping analysis and having installed the temporary stabilization, Phase 3, was developed to design and test a grout which could be introduced to the voids in the ceiling plaster. This grout needed to function as an adhesive material reattaching the delaminations to the original surface. It needed to perform well enough to ensure plaster reattachment without introducing rigid connections. In order to accomplish this goal, extensive laboratory analysis of the plasters was done including X-Ray Diffraction, Scanning Electron Microscopy, Fourier Transform Infrared Spectroscopy, as well as mechanical testing for both tensile and compressive strength of the plasters and grouts. The following guidelines were used to design a grout for plaster reattachment:

1. Mechanical strength and modulus of elasticity should be in the same range as those of a good lime/sand mortar.
2. Pore size distribution should be comparable with that of a lime/sand mix.
3. No soluble salts should be present.
4. Good workability.
5. Set should be sufficiently rapid and reliable both in a dry and a wet environment.

In conjunction with these guidelines for an effective grout, the following conditions associated specifically with the Great Hall were taken into consideration

1. ***High humidity***- Moisture is always an issue with the setting of any non-hydraulic material. The high humidity of Charleston was seen as a potential problem.
2. ***Large voids with small injection gapping***- each of the voids covered a large area relative to their height. Since the only direction that treatment could be undertaken was from the visible side below, it was important to create a grout which displayed good flowability in order to help limit the number of drilled holes needed as injection ports.
3. ***Limited surface of the grout exposed to the atmosphere-*** Since the gaps existed between two layers of the ceiling plaster system, the minimal amount of surface area exposed to the atmosphere could limit the ability of a lime-based grout to set.
4. ***Orientation of the surface being treated-***

Gravity was working against the treatment instead of with it. Because the surface being treated was a horizontal plane, there was no advantage gained through gravity pulling the grout downward through the void. Additionally the decorative exposed surface of the treated area sat below the grout, increasing the chances that gravity would adversely affect the treatment by drawing water down through the exterior surface resulting in possible staining.

Samples of the original material showing the remains of the broken keying. (UPenn 2002)

5. ***The relative thinness of the visible surface of the treated areas-*** The exposed surface of the treated area is extremely thin, in some places possibly being as thin or thinner than the delaminated voids. This problem in conjunction with the surface orientation was an issue as the material set. Additionally the thin surface area was susceptible to failure with the addition of even the slightest pressure which could arise due to the build up of pressure from the injection. The delicate threatened surface of the treated area now had the additional weight from the grout as well as the water weighing downward before it set.

Samples prepared for tensile strength testing at the University of Pennsylvania Laboratory for the Research on the Structure of Matter. (UPenn 2002)

Testing the mechanical properties of different formulations based on the results of testing the original fabric, as well as using precedents found in documentation both in modern as well as historic plaster treatment, was vital for success. In order to develop a grout that could provide good adhesive strength without being adversely affected by any of the above variables, admixtures were required. Admixtures are designed to affect the flow behavior of a cementitious paste without altering the composition or behavior of the aggregates. The viscosity needed to be kept low in order to increase flowability. Because of this fact, changes in the composition were viewed as necessary, requiring the addition of materials which can impart both strengthening as well as drying properties. Because the grout needed to have a low viscosity (good injectability) for affective application, using precedents from other research were important because all grouts and plasters exhibit different mechanical properties depending on their Particle Volume Content. Simply recreating a diluted version of an original formulation was not an option due to the intrinsic negative changes (e.g. shrinkage) in the properties of the grout from additional water. A fluidizer needed to be considered in order to reduce the amount of water to be added to the mixture. Fluidizers allow one to obtain a less viscous slurry at an equal water/solids ratio or in our case a grout with the same viscosity that required lower water addition. A thixotropic additive needed to be considered in order to assist in preventing the grout from continuing to flow once it had reached its desired limit.

A comprehensive survey of available information was done which included creating a database of articles that could be culled for relevant treatment methods which incorporated admixtures. From this survey, 32 articles were chosen for their content focusing on reattachment, filling, and consolidation of plasters. This selection was then narrowed down to a single method developed by Morgan Phillips outlined in his article *Adhesives for the reattachment of loose plaster* found in the Bulletin of the Association for Preservation Technology as well as in *Experiences in the use of Acrylic Plaster Adhesives* (IIC, Case Studies in the Conservation of Stone and Wall Paintings, 1986) The materials which Phillips uses in his reattachment method consist of a combination of the following 7 ingredients:

- **Lime** (small sized particle filler)
- **Microballons** (medium sized particle filler)
- **Fluid Coke** (large sized particle filler as well as a shrinkage compensator)
- **Rhoplex MC-76 Acrylic Emulsion** (the stronger component originally designed as a masonry binding agent)
- **Rhoplex LC-67 Acrylic Emulsion** (The more flexible component originally designed as a binder for elastomeric sealants)
- **Water**
- **Thickener** Unfortunately Rohm and Haas no longer manufactures Rhoplex LC-67 requiring a replacement using Rhoplex 1950.

The decision to test the recipe on original material was based on its availability. Due to an unfortunate event during Hurricane Hugo, a portion of the ceiling fell. This material was retained by Drayton Hall who allowed us to use it for the testing program. While a facsimile of the original brown coat could easily have been recreated, it was uncertain if the material would exhibit the same original properties, leaving questions about the suitability of the reattachment material. The following issues needed to be addressed:

Issue-1

It was believed that the voids associated with detachment ranged in size. Phillips suggested two different formulas of “filled” and “non-filled” to address this variation. The non-filled formula was designed for easy injection into narrow spaces while the filled formula was used where larger gaps existed between plaster and substrate. Since the detachment in the Drayton Hall ceiling ranged in size, the following two types of formulas were used in the testing procedure:

- Filled **(fi)**
- Unfilled **(ui)**

Issue-2

The greatest associated problem with the cracking and detachment of the Drayton Hall ceiling was the flexing of the ceiling structure. Due to under-sized joists, the ceiling had been subjected to extensive deflection under live load since it was first installed. While the engineering solution for the floor removed a great amount of the associated problem, it was decided that a flexible as well as non-flexible adhesive mixture would be tested.

- Flexible **(1)**
- Non-flexible **(2)**

Issue-3

A limited number of 30 samples were cut into 1-inch squares from the available fallen material. As a result of the different potential problems associated with the detachment, testing needed to be run on three different types of substrates which included finish coat plaster, brown coat plaster, and wood lathing. Unfortunately no original wood lathing was available and the available original finish coat was too thin to be useful as a testing sample. As a result, facsimiles of these two materials were required. Since the ultimate goal was the reattachment of the brown coat to one of the three substrates, the following combinations were required for the testing procedure:

- brown coat / brown coat **(B)**
- brown coat / finish coat **(W)**
- brown coat / lathing **(L)**

TESTING MATRIX

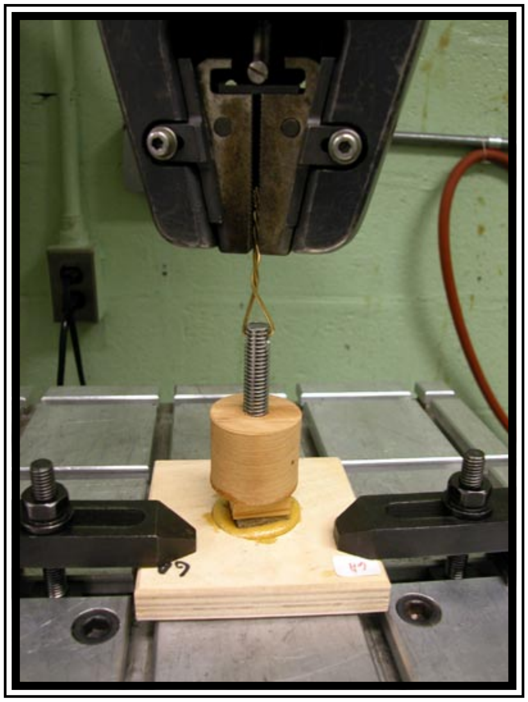
As a result of the above mentioned 3 issues, the following matrix was created for the testing procedure.

Wood / Brown Coat

Sample- 5a (fi-1-W)	Sample- 5b (fi-1-W)	Sample- 5c (fi-1-W)
Sample- 6a (fi-2-W)	Sample- 6b (fi-2-W)	Sample- 6c (fi-2-W)
Sample- 7a (ui-1-W)	Sample- 7b (ui-1-W)	Sample- 7c (ui-1-W)
Sample- 8a (ui-2-W)	Sample- 8b (ui-2-W)	Sample- 8c (ui-2-W)

Lath / Brown Coat

Sample- 9a (fi-1-L)	Sample- 9b (fi-1-L)	Sample- 9c (fi-1-L)
Sample-10a (fi-2-L)	Sample-10b (fi-2-L)	Sample-10c (fi-2-L)
Sample-11a (ui-1-L)	Sample-11b (ui-1-L)	Sample-11c (ui-1-L)
Sample-12a (ui-2-L)	Sample-12b (ui-2-L)	Sample-12c (ui-2-L)



A sample during tensile strength testing. (UPenn 2002)

The data collector used during tensile strength testing. (UPenn 2002)

Brown Coat / Brown Coat

Sample- 1a (fi-1-B)	Sample- 1b (fi-1-B)	Sample- 1c (fi-1-B)
Sample- 2a (fi-2-B)	Sample- 2b (fi-2-B)	Sample- 2c (fi-2-B)
Sample- 3a (ui-1-B)	Sample- 3b (ui-1-B)	Sample- 3c (ui-1-B)
Sample- 4a (ui-2-B)	Sample- 4b (ui-2-B)	Sample- 4c (ui-2-B)

This matrix required the availability of 48 original brown coat coupons. Unfortunately due to the limits of available original material the matrix was reduced.

RECIPES

Phillips' recipes suggested that the addition of a flexible agent such as Rhoplex LC-67 compromises the binding strength of the MC-76. Phillips outlined the following recipe to create "a truly flexible [but strong] product".

Flexible

- 2 parts lime
- 2 parts microballoons
- 2 parts fluid coke
- 3 parts of a mixture of equal parts of

Drilling holes to allow for the injection of a filled acrylic emulsion. (UPenn 2002)

Rhoplex MC-76 and Rhoplex LC-67

- ½ part water
- thickener as desired

Non-flexible

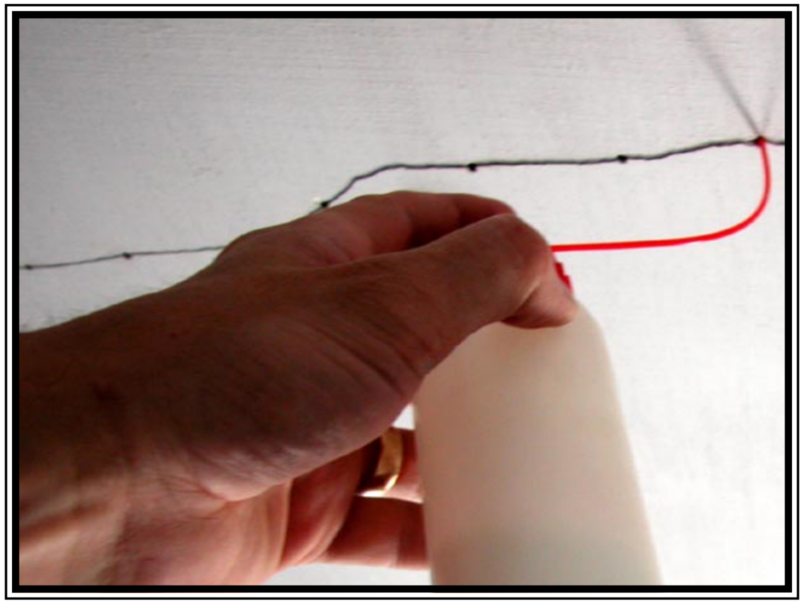
- 2 parts lime
- 2 parts micro balloons
- 2 parts fluid coke
- 3 parts of a mixture of 3 Rhoplex MC-76 to 1 Rhoplex LC-67
- ¼ parts water
- thickener as desired

Treatment

Once the grout mixture had been identified and thoroughly tested, the next and final phase involving the actual treatment was undertaken. Before treatment the temporary stabilization was removed, however the telescoping poles were retained to be used as supports that were installed over night after the grout was injected to provide pressure to the surface of the ceiling along the filled joints, thus increasing the bond. For each of the areas identified for treatment, 7/64" holes were drilled approximately 1 inch apart along the existing crack lines. No holes were drilled into the undamaged fields between the cracks in an effort to protect the original fabric of the ceiling. Although there was some thought about how the limitations of where the holes were drilled might affect the quality of the adhesion, it was decided that the worst areas for the detachment would most

Applying the unfilled acrylic emulsion directly onto the lathing was possible in areas where the plaster field had been completely detached. (UPenn 2002)

likely be at these joint lines of the cracks. In essence, what we were doing was closing the seams like a zipper with the knowledge that the most threatened areas immediately around the seams were treated. With the inclusion of the admixtures, it was hoped that the affected areas within the undamaged fields would be readhered without needing the addition of drilled holes.



Injecting the pre-wetting agent to increase the adhesive ability of the emulsion. (UPenn 2002)

With the holes drilled, air was blown into the holes using a narrow cannula attached to the end of a small compressor. This was intended to remove any dust and loose debris which could adversely affect the adhesive quality of the grout. The first liquid injected into the hole was a consolidating agent which decreased the intrinsic friability of the brown coat. The choice of consolidant was B-67 which was mixed with mineral spirits as a solvent and carrier. Testing was executed on different solvents, however all of them with the exception of mineral spirits caused staining from the brown coat beneath to leach through to the finish coat . The consolidating agent was injected and allowed to dry over night. The following day the holes were injected with a pre-wetting agent consisting of a 20% mixture of Rhoplex MC-67 just prior to injection of the mixed grout. While the Phillips recipe was followed accurately, it was decided after probing with the end of a syringe needle that in almost every case the voids were deep enough to warrant the

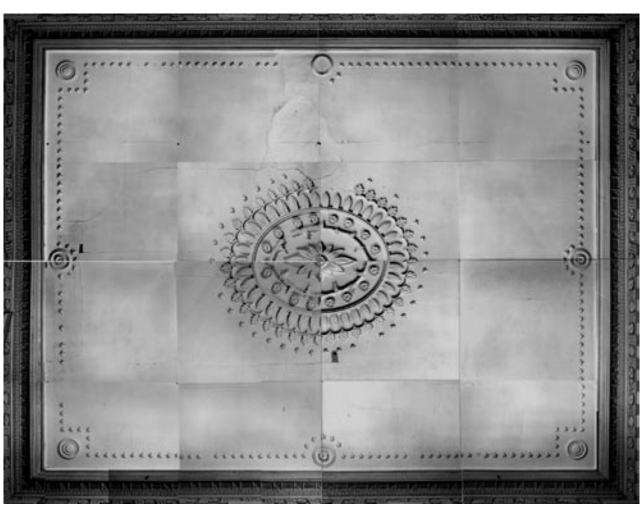
Using a palette knife to apply a light weight spackling paste to fill existing cracks. (UPenn 2002)

use of the filled formula. Injection was carried out using a standard 60 cc syringe with a 12-gauge reusable stainless steel needle. Each hole was injected with enough material to a point at which it extruded from the holes on either side. Once the material was injected, the poles were removed, each injection hole was drilled with a conical "countersinking" bit mounted in a portable Dremel, removing all grout to a maximum of 1/4" depth. The acrylic "halos" around the injection ports resulting from the overflow of the prewet were gently removed

Supports in place to allow the emulsion to set. (UPenn 2002)

the exposed excess was removed from the holes. This process was carried out the full length of a crack at which point the padded telescoping poles, being reused from the temporary stabilization, were brought into contact with the crack and enough pressure was applied to ensure that this area of the ceiling had positive pressure to help with the bonding. These poles were left in place for a minimum of 12 hours. Across the entire surface of the ceiling, more than 1000 holes were treated. Once with 320 grit sanding pads. Each of the holes was then filled with DAP's Fast 'n Final lightweight spackling, a light weight commercial filler which was cut in half with white microspheres to reduce the moisture content. The fill was allowed to dry at which point it was lightly sanded and any excess dust was brushed away.

While the current responsibilities of this project were focused on the reattachment of the plaster ceiling, a critical goal was the establishment of a baseline of conditions for future monitoring. The earlier 1977 intervention had addressed the failing plaster of the ceiling as a single overall problem for which a one time treatment had been applied. It was possible that this approach had been too aggressive as well as too shortsighted. While the approach had been partially successful, eliminating the direct cause of the detachment by rebuilding lost keys, it was not known how successful the rekeying was. It had also eliminated the ability to treat the ceiling from above in any future treatment efforts. Additionally the process had not successfully eliminated the deflection of undersized joists. The treatment itself had also introduced considerable additional weight to a flooring system which was already exceeding its load limits, thereby possibly contributing to the size and extent of the present conditions. Our team decided to address the new treatment differently than the approach taken in 1977. While our conditions assessment addressed the entire ceiling, the new plan for the treatment was to apply it only to the areas where complete failure was immanent, leaving the rest of the ceiling unaltered allowing treatment in the future if necessary. This softer approach was intended to eliminate preventive treatment which may or may not have a negative impact on the stability of the ceiling in the long term. In areas of the ceiling where there was no clear need for treatment, it was decided that no preventive treatment would be undertaken, helping to eliminate added weight as well as reducing the small potential risk of unforeseen problems that could occur as a result of long term contact between the treatment and the original material. Additionally the stability of newly treated areas could be compared with that of older untreated areas over an extended period of time in an effort to determine the success of the 2001 treatment method. Through the present efforts of a team of conservators, Drayton Hall has undergone extensive monitoring in order to identify and understand deterioration phenomena and mechanisms, the goal of which is not the replacement of failing materials, but the application of sympathetic treatments including preventive conservation measures to curtail further decay. We believe that the efforts of the Architectural Conservation Laboratory at the University of Pennsylvania, in retaining the valuable historic fabric of the Great Hall ceiling, are in keeping with this philosophy.



A photomontage of the ceiling used for both the 1991 and 2002 condition surveys. (UPenn 1991)