Victorian Splendor: Analysis of the Late 19th Century Decorative Ceiling at Ebenezer Maxwell Mansion in Germantown, Pennsylvania

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Abstract
The decorative ceiling in the Stevenson Bedroom of the Ebenezer Maxwell Mansion in Philadelphia is one of the most outstanding examples of post-Centennial ornamental designs. The exotic, stylized, geometric pattern of the ceiling illustrates ideals set forth during the Centennial International Exhibition, held in Philadelphia in 1876, and emphasizes Victorians’ predisposition to live à la mode. However, as a result of harsh treatment conducted in the 1970’s and ‘80s and damaging environmental conditions, the ceiling design only partially remains today. This thesis considers an approach for interpreting decorative paintings where the original fabric is altered or missing. It argues that, in the absence of material evidence, an accurate estimation of decorative painting can be achieved by consulting a wide range of sources. Recommendations provided in this thesis incorporate raw data to create an authentic representation of a late 19th century interior, contributing to the historic interpretation of the site.

Keywords
Ebenezer Maxwell Mansion, decorative painting, microscopy, color matching, digital reconstruction

Disciplines
American Art and Architecture | Architectural Technology | Historic Preservation and Conservation | Interior Architecture

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Victorian Splendor: Analysis of the Late 19th Century Decorative Ceiling at Ebenezer Maxwell Mansion in Germantown, Pennsylvania

Johanna Sztokman

A THESIS

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Dedicated to my parents who supported me through all of my adventures and inspired me to follow my dreams.
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1. INTRODUCTION

1.1 Statement of Intent
Historic finishes reflect the stylistic influences, individual preferences, and industry of their time. The colors, design, and materials demonstrate the financial means, tastes, and sophistication of the owner, while also providing insight on the design, influences, and advances in paint and coating technology. When combined with professional standards of paint analysis, consideration of this wide array of factors ensures the greatest degree of accuracy in documenting and interpreting this important aspect of historic buildings.

The decorative ceiling in the Stevenson Bedroom of the Ebenezer Maxwell Mansion in Philadelphia presents a case of an elaborately painted design requiring extensive contextual research for its interpretation. As a result of harsh treatment conducted in the 1970’s and ‘80s and damaging environmental conditions, the ceiling design only partially remains today. Despite previous efforts to document and interpret the design, as illustrated by a mock-up of a quadrant of the ceiling, this research has made clear that a new campaign of analysis and interpretation is needed.
Insufficient materials and incomplete records of previous investigation sometimes make comprehensive interpretation of finishes impossible. Traditional approaches of either not interpreting the painting at all or representing it as incomplete archaeological evidence limit the possibility for other approaches. On the other hand, a restoration approach that extrapolates from the available evidence impedes visual interpretation. While all approaches present limitations, the latter risks departure from the guiding principles of preservation and conservation professions that protect authenticity and demand scientific rigor.

Methodologies for the analysis and conservation of architectural paintings


2 Lei Yong et al, “From Deciphering Layers to Gel Cleaning: History and Application of Traditional and Modern Methods in the Conservation of Paint Finishes,” in Architectural Finishes in the Built Environment, ed. Mary A. Jablonski et al. (London: Archetype Publications, Ltd., 2009), 159-169. A similar approach has been undertaken in the restoration of interior finishes at Maxwell Mansion.

3 “The process of restoration is a highly specialized operation. Its aim is to preserve and reveal the aesthetic and historic value of the monument and is based on respect for original material and authentic documents. It must stop at the point where conjecture begins, and in this case moreover any extra work which is indispensable must be distinct from the architectural composition and must bear a contemporary stamp. The restoration in any case must be preceded and followed by an archaeological and historical study of the monument.” Article 9, The Venice Charter: International Charter for the Conservation and Restoration of Monuments and Sites (1964).

“The conservation professional should only recommend or undertake treatment that is judged suitable to the preservation of the aesthetic, conceptual, and physical characteristics of the cultural property.” Article 21, AIC Code of Ethics and Guidelines for Practice (1994).
are well established. The most widely accepted practices rely on material evidence and documentary research from a range of angles, including historic context and technological development. While this works well when the original painting is sufficiently intact, it does not specify approaches for estimating the appearance of severely compromised paintings.

This thesis considers an approach for interpreting decorative paintings where the original fabric is altered or missing. It argues that, in the absence of material evidence, an accurate estimation of decorative painting can be achieved by consulting a wide range of sources: those concerned with the historic, stylistic, and technical context; existing historic finishes in the study area and elsewhere in the building, and finishes studies of the same period and style. By seeking to find a compromise between a formalist archaeological approach and one that departs from the principles of the conservation profession in favor of a complete restoration, it acknowledges the dilemma that precise recovery of the original scheme and palette are sometimes impossible. This thesis

4 “Authenticity judgments may be linked to the worth of a great variety of sources of information. Aspects of the sources may include form and design, materials and substance, use and function, traditions and techniques, location and setting, and spirit and feeling, and other internal and external factors. The use of these sources permits elaboration of the specific artistic, historic, social, and scientific dimensions of the cultural heritage being examined.” Article 13, The Nara Document on Authenticity (1993).
makes the case for rigorous scientific and documentary research to arrive
at the most accurate palette and design and proposes that the process
and interpretation be presented with extensive explanation.
1.2 Site Description

Ebenezer Maxwell Mansion, located at 200 West Tulpehocken Street in the historic suburb of Germantown north of Philadelphia, is one of the most outstanding High Victorian structures in the city. Built in 1859, the Second Empire- Gothic design integrated avant-garde ornamental motifs with vernacular construction techniques and materials. Today, the Maxwell Mansion serves as a Victorian house museum, receiving thousands of visitors yearly. The house was restored in the 1970’s to represent two distinct periods in late Victorian history. The first story is interpreted to represent the Civil War period while the second story represents the period following the Centennial Exhibition held in Philadelphia in 1876.
Chapter 1: Introduction

Figure 1.2: Reflected ceiling plan of the second story showing the location of the decorative ceiling of the Stevenson bedroom.

The house’s asymmetrical design is typical of the exuberant late Victorian period. A three-story Second Empire tower projecting half a story above the house emphasizes its irregular floor plan. Hewn local Wissahickon schist of random widths lines the wooden structural system of the house. The stone bearing walls are supported by a dressed rubble foundation and adorned with diamond silhouettes of maroon brownstone. A wooden cornice, cut and sand-painted to resemble stone, extends the length of the house. Dormers with stepped gables interrupt the strict cornice and four chimneys soar above the polychromatic Mansard slate roof.
Fenestration is composed of four-sash casement windows, each with two lights and a single transom, with the exception of porthole windows in the dormers and a Gothic arched window in the kitchen addition. Dormer windows appear on three sides of the tower. The semicircular front door is recessed in a stone arch, set in a projecting gable entrance.

The original floor plan included a vestibule leading into a central stair hall with a large parlor on the north side and a dining room, library, and kitchen on the south end. A rear entrance opened the central hall to the garden and a conservatory, which has since been removed. The 1859 fire

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insurance described the main stair as a “continual rail stairs with yellow pine steps, turned ash balusters, walnut rail and newel post,” which has remained largely unchanged, as does the configuration of six bedrooms and a bathroom equipped with a wooden bathtub with copper lining and three additional rooms and storeroom in the attic.\textsuperscript{6} A gravity hot air system with iron ducts leading to a brick furnace in the cellar supplied heat to the upper floors. Along with gas lighting fixtures and plumbing this house was at the forefront of technological innovation for its time.

Interior finishes and furnishings were elaborate. Since the 1970s restoration, the board of directors was able to retrieve many books, textiles, and furniture owned by the mansion’s previous owners. It was found that the original sap pine wood flooring was covered with wall-to-wall carpets, which complemented the predominantly machine-made Rococo and Renaissance revival furniture.\textsuperscript{7} Interior walls and ceilings were made of a three-coat plaster system on which paint or wallpaper was applied.

\textsuperscript{6} Ibid, 5.
\textsuperscript{7} Ibid, 6.
The plaster was laid on wooden lath supported by studs. Run-in-place stucco cornices and elaborate cast plaster medallions decorate the main rooms of the house. Grained doors and marbleized mantels introduced natural elements to the interior, capturing the ideals set forth by pattern books of the time. Gas chandeliers and wall sconces that originally lit the room were converted to electricity and are still used today. The lambrequins, full length drapes and ties, and sheer lace drapes window treatments in the parlor were taken from Gleason’s *Pictorial Drawing*

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8 Idem.
Chapter 1: Introduction

Room Companion of 1854. The Scalamandre Rococo Revival wallpaper is a documentary reproduction installed in the French style— from floor to ceiling.

![Figure 1.5: View of plaster medallion in the parlor, photo by author.](image)

10 Idem.
Stenciled walls in elaborate Egyptian Revival motifs in the stair hall mark the transition into the post Centennial period of interpretation chosen for the second story. Like Egyptians, the Victorians derived influence from nature and considered such motifs to be of “pure original design.”\textsuperscript{11} The lotus and papyrus growing on the banks of the Nile River, for example, symbolize the food for the body and mind, and palm leaves symbolize victory, immortality, and eternal life.\textsuperscript{12} The use of stylized and classical ornamental motifs continues throughout the second story, which includes an astounding display of stenciled and hand painted walls and ceilings.


\textsuperscript{12} Idem.
Figure 1.7: Graining details of the Carnell Suite door facing the room (left) and the stair hall (right), *photo by author.*

Figure 1.8: Stenciled geometric pattern on wainscot beneath the windows in the Stevenson bedroom, post Centennial, *photo by author.*
Image 1.9: Repainting of Egyptian Revival décor in stair hall completed in the late 1970s, Ebenezermaxwellmansion.org.
1.3 The Stevenson Bedroom

Nestled on the northwest corner of the second story, the Stevenson room, as it came to be known, functioned as the patriarch’s master bedroom. With increasing desire for privacy in the early years of the Victorian era, it had become common for husband and wife to have separate bedrooms, often with an inter-connecting door.\(^{13}\) Same sex children shared a room and women frequently had a private boudoir or sitting room, which they used for leisure or nursing.

Although no evidence survives of the wall treatments from either the Maxwell or Stevenson era, pre-Centennial bedrooms are typically characterized by their simplicity in style and color. Decoration was primarily derived from trefoil, quatrefoil, or floral motifs in the cornice and exposed rafters, either stained or varnished.\(^{14}\) Since walls accumulated dirt from oil lamps and fire, painted walls were easier to clean and refinish than wallpaper, which was thought to harbor bed bugs. Pattern books dictated the appropriate color choices for bedrooms. Pastels such as “seashell pink” or “pearly gray” were favored.\(^{15}\)

\(^{14}\) Ibid, 72.
\(^{15}\) Idem.
Mass production of wallpaper following the Centennial Exhibition and overall improvements in hygiene made wallpaper a popular choice for the bedroom. Soft pastels that decorated the surfaces of early 19th century interiors were replaced with subdued earthy tones of the Aesthetic Movement, comprised mainly of secondary and tertiary colors. The Aesthetic Movement was a period of “extraordinarily rich artistic activity” in Europe and the United States, centered on the decorative arts of the 1870s and 80s. A decorative surface finish was revered aesthetic if it was the product of a known architect or artist who called his work “art.” The term was also considered appropriate for adaptations of exotic styles, such as Japanese or Egyptian motifs seen in the decorative finishes at Maxwell Mansion, particularly in the Stevenson bedroom and stair hall.

Overall decoration in the ceiling combined free hand patterns with pre-cut stencils. Generally, the painter would pencil in the geometric outline of the design to guide the stenciling process. The radiating lines from the center would be measured with a compass and marked. Since painters mixed colors on site it was customary to use a rather limited palette, repeating colors in different areas of the design. Not only was this method

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16 Harriet Prescott Spofford’s, *Art Decoration Applied to Furniture* (New York, 1878).
18 Ibid, 65.
more economically viable, it also provided a more subtle and consistent color palette throughout the room.

Only traces of the highly ornamental polychrome design remain today on the ceiling and woodwork. Unnecessary exposure of the design and use of chemical substances for paint removal resulted in irreparable damage to the paint film. Where the design is more pronounced, the colors are often faded or missing. The decorative finishes on the window surrounds and shutters, which remain largely covered, have withstood weathering to a greater degree. Although mostly faded, those colors and motifs have been used to guide the interpretation of the ceiling design.  

19 Figure 1.8 of the window surround illustrates the color palette of the Stevenson bedroom.
Figure 1.10: Photomontage by author of the Stevenson bedroom ceiling, showing the severe damage of the paint.
Figure 1.11: Photomontage with overlaid drawing of original design.
2. SITE HISTORY

2.1 Germantown and Ebenezer Maxwell Mansion

On August 20, 1683, twelve German immigrants, mainly from the Frankford-on-the-Main neighborhood, arrived in Philadelphia accompanied by Francis Daniel Pastorious, owner of the 15,000 acres of land on which Germantown was established. The land was surveyed on October 24 of that year and the next day fourteen lots were allocated by lottery to each one of the families. Inhabited predominantly by Quakers, Mennonites, and Pietists, this peaceful community held an independent government between the years of 1691-1707 until a representative of the British crown declared it illegal and incorporated Germantown as a township of Philadelphia, a status it maintained until the Act of Consolidation of 1854. The advent of the railroad and affordable real estate by the late 19th century made Germantown a center for industrial activity and capitalist ventures.

Germantown was an extremely important center of civic and industrial activity in the early history of the United States. The birthplace of the

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21 Ibid, 9.
22 Ibid, 58.
Antislavery Movement in 1688, location of the Battle of Germantown during the Revolutionary War, and temporary residence of George Washington between 1783-1794, Germantown’s many “cottages and villas, surrounded by neat grounds, trees, shrubbery & flowers, many of them costly and handsome” earned recognition as National Historic Landmarks.\(^\text{23}\) By the mid 19\(^{\text{th}}\) century, small-scale private enterprise dominated the development of Germantown as a suburb. Individual developers constructed new roads and sold vacant lots to entrepreneurs who erected speculative houses that “set the tone” for the new streets.\(^\text{24}\)

A contributing building to the Tulpehocken Station Historic District, Ebenezer Maxwell Mansion was the speculative undertaking of a city businessman. Driven by the railroad and facilitated by a water reservoir, this district was one of the first in the nation to employ factory driven residential construction to create a picturesque oasis on the outskirts of large metropolises.

As successful Philadelphia businessmen ventured into a capitalist market economy of “spec housing” during the latter half of the 19\(^{\text{th}}\) century,

\(^\text{23}\) Idem.
Germantown transformed. Andrew Jackson Downing described men drawn to such endeavor as “Men of imagination- men whose aspirations never leave them at rest... whose ambition and energy will give them no peace within the mere bounds of rationality. These are the men for the picturesque villas.” Bold, intricate, and irregular houses with steep gables and high roofs contoured the streets of Germantown, and by the mid 19th Century, affluent families uprooted their lives from the cities in favor of the idealized suburban living with modern transportation and amenities.

![Figure 2.1: Ebenezer Maxwell Mansion, 1974. Library of Congress.](image)

Ebenezer Maxwell was such a “man of imagination.” Born in New York City in 1827, Maxwell moved to Philadelphia at a young age to take up a sales
position with a wholesale drug importer. Two years later he met William Bangs and the two men established a successful textile business together known as Maxwell and Bangs, which was funded primarily by his wife and second cousin Anna Smith’s inheritance. Esteemed by his peers, Maxwell was nominated to the board of directors of the old Mechanics National Bank in 1858. A prominent member of his community and co-founder of the Second Presbyterian Church, Maxwell befriended many of Philadelphia’s elite engaged in the real estate business of “buying to sell.” Joseph G. Mitchell, Frederick A. Van Dyke, Jr. and Maxwell among others, all affluent men, held elegant residences in Germantown for a short period before selling at a high profit. This allowed them time to assess the potential for return on investment and commute time to Center City, where most men worked.

Mark F. Lloyd wrote in “An Historical Update on the Ebenezer Maxwell Mansion” in 1977:

> It is now clear from study of the development of the general neighborhood that Ebenezer Maxwell built his mansion as a fairly straightforward venture into real estate speculation. Exhaustive research has revealed that many, if not most of the antebellum houses on Walnut Lane and Tulpehocken street were what is known

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25 Philadelphia, Pennsylvania City Death Certificates 1803-1915, Philadelphia City Archives.  
27 Hoist, 393-394.
in real estate circles as “spec houses,” i.e. stylish villas erected with the realistic prospect of sizable profits in the incredible bull market that was Germantown real estate in the decade of the 1850s. The number of private dwelling houses in Germantown almost doubled between 1850 and 1860 and it was not until the 1880s and 1890s that a market as bullish as that of the 1850s reappeared in Germantown real estate.\textsuperscript{28}

Maxwell purchased the lot north of the city in 1858 and commissioned architect Joseph C. Hoxie to design a Second Empire- Gothic villa for him and his family.\textsuperscript{29} The advent of standardized design through pattern books facilitated inexpensive, swift construction, and enabled Maxwell to select features illustrated by notable architects at the time such as Samuel Sloan and Charles Wickes.

\textsuperscript{28} Mark F. Lloyd “An Historical Update of the Ebenezer Maxwell Mansion” \textit{Germantown Crier}, (May 1977).


It is believed Joseph Hoxie and Samuel Sloan were involved in the design of this house due to their close relationship with Ebenezer Maxwell. Joseph Hoxie designed the Second Presbyterian Church, of which Maxwell was a founding member, and Sloan had designed a residence nearby of one of Maxwell’s close friends.
The house was completed in 1859 for a total of $10,000 and sold less than three years later to William Hunter for a profit of $3,000, equivalent to approximately 70,000 dollars today.\textsuperscript{31} Shortly after moving into the house, Maxwell began construction of a new home on the adjacent lot west on Tulpehocken Street, to which he moved with his family in 1860.\textsuperscript{32} By the turn of the century elegant mansions lined the streets of Germantown and real estate in the area boomed.

\textsuperscript{30} Charles Wickes, \textit{A Handy Book of Villa Architecture} (London: Crosby Lockwood & Co., n.d.), 257. Charles Wickes was a British architect and publisher who conducted extensive surveys on ecclesiastical and suburban architecture.

\textsuperscript{31} Hoist, 139. An inflation calculator was used to estimate the monetary amount that would have been earned today.

\textsuperscript{32} Ibid, 5.
William Hunter, a salesman, and wife Rosalie Cecilia Allan Hunter had five children: William Allan, who died as an infant, Helena, Frances Allan, Rosalie Cecilia and Allan. The Hunter family resided in the house for three short years. In the fall of 1867, William Hunter fell from the window of a New York City high-rise, an unfortunate accident that cost him his life. A passage from the public ledger of 1867 reads:

_Mr. Hunter, whose death was occasioned by a fall from one of the windows of the Fifth Avenue Hotel, in New York, was not subject to fits. The supposition in respect to the accident is, that he stepped upon a rocking chair to look out the window, and while opening_
the sash, the chair tilted and threw him head long out. He had taken off his coat, as if to retire.\textsuperscript{33}

Widowed, Rosalie married Howard A. Stevenson, a prosperous, middle-class, Philadelphia businessman. The Stevensons maintained a residence in New York City and beach houses in Newport, Rhode Island and Long Beach, New Jersey. Their only daughter Augusta lived in the house until her death in 1956 keeping the house in the Hunter-Stevenson family for nearly a century, during which time the Stevensons upgraded interior surfaces of the house according to contemporaneous fashions.\textsuperscript{34}

\textsuperscript{33} “Hunter-Stevenson Family,” Ebenezermaxwellmansion.com.
\textsuperscript{34} Peterson, Karin E. “The Ebenezer Maxwell Mansion,” Excerpt from unknown publication (Philadelphia Historical Commission).
In the following years the house suffered from neglect and escaped demolition twice between 1956-1965. A barricaded first story and faint glow from the gas lamps gave the house an ominous appearance. Finally in 1965 a group affiliated with the Germantown Historical Society raised sufficient funds to lease the house, from which they ran an independent, non-profit museum depicting the life of Philadelphia's Victorian socialites. Today, the Ebenezer Maxwell Mansion is known as Philadelphia's only authentically restored Victorian Mansion. The house's architectural significance earned it recognition on the National Register of Historic Places in 1971.

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36 Moss, 130.
37 Stokes, 10.
Figure 2.5: Condition of stair hall prior to 1970s restoration, *Library of Congress.*
Chapter 2: Site History

Figure 2.6: Same view of vestibule following the restoration. *photo by author.*
2.2 Previous Interventions

A decade after the Germantown Historical Society acquired the Ebenezer Maxwell Mansion, sufficient funds were raised to commence on a monumental restoration of the house and reconstruction of the highly ornate interior finishes.\(^{39}\) Two paint analyses, conducted between 1975 and 1979, were aimed at determining the nature of stenciling and graining on the second story, particularly in the Carnell Suite; the first by Mary Oehrlein of Building Conservation Technology, and the latter by Frank Matero, consultant to Micro Delta Ltd, centered on the graining on the walls.\(^{40}\)

Oehrlein’s report from 1979 derived significant conclusions regarding the chronology of painting campaigns and layout of the decorative layer. According to Oehrlein, the woodwork in the Carnell Suite was originally primed with three coats of white lead-in-oil paint, ceilings were white, and the walls covered in wallpaper. A layer of dirt and poor bond between the original and decorative layers suggests the former was exposed for a considerable amount of time. Ornamental woodwork in the suite was finished with walnut graining surrounding stenciled patterns simulating

\(^{39}\) Due to limited time and lack of documentation, only interventions in the Carnell Suite, stair hall, and Stevenson bedroom are mentioned in this chapter.

\(^{40}\) Mary Oehrlein, “Paint Analysis Report” (Ebenezer Maxwell Mansion archival material, 1979).
wood inlay or marquetry.\textsuperscript{41} A similar pattern exists on the woodwork of the Stevenson bedroom.

Exposure of the plaster walls in the Carnell Suite revealed additional graining. The decorative scheme was made up of a pattern of vertical and horizontal bands, approximately seven inches wide and stretching the length of the walls. Bands were grained light maple or walnut and were delineated by a narrow black stripe along the edges. Squares formed at the intersection of the bands were stenciled to imitate wood inlay. Remnants of this design are evident in an exposed section of the north wall in the sitting room.

\textsuperscript{41} Idem.
Figure 2.8: Exposure showing the graining and stenciling of the historic decorative layer. Photo by author.

The ceiling, like that of the Stevenson bedroom, was also stenciled. An illustration by Oehrlein shows the flat, stylized pattern of the ceiling, reminiscent of patterns from the Aesthetic Movement. Restoration artist Carla Wolf with assistance from William Seal, professor of historic preservation at Columbia University, exposed the decorative paintings in the Carnell Suite, stair hall, and Stevenson bedroom. Wolf used a Marine chemical paint stripper containing methylene chloride to soften the overlaying paint layers.\textsuperscript{42} An X-Acto knife with a blade no wider than half inch was then used to strip the paint. While the report implies special

\textsuperscript{42} Foust, 2-3.
attention was given to maintaining the integrity of the decorative layer, it is evident the stripper has severely damaged the original paint film.

Figure 2.9: Carla Wolf on the scaffolding while removing overpaint with a chemical stripper in the Stevenson bedroom, 1986, Maxwell Mansion Archives.

Figure 2.10: Condition of the ceiling of the Carnell Suite sitting room after the removal of the modern paint in 1986, Maxwell Mansion Archives.
Once all the paint was stripped, the design on the walls and ceilings of the Carnell Suite and stair hall was traced and recreated. Artist Liddy Mytas from the Tyler School of Art at Temple utilized illustrations to reconstruct the decorative scheme. While the design of the stair hall and ceiling of the Carnell Suite were preserved, a decision was made to draw a new design for the grained walls composed of a dado, field, and frieze, prevalent at the time.

![Figure 2.11: Current decorative scheme of the Carnell Suite sitting room, photo by author.](image)

Funds for restoration were exhausted before the reconstruction of the ceiling in the Stevenson bedroom began. Although the restoration was

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Liddy Mytas studied at L’Accademia di Belle Arti in Peruglia, Italy and spent six years working on decorative paintings in Italy before returning to Philadelphia.
halted, a third campaign of paint analysis was conducted to record and study the ceiling of the Stevenson bedroom. Frank S. Welsh, president of Welsh color and Conservation, Inc. examined numerous samples approximately a quarter to half an inch wide from the ceiling. The samples were collected by Carla Wolf and recorded in a series of drawings held at Maxwell Mansion. While the prefatory and analysis reports neglect to mention the methods of analysis, a list of Munsell colors matched at that time provides insight on the ceiling as it appeared immediately after the modern paint was removed. Gold leaf and some of the colors mentioned in Welsh's report are no longer visible on the ceiling. 44

While the restoration of the Stevenson bedroom was never implemented, research of the ceiling conducted during the 1970's and 80's provides a useful guideline in the approach for analysis today. As an outgrowth of Welsh's analysis, a full-scale facsimile of one quadrant of the ceiling was produced on board and has been displayed in the room since that time. The reproduction illustrates a higher level of detail and color than is currently visible. Yet, the level of accuracy is debatable. Based on evidence gathered during this research research, the color palette

44 Frank Welsh, “Prefatory Notes” (Ebenezer Maxwell Mansion). Frank Welsh’s report suggests that the decorative paint is distemper with a flat finish.
chosen for this illustration is inconsistent with the literature and physical evidence from the ceiling. For that reason, the drawing was used as a reference only.
Figure 2.12: Illustration from 1970s depicting a section of the decorative ceiling (above) and location of the illustration in the ceiling drawing (below), photo and drawing by author.
3. **Literature Review**

In order to establish the status of scholarship on the principle subjects addressed in the study of the Howard Stevenson master bedroom, a review of literature was undertaken. The stylistic context of the period was first considered. Sources addressing fashions and trends of the period, especially those that may have influenced the paintings in the Stevenson bedroom, were consulted. Such sources facilitated an understanding of influences and innovations as well as regional or individual idiosyncrasies. Sources of design, such as pattern books, were also studied. New developments in paints and coatings introduced new products on the market. Literature on the development in paint and coating technology of the period was reviewed as to set the stage in which painters were working. Finally, with the intention of assessing current methodologies of finishes analysis, literature on current practices was reviewed.
3.1 Stylistic Context

A dissertation by Nancy Hoist titled *Pattern Books and the Suburbanization of Germantown, Pennsylvania in the Mid 19th Century*, declared the suburbanization trend that spread across the northeast as being “not a natural outcome of accessibility or indicator of pattern-book influence, but a sign of gradually changing cultural attitudes.”

By 1850, an expanding network of railroads afforded urbanites the possibility of making their summer retreats in the country permanent residences. Although the idea of living in the suburbs year-round was still novel and considered by many to be a form of “social isolation” and disconnect from the culture and social status associated with city living, the search of the American dream lured many to explore country living. This offered many of Philadelphia’s middle class socialites a break from periods of economic distress by adopting a lower cost of living. It is during this time that Germantown began to flourish as a commuter suburb and year-round destination.

Pattern book authors of the 19th century emphasized the importance of family life and particularly the home. Andrew Jackson Downing, a

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45 Hoist, 166.
46 Ibid, 170.
renowned landscape architect and author, prefaced *The Architecture of Country Houses* in stating that “a good house is a powerful means of civilization.” In a sense, pattern books sought to influence city dwellers to find solace in agriculture as a means of correcting the spiritual decline of the materialistic urban society. Hoist described this disconnect as a contrast between experiences stemmed from sincere appreciation of the country and those influenced by fashion and social vanity. Yet, it was pattern books that ultimately enticed a new way of life. Hoist’s hypothesis of social change as the driving force of suburbanization, although compelling, detracts from the significance of the technological and stylistic advances that encouraged that change.

Pattern books infiltrated all aspects of life- from books guiding matriarchs on how to organize a kitchen or garden, to construction trade pocketbooks aimed at teaching workers how to lay brick on site. By the end of the 19th century, pattern books were no longer viewed as suggestions, but rather as definers of social stature in their own right. A person of class could thus showcase his fortune by constructing a mansion- “the true country house”- surrounded by agricultural land,

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48 Hoist, 165.
gardens, and parks. Any one familiar with Downing’s book would know exactly how much was spent on such endeavor.

When it came to interior decoration, pattern books defined distinct spaces and finishes to be utilized in each space. Owen Jones, author of The Grammar of Ornament written in 1868, delineated several propositions for the arrangements and forms of interior decoration:

Proposition 10: The harmony of form consists in the proper balancing and contrast of the straight, the inclined, and the curved.

Proposition 13: Flowers or other natural objects should not be used as ornaments, but conventional representations founded upon them sufficiently suggestive to convey the intended image to the mind, without destroying the unity of the object they are employed to decorate.

Proposition 14: Color is used to assist in the development of form, and to distinguish objects or parts of objects one from another.

Proposition 17: “The primary colors should be used on the upper portions of the objects, the secondary and tertiary on the lower.”

The Architect’s Manual of Painting and Decoration of 1891 described the finishes befitting a first class residence stone house. Generally, it was suggested that the finishes in this type of house include three coats of the

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49 Idem.
50 Jones, 5-6.
best quality oil paint atop a “rough pebbled”, “roughing,” or “Morocco finish” ground. The ceilings of the main and lower stair hall are said to be painted “a reddish buff” to harmonize with the mahogany woodwork and decorated in Renaissance style hand-painted ornaments in the colors of mahogany, old blue, and gold. Finally, the walls are to reflect the colors of the ceiling in an overall stenciled pattern relieved with handwork and finished with gold leaf.

For the master bedroom, this manual suggests five coats of flatted oil finish for the walls and ceiling, which is to be decorated in a Persian style design painted in shades of turquoise blue and salmon color with nickel and gold leaf and hand-painted flowers in natural tones. Interest in oriental designs was prevalent among fashion trendsetters. The Grammar of Ornament entirely rests upon international styles of design, implying that such interests were common prior to their debut during the Centennial International Exhibition of 1876, particularly in Europe.

Egyptian ornament, Jones asserted, was of “pure” nature devoid of

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52 Idem. In the literature, ground refers to the background of the finished decorative layer.
53 Ibid, 27.
54 Ibid, 32.
foreign influences.\textsuperscript{55} The adaptation of forms from natural objects such as the lotus or papyrus appealed to the Victorian ideals of purity and truth. It was no surprise then that authors of Victorian pattern books adopted forms of oriental ornament in its polychromy, symmetry, and even symbolism. In that regard, whether the ornament pertains to the structure, is representative of actual things, or is simply decorative, the conventions of symbolic interpretation were of utmost priority.\textsuperscript{56}

Figure 3.1: Egyptian motives for wall décor, Grammar of Ornament, Plates IV and V, 1856.

\textsuperscript{55} Jones, 22.

\textsuperscript{56} Ibid, 24-25. Egyptian ornamentation was divided into three types: constructive-forms part of the structure, representative-representation of an actual object in abstract form, or decorative-symmetric shapes evenly distributed throughout the work.
Christopher Dresser, a British author and design theorist, published *Studies in Design* in 1875. In order to achieve the highest level of truth, Dresser believed knowledge of history or materials of far lands was not enough, and had to be compensated by fully immersing oneself in that culture.\(^{57}\)

A section from his introduction reads:

\begin{quote}
My success in the production of such a pattern (Indian, Arabian, Moresque, etc.) depends largely upon the extent to which I become, in feeling, for the time a Chinaman, or Arabian, or such as the case requires. But I must not only become, in spirit, a citizen of the country whose ornament I wish to simulate, but I must become, in a sense, a scholar of that country.\(^{58}\)
\end{quote}

Dresser further reiterated conventions of harmony in the use of color. According to his book, small masses of strong colors on the walls and ceilings, particularly blue, red, yellow, together with white, black, or gold generate a neutral effect desired for its tranquil nature.\(^{59}\) When employed on a grand-scheme design on the ceiling, the decoration can render the apartment “rich” and “snug.”\(^{60}\)

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\(^{58}\) Idem.

\(^{59}\) Ibid, 11.

\(^{60}\) Ibid, 22.
The walls should continue the use of primary colors in masses. The wall is divided into a dado, field, and frieze as commonly seen in later 19th century period rooms, and ornament suggested consists of diaper patterns for the frieze, a dado rail separating the dado and field, and a stenciled pattern on the dado with gold ornaments in the dado, frieze, and ceiling.\(^{61}\)

Since color was considered the most important factor influencing the harmonious aspect of interior rooms, an entire science on human

\(^{61}\) Ibid, 24.
perception of color developed. Color was used not only to adorn interior spaces, but also to create breaks in the general mass of the walls by selecting different colors for blinds, doors, sills, sashes, etc. P. J. Rousseau's *House and Decorative Painter*, published in 1871, emphasized the importance of gold as a harmonizing color. Rousseau was one of many authors to suggest that colors affect human behavior. Such perceptions on color and ornament continued to influence decorative finishes well into the 21st century.

Discussion

Ornaments such as stenciled and hand painted walls and ceilings, carpets, draperies, and upholstery in eclectic patterns and motifs decorated most of the surfaces in Victorian interiors. Elaborate designs expressed the stylistic preferences of their makers and standards set forth by pattern-book authors of the time. Ornate interiors composed of earthy tones with gold accents induced a state of serenity to the inhabitants of the house.

Dresser, a pivotal figure in the Aesthetic Movement that swept the country

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63 Burke, 53.
following the Centennial International Exhibition, professed in *Studies in Design* that “the desire for decoration is natural to the human mind."  

Extensive collections of late 19th century literature on design theory and color harmony reveal a fascination with the tangible and intangible aspects of décor. In a sense, surface ornament was more than just the dressing on the wall, it was the means by which Victorians “purified” their lives and proclaimed their economic and social stature. Victorians' fascination with “truthfulness of décor” dictated the most appropriate methods for interior decoration.  

Contrasting schools of thought by the late 19th century dominated the market for surface ornament. The first, advocated by architectural pioneers like John Ruskin and William Morris, condoned the mechanization of building crafts and celebrated workmanship. The other, to the likes of Christopher Dresser, reflected a more practical approach, which encouraged the mass production of stencils, wallpaper, upholstery, and paint. The influences these approaches had on interior ornament are manifold in their nature. Yet, what they all shared was an appreciation for the orient, which inspired many of their designs.

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64 Dresser, 1.  
65 Dresser, 17.  
66 Catherine Lynn, *Wallpaper*
Period literature suggested the most appropriate decoration for a ceiling. Persian or Egyptian patterns of turquoise blue and salmon pink with gold and nickel accents enriched with "softly painted flowers" were most often suggested. As the only element in a room visible in its entirety at all times, it was strongly recommended to use harmonizing colors, which render the room "rich, snug, and cozy." Strong colors accentuated by gold, white, or black details were suggested in small masses imparting a "subtle" effect on the overall design. While harmonious designs could be executed with a central element surrounded by a rough pebbled or Morocco-finished cream-colored ground, an overall pattern such as the one in the Stevenson Bedroom was most revered.

3.2 Technological Context

Morgan W. Phillips characterized paints in his "Survey of Paint Technology" as "any substance that can be applied to the surface as a liquid at or near room temperature and that then form a solid, opaque, adherent

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68 Dresser, 22.
69 Ibid, 11.
70 Ibid, 21.
Historically, the most common paints used were oil paints—paints that dry by the evaporation of a binder, generally linseed oil—and distempers or calcimine—paints that dried by the evaporation of the solvent, in most cases water, and normally bound by an animal glue binder. Such organic binders used in paints are transparent before application and must be pigmented in order to produce color.

While both paints continued to be popular choices until the mid 20th century, distemper paints were often preferred for their low-cost, quick application, great hiding power, and resistance to yellowing over time. Since distempers were composed mainly of water, once the water evaporated enough glue was left to fill the spaces between the pigments. The result was a highly porous film, which scattered light without containing expensive high-refractive-index pigments such as white lead giving the paint colors high opaqueness. The ability to scatter rather than absorb light was the main reason whiting became the most popular white

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72 Ibid, 240. Rousseau, 23.
Glue, or size, refered to other adhesives as well but animal glue was the most commonly used. Animal glue is a protein derived from bones, hides, or other parts of animals and fish, which provides connective tissues such as ligaments cohesion and strength. Traditional oil paints used organic binders but by the first World War synthetic oils and alkyd resins came into play.
74 Phillips, 241.
pigment for distempers. The refractive index difference between whiting, or calcium carbonate \((n = 1.5)\), and air \((n = 1)\) was successful in generating scattering of light.\(^{75}\)

Yet, distempers’ solubility made them susceptible to damage by moisture and extremely difficult to clean. Given their high solubility, they dissolved on contact with water or water borne cleaners. This is why distempers were often used for temporary decoration and were either removed or covered with a sizing of shellac or rosin sealant before applying new paint.\(^{76}\) Such sealants created an unstable base for moisture resistant paints such as oils and acrylcs, resulting in the “dramatic” peeling of the latter paint layers and darkening of the distemper paint underneath.\(^{77}\) For this reason and due to the difficulty of articulating detail, distempers were preferred for solid wall paints and often as a temporary finish. Long working time, permanence, and wide range of color made oil paints the more popular choice for decorative designs.

Oils for decorative paintings were made from drying oils such as linseed or

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\(^{75}\) Ibid. Whiting was obtained by crushing limestone. Unlike limewash, the limestone particles in whiting act as pigment as opposed to binder.

\(^{76}\) Idem.

\(^{77}\) Idem.
walnut, which dry to a solid film by cross-linking. Richard Newman divides oil paints in “Historic and Modern Paints: Composition and Conservation” into three categories: drying oils, such as linseed, walnut, or poppy-seed, semi-drying oils, such as soybean or corn, and nondrying oil like olive and coconut. The drying capabilities of which is dependent upon the chemical reaction between an alcohol-based solvent and the fatty acids present in all oil types, which produce the main component of nearly all oils- triglyceride-esters.

The most striking change in house paints, however, occurred in the industry of paint making in the middle of the 19th century. Since the Colonial period, paint manufacturing remained largely unchanged. Hand mixed oils and water based paints, such as lime, distemper and casein, prevailed as rapidly changing architectural fashions swept the nation. Following the Civil War, paint production transformed from the practice of mixing colors on site to the mass production of factory mixed paints. This

78 Cross linking is a process in which oxygen molecules in the air react with carbon hydrogen bonds within unsaturated fatty acids. The bonds forming between neighboring fatty acid chains result in a polymer network, which makes the oil film incredibly resistant and stable.
80 Ibid, 260. Fatty acids comprise the majority of the overall weight of oils and are the reactive portion of the triglyceride-ester which determines the drying capabilities of the oil.
revolutionized the entire industry but not without some difficulties.

The first ready-mixed paint color was green, the preferred shade advertised by many pattern-book authors for blinds, ornamental ironwork, and machinery. By the 1870s, companies such as John Lucas and Company of Philadelphia and F. W. Devoe and Company of New York advertised specially made “French Imperial Green” and “Park Lawn Green” for such uses. As more colors became available, a new industry of color cards was born. A sample color card published by Averill Chemical Paint Company in 1869 showed the user the variety of colors available and enabled painters to view colors side by side in order to make the most appropriate choices for decoration.\(^\text{82}\)

Over the next few years, pattern-books dictated the colors to be made. Architects like Samuel Sloan and A. J. Downing preferred “soft neutral tints” reflecting the colors of nature, while the Victorian color palette tended towards the tints of soil, rocks, and wood.\(^\text{83}\) The wide variety of colors on the market led to the development of two new approaches to color harmony: “harmony by analogy” and “harmony by contrast”.

\(^{82}\) Ibid, 56.
\(^{83}\) Idem.
Figure 3.3: Averill Chemical Paint Company color sample card, *Paint in America*, 56.
The former utilized adjacent colors on the color wheel like crimson and purple or yellow and gold. The latter, sought to achieve harmony by combining complimentary colors- those opposite each other on the color wheel- like orange and blue or scarlet and green. This theory was based on Michel Eugène Chevreul’s *Principles of Harmony and Contrast of Colors and Their Application to the Arts*, which emphasized the ability of certain colors to intensify of dull other colors when placed near one another, deeply influencing color choices during the 1870s and 80s.

Roger Moss, author of “Nineteenth Century Paints: A Documentary Approach,” reveals some of the complications that accompanied the early ready-mixed paint industry. Paint was difficult to package and ship, and mass production required a certain longevity of shelf life and availability. Distribution was also limited by container size and a deficient transportation system. Yet the drastic increase in population from 5.3 million in 1800 to 76 million by 1900 accompanied by vast urbanization of the country demanded mass manufacturing of paint products. This was accentuated even further by the standardization of the construction

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84 John W. Masury’s *House-Painting, Plain and Decorative* (1868), 57.
85 Moss, 57-58. Michel Eugène Chevreul (1786-1889) was the director of dyes for the Gobelins tapestry works in Paris and, according to Moss, was the first to record this phenomenon systematically.
86 Moss, 55.
87 Ibid, 56.
industry, which necessitated an improved, coordinated paint industry to
go along with it.

The advent of the ready-mixed paint industry also required better
advertisement through pattern books. In the early 19th century, pattern
book illustrations were applied manually by dissolving pigments on the
page after printing. Architects like Downing and A. J. Davis included
hand colored illustrations in their books, however the nature of hand
painting resulted in inconsistencies between publications and unreliable
sources for homeowners and painters. By the middle of the century, a
colored lithograph appeared in John Riddell’s Architectural Design for
Model Country Residences, Illustrated by Colored Drawings of Elevations
and Ground Plans. Although revolutionary, color separation was still a
man’s job and painters were advised to select colors from color chips and
not pattern book illustrations. It was not until steam-driven presses that
colorful illustrations afforded owners a reliable source of color choices for
their homes.

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88 Ibid, 60.
89 Moss, 62.
3.3 Current Practices in Finishes Analysis

Richard Newman recommends in “Historic and Modern Paints: Composition and Conservation” micro-chemical or spot testing as an inexpensive method to test for lipids in situ.\(^90\) This is an ideal starting point for analysis, since it can provide guidance on best areas for sampling.\(^91\) Willie Graham, author of “Architectural Paint Research at American Museums” also discourages the practice of over-sampling for sake of investigation. He suggests the best method for paint analysis is to “test heavily but sample lightly.”\(^92\) Non-invasive techniques offer many advantages, particularly in the case of extremely friable paints, and are continually exploited as the basis for microscopic and instrumental analysis.

In “A Re-Evaluation of Three Period Rooms in the Wrightsman Galleries at the Metropolitan Museum of Art in New York,” Mechthild Baumeister illuminated the Bordeaux Room using long wave ultraviolet radiation in order to confirm the heterogeneity of the binder and compile a selection of samples from different areas, representative of the various types of

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\(^{90}\) Newman, 269.
\(^{91}\) Ibem. A concentration of equal parts 30% hydrogen peroxide and concentrated ammonium hydroxide is the best test for drying oils, confirmed by the development of foam during testing.
Microscopic analysis of cross sections provides information on the stratigraphy of the paints. Richard Wolbers suggests in *Cleaning Painted Surfaces* the use of a laboratory grade microscope with two light sources, one for visible light and another for ultraviolet illumination with several filters to view primary and secondary fluorescence from samples. Fluorescence microscopy allows for preliminary characterization of binders using fluorescent stains, or fluorochromes, which react with certain binders to produce compounds that fluoresce uniquely under ultraviolet light. Yet, as with any chemical reaction, this method must be conducted under certain conditions for the reaction to occur. According to Wolbers, microscopic analysis often provides sufficient information regarding the structure of paint layers and the pigment’s particle size and distribution. Polarized light microscopy and microchemical spot testing aid in identifying the inorganic components. Together, these types of analyses can either lead to conclusions or aid in determining the types of testing.

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94 Newman, 270. Most commonly used stains for lipids are Rhodamine B and 2, 7-dichlorofluorescein and for natural resins a solution of antimony pentachloride in chloroform can be applied and observed under a microscope with ultraviolet light.
required for confirmation.\(^95\)

In 2004, Susan Buck outlined a methodology for paint research involving polarized light microscopy, Fourier Transform Infra-Red (FTIR), Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS), and Gas chromatography mass spectroscopy (GC-MS).\(^96\) These methods were exploited in different projects around the same time, reiterating their successful application in the study of interior finishes. At the Bordeaux Room, Baumeister confirmed her findings from the ultraviolet test with FTIR and GC-MS of scrapings, which confirmed the presence of three different classes of binding media: protein, oil-alkyd, and polyvinyl acetate-based.\(^97\) In another case outlined by Mads Chr. Christensen in “Material Analysis in Relation to Architectural Paint Research,” micro-FT Raman spectroscopy combined with optical microscopy and low vacuum SEM-EDS (LV-SEM-EDS) proved to be useful tools in characterizing pigments in

\(^95\) Mads Chr. Christinsen, “Material Analysis in Relation to Architectural Paint Research,” In Paint Research in the Built Environment, ed. Mary A. Jablonski et al. (London: Archetype Publication Ltd., 2009), 17. In the case of GC-MS, samples often have to hydrolyzed to transform polar groups into methyl or ethyl ethers, esters or amides volatile enough to pass through the gas chromatograph column.


\(^97\) Baumeister, 206.
multilayered cross sections.\textsuperscript{98}

Christinsen noted vibrational spectroscopy, such as infrared and Raman, as the best method to characterize pigments and binders in paint samples, and mass spectroscopy the ideal method for studying the specific composition of binding media.\textsuperscript{99} In the case of paint films where the binder makes up less than 20% of the sample, such as distempers, FTIR has been used to subtract the pigments by a computer to allow for a more accurate identification of the binder.\textsuperscript{100} In case of pigment identification, a typical mid infrared FTIR is used to identify inorganic compounds containing complex anions, such as carbonates, sulfates, and silicates, however inorganic compounds containing simple ions such as oxides and sulfides cannot be detected and must be confirmed with SEM-EMS and/ or Raman.\textsuperscript{101}

For binder identification, vibrational spectroscopy is often ineffective in extracting data from multilayered cross sections due to the presence of inorganic substances, which block absorption bands related to the

\textsuperscript{98} Christensen, 17.
\textsuperscript{99} Ibid, 16.
\textsuperscript{100} Newman, 271.
binding medium. Since separating thin layers can be problematic at times, GC-MS is often the analysis of choice. Several publications including B. Hochleitner M. Schreiner’s “Analysis of Paint Layers by Light Microscopy, Scanning Electron Microscopy, and Synchrotron Induced X-ray Micro-Diffraction,” and Lucas Helfen’s “Three-Dimensional Imaging of Paint Layers and Paint Substructures with Synchrotron Radiation Computed µ-Laminography,” mention synchrotron as the optimal method for examining multilayered cross sections. In both cases, the synchrotron radiation enabled the identification of the crystalline structure of the pigments used in addition to the main elements present.

Color matching is one of the most significant factors in determining compatible swatches for inpainting or color reconstruction. Generally, color matching is accomplished by comparing paint samples to standardized color systems such as Munsell, Natural Color System (NCL), or

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102 Christensen, 17.
In recent years, more and more conservators are advocating for the use of instrumental techniques to complement visual examination of paint samples. At the George Tucker House in Williamsburg, Virginia, Natasha Loeblich achieved a high level of accuracy combining colorimeter and microscope readings in both CIE L*a*b and Munsell color systems, and later matching them to commercial paint swatches using a color-corrected light source. Since most of these systems are limited to the current appearance of the paints and do not account for later alterations, the incorporation of several different techniques can be a valuable tool in determining the closest match.

3.4 Remedial Treatments and Conservation Techniques for Compromised Interior Finishes

The Venice Charter for the Conservation and Restoration of Monuments and Sites, established in 1964, set universally accepted professional standards for the treatment of significant historic buildings and sites. The charter expanded on principles set forth during the Athens Charter for the

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105 Idem.

restoration of historic monuments in 1931, and continued to be elaborated as new technologies for analysis and conservation became available. In 2003, the ICOMOS 14th General Assembly held in Zimbabwe determined the principles for the preservation and conservation or restoration of wall paintings. Given that painted surfaces are essential in understanding the historical and technological history of their makers, all conservation projects are to incorporate substantial visual, archival, and scientific examination, extensive documentation of conditions and past alterations, and preventive means to minimize failure in the future.

While the Charter advocates for retention of pictorial authenticity and sees natural aging as a “testimony of the trace of time,” in practice, restoration of decorative finishes is often desired when presentation and interpretation of the building as a whole are of utmost importance. Where little comparative material and physical evidence exist, restoration of painted surfaces can be a useful tool in establishing the context in which other similar paintings can be studied.

In “The Rediscovery of the Lost Ceiling Decorations in the Saloon at Burlington House,” Pauline Plummer outlined the uncovering of two separate decorative schemes. In this conservation approach, the
exposed painted walls were preserved in their original aged state protecting the authenticity of the design.

Non-destructive methods were first utilized to determine the location and integrity of the original design. While raking visible light revealed the outline of a later scheme by John Dibble Carce from 1891, Infrared Reflectography (IRR) used in situ to determine the original 1720 scheme by William Kent proved unsuccessful. Test scrapes confirmed the presence of an original decorative layer. Several paint removal techniques were considered, including chemical-borne gels, heated and ultrasonic vibrating scalpels, hot air jets, and laser. In this case, the most appropriate method for paint removal proved much simpler - overpaint was removed using Nitromos green label paint stripper followed by acetone and cellosolve. Once most of the overpaint was removed, saliva and gentle scrapings were used to achieve the desired clearance.

Once the original material was uncovered, Plummer treated salvageable flaking paint chips with Acryloid B72 followed by the application of heat and pressure. In the conservation of Juan’qin’zhai, the Studio of Exhaustion from Diligent Service located in the Forbidden City in Beijing,

107 Plummer, 166.
108 Ibid.
109 Ibid, 167. Acryloid (Paraloid) B72 is an ethyl methacrylate copolymer often used as a consolidant or binding medium for inpainting in conservation work.
architectural conservator Lei Yong used Acryloid B72 as a barrier and finish coat to treat the tung-oil-based faux bamboo finishes. Yong prepared the surface by dusting off loose dirt and grime with a soft brush and rolling ethanol solvent gel (C2H5OH) with a cotton swab to remove darkened varnishes. Unsalvageable paint flakes were removed and those in better condition were re-adhered with cold fish glue. A barrier coat of 8-10% weight to volume solution of Acryloid B72 in acetone (CH3COCH3) was then applied followed by shellac to match surrounding surfaces in color and topped with a final layer of the same Acryloid-in-acetone mixture.

Tobit Curteis approached the restoration of Entrance Hall at the Fitzwilliam Museum in Cambridge differently, focusing on stabilization of the polychromatic scheme and improving its overall appearance. In an effort to retain as much of the original fabric, a painstaking task of reattaching flaking and delaminating paint was undertaken. Paint chips were re-adhered using a weak solution of Plextol B500 adhesive through an intervention layer of Japanese tissue, which aids in preventing further

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110 Yong, 168.
111 Ibem.
flaking. Where retouching was necessary, inpainting was carried out with watercolors, which can be easily removed in the future, and a mixture of pigments in a medium of Acryloid B72 acrylic resin in areas more susceptible to mechanical damage.\textsuperscript{113} While this approach is ideal when treating significant historical finishes, it requires a substantial amount of salvageable material. Given that ninety percent of the finishes on the ceiling are absent, this restoration approach is not appropriate for the case of the Stevenson bedroom.

Where structural delamination occurred between the plaster and substrate, Curteis utilized lime putty with brick dust grout to reestablish cohesion between the two surfaces.\textsuperscript{114} Plummer also used lime slurry to reattach areas where the plaster skin and paint film separated from the underlying plaster. This method proved useful in achieving cohesion without causing irreparable damage to the painted surface or structural system.

Careful documentation of the methodology and conditions, before and after treatment, is essential in informing adequate treatments in the future.

\textsuperscript{113} Ibid, 177.  
\textsuperscript{114} Ibidem.
While documentation is often overlooked due to limited resources, establishment of proper recording procedures is vital in predicting problems in the future. Generally, conservators rely on rectified photography, computer-assisted drawing (CAD), and computer-based image manipulation programs to record their findings.\(^{115}\) Yet advances in technology over the last decade afford an incredible range of alternatives to document painted surfaces in a high level of detail. Kate Frame and Sophie Julien-Lees utilized the aforementioned techniques to record the condition of the murals in the historic Royal Palaces of England.\(^{116}\) Condition drawings were supplemented with a series of monitoring systems used to track changes in relative humidity, temperature, and light measurements aimed at detecting potential sources of failure.

Frank Matero and John Hinchman of the University of Pennsylvania’s Architectural Conservation Laboratory explored early detection of sources for failure in a publication titled “A GIS Assessment of the Great

\(^{115}\) Curteis, 177. Plummer, 164.

\(^{116}\) Kate Frame and Sophie Julien-Lees, “Mural Paintings within the Historic Royal Palaces: Our Approaches to their Continuous Care,” in All Manner of Murals, ed. Robert Gowing et al. (London: Archetype Publications, Ltd., 2007), 73.
Hall Ceiling at Drayton Hall, Charleston." 117 Data sets collected over the period of one year were recorded in a database, which facilitated tracking changes and predicting current and future damage.

Precise GPS locations of four and three-way crack intersections and meeting points of perpendicular cracks were used as references to monitor movement. 118 Numerical values allocated to each condition were inserted into the database, which the Geographical Information System (GIS) uses in order to produce a cartographic representation of the surface. A raster image where each pixel represents 0.5 square-inches of the ceiling allowed for calculated predictions of areas prone to structural damage or detachment. A regression equation was then used to calculate areas of highest threat and prioritize treatment locations. 119 GIS allowed for a low-cost, non-invasive recording and monitoring technique, which will minimize conservation efforts in the future.

118 Ibid, 29.
4. **Methodology**

4.1 **Historical Research and Condition Survey**

Investigation on the decorative painting on the ceiling of the Howard Stevenson Bedroom began with a study of archival documents and period literature. A study of prevalent decorative designs and painting materials used in high and middle class residences shed light on possible schemes and paints used at Maxwell Mansion.

Assessment of the current condition of the ceiling both in terms of structural stability and integrity of the paint helped identify certain pathologies and the best locations for sampling. The condition assessment was organized into three categories: (1) structural stability, (2) condition of substrate, and (3) condition of the paint. Only conditions that best represent the state of the ceiling, such as major cracks and deformation were noted in the first category. Detachment of the plaster from the lath and intra-layer detachment of the plaster itself were recorded in the second category. Non-structural cracks and previous repairs were also noted. Detachment was determined by lightly tapping along crack outlines throughout the ceiling. The third category focused on the integrity of the design and condition of the paint film.
In order to test the feasibility that the ceiling was originally painted in distemper paints, as suggested in the Welsh analysis, a mockup of a small section of the ceiling design was painted on a two square foot piece of drywall. By copying aspects of the detailed design, the test allowed for the opportunity to render in both oil and distemper paint thin lines, to layer colors on top of one another, and to create colors at the level of saturation found in the samples. Blue, yellow, and red/brown were chosen as the colors.

Distemper paints were prepared according to historic recipes of the time. To prepare the distemper, one part gelatin was soaked in five parts of water and gently heated in a double boiler until the gelatin dissolved. Ultramarine blue, yellow ochre, and burnt sienna pigments were ground on a glass surface with water and a paint muller and then mixed with whiting to achieve the desired color. The gelatin was added in a ratio of about 30% to produce distemper paint. Two identical sections of the wall were painted side by side on the plaster, one with distemper and the other with artist grade oil paints.

4.2 Sampling Method

Sample locations were systematically chosen to represent the original color palette. Both exposed and over-painted areas were selected in an effort to offer insight into the chromachronology of the ceiling. Damage resulting from sampling was minimized to prevent further deterioration of the historic paint layers. In order to best document sample locations, the ceiling was divided into four quadrants according to cardinal orientation.
A total of thirty-six samples were collected from the south, north, and east quadrants; thirteen samples retrieved in the first sampling campaign and examined before collecting the remaining twenty-three samples. Each sample location was photographically documented and noted in a sample data sheet according to a unique numbering system labeled in chronological order starting at SB.C.01, where SB is the room being studied (Stevenson Bedroom), C is the actual location of the sample in the room (Ceiling), and 01 indicates the numerical order of each sample taken. This system for numbering samples was used for all sampling, documentation, and analysis.

Samples of approximately 2-10mm were taken using an X-Acto knife with a rounded edge blade. Due to the friable nature of the paint and scarcity of vivid painted sections worthy of sampling, the sample size was kept to a
minimum. All samples were placed in enclosed glass containers for transport to the University of Pennsylvania Architectural Conservation Laboratory where they were prepared and studied.

4.3 Sample Preparation

Paint samples were first viewed under a Leica Stereoscope at 11X magnification to guarantee samples chosen for further study include substrate as well as the full stratigraphy of paint layers. Chosen samples were embedded onto half-filled, partially cured polyester resin cubes with the appropriate label and filled to the level of the ice tray with a second layer of resin. This ensured that the samples remain secure in the center of the cube, which aided in the cutting process. The samples were allowed to cure for a number of days in a fume hood until fully hardened.

Once removed from the ice tray, the meniscus that formed at the top of the cube was sanded with 80-grit sandpaper until flat. Each cube was then cut twice to create a thin cross section using a Buehler Isomet microsaw. Cross sections were polished using micro mesh abrasive papers and

121 Resin used was Bioplast catalyzed with a methyl ethyl ketone peroxide.
mounted on microscope slides. \textsuperscript{122} Samples that were not selected for analysis or duplicates were stored in labeled coin envelopes for future reference.

4.4 Techniques of Analysis

All embedded cross sections were first examined in reflected visible light at 100X and 400X magnification using a Nikon Alphaphot-2-YS2 compound microscope. Cross sectional examination aided in gaining a general understanding of the number and character of paint layers and in distinguishing the decorative layer from other painting campaigns. Highly resolved magnification enabled a detailed view of the microstructure, texture, and color of each paint layer. Particle distribution, size, and shape were noted. Cross sections were particularly useful in determining the level of deterioration of some exposed and covered layers.

In an effort to continue to observe the samples' stratigraphies, fluorescence microscopy was used. Cross sectional samples were

\textsuperscript{122} Each sample was polished using 1500, 1800, 2400, 3200, 3600, 4000, 6000, 8000, and 12000 grit aluminum oxide paper and temporarily mounted on slides using double sided tape. This allowed the samples to be removed and repolished when necessary. The samples will be permanently mounted to a glass slide at the end of this research and given to Maxwell Mansion.
examined under reflected quartz halogen illumination with blue-violet fluorescence in a Nikon Alphalot 2-YS2 compound microscope, which has been retrofitted with fluorescence capabilities. Nikon filter block BV-1A for blue-violet fluorescence of excitation wavelength 430-440nm, dichroic 455 nm, and barrier wavelenth of 470nm was used. Fluorescence microscopy made it possible to characterize layers according to their autofluorescence. Since different pigments and binding media display characteristic fluorescence, examination under ultra violet light allowed for preliminary classification of the paint layers. For instance, knowing that zinc oxide pigments fluoresce bright yellow and that they began to be widely used as an alternative to lead white pigment in architectural paint around 1850 enables the general dating of those fluorescing layers. Fluorescence has also been used to examine the ceiling in situ. Materials not visible in normal light often become more apparent with ultra violet

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123 The narrow excitation band minimized autofluorescence while the barrier filter passes all fluorescence wavelengths above 470nm, allowing the detection of fluorochromes in the blue, green, yellow, orange, and red spectral regions. This filter combination is also best suited for use with mercury arc-discharge lamps, which have a prominent spectral line at 436nm. Nikon MicroscopyU: The Source for Microscopy Education. Web.http://www.microscopyu.com/articles/fluorescence/filtercubes/blueviolet/bv1a/bv1aindex.html.

illumination. This allowed for better interpretation of the decolorized patterns on the ceiling.

In addition to distinguishing layers by their autofluorescence, a limited number of fluorochromes were used to observe secondary or auxiliary fluorescence. Stains for tagging proteins or lipids were applied to two cross sections. Fluorescein 5 isothiocyanate (FITC) was selected for characterizing proteins and dichlorofluorescein (DCF) for lipids.

Pigment particles observed during initial microscopic analysis were isolated, prepared as dispersions, and analyzed using polarized light microscopy. Pigment particles were carefully scraped from selected uncast samples using a round-tip X-Acto knife under a Leica stereoscope. A tungsten needle was then used to place the pigment particles on a microscopic slide. The particles were grounded by pressing two slides

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126 Ibid, 168. The two samples studied with fluorochromes are discussed in the findings section of this thesis.
127 A 50µl volume of a 0.1% w/v solution of FITC in anhydrous acetone was applied to sample SB.C.30 to test for protein-containing samples. Any excess material was wiped off. When viewed under ultra-violet light, a bright yellowish-green fluorescence indicates the presence of proteins. A solution of 0.2% w/v DCF in ethanol was made to test for drying oils. In the presence of oil, the fluorescing colors of DCF can range from pink in relatively saturated lipids to a bright yellow in unsaturated lipids.
128 A sample of approximately 50-100µm is sufficient.
together and then covered with a round cover slip and placed over a hot plate to allow the Melt Mount to dissolve into the covered area, dispersing the individual pigment particles. The dispersions were studied under 400X magnification in an Olympus CX31 polarizing microscope. Each sample was viewed under plane and crossed polarized light to determine their refractive indices, birefringence, relief, texture, and opaqueness.

In order to confirm or refute the previous findings, more precise methods of analyses were utilized. Catherine Matsen, Associate Conservation Scientist at the Scientific Research and Analysis Laboratory at the Winterthur Museum assisted with sample preparation and analysis of the binding media and pigments using several instrumental techniques.

Fourier Transform Infrared (FTIR) microspectroscopy was performed on select uncast samples to determine the general composition of natural organic binding media. Sample material was scraped from uncast samples using a stainless steel scalpel while viewed under a

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129 Fourier Transform Infrared microspectroscopy (FTIR) is an instrumental technique that allows for the general classification of natural organic materials such as waxes, proteins, oils, polysaccharides, and resins, and more specifically the identification of synthetic resins, inorganic pigments, and natural minerals. Data was acquired for 128 scans from 4000-650cm-1 at a spectral resolution of 4cm-1. Multiple spectra were collected from different areas within each scraping, which were taken from several bulk samples. Spectra were collected and analyzed using Omnic 8.0 software with various IRUG and commercial reference spectral libraries.
stereomicroscope and placed directly on a diamond cell. A steel micro-roller was used to decrease sample thickness and increase transparency. The samples were analyzed using a Thermo Scientific Nicolet 6700 FT-IR with Nicolet Continuum FT-IR microscope in transmission mode. When testing for oils, the intensity of the spectral graph depends on the state of dryness of the oil, and in well-dried oils the spectral band will be rather small. A sharp carbonyl band at 1750-1740 cm\(^{-1}\) is a clear indicator of oil presence. On the other hand, proteins, composed of amino acid monomeric units derived from animal tissues or their by-product (egg, glue, casein, blood) have distinct spectral bands characterized by the presence of amide I and amide II bands near 1650 and 1550 cm\(^{-1}\), forming a stair-like pattern.

Gas Chromatography Mass Spectroscopy (GC-MS), a more exact method for identification of binding media, was used to confirm the identity of the binder analyzed previously in FTIR. Dr. Christian Petersen, Researcher and Adjunct Associate Professor at the Winterthur/University of Delaware Art Conservation Program, treated uncast samples with MethPrep II reagent to reduce the sample’s molecular weight and make

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131 *Idem.*
the components more volatile.\textsuperscript{133} Samples were analyzed using the Agilent Technologies 7820 gas chromatogram equipped with Agilent 5973 mass selective detector (MSD) and an automatic liquid injector.\textsuperscript{134}

Samples thought to contain proteins were heated for 24 hours at 105°C with approximately 50-100µl 5.5M HCl in a tightly capped, heavy-walled vial.\textsuperscript{135} To eliminate the presence of oxygen or water, the samples were purged with nitrogen during hydrolysis. The samples were then evaporated to dryness with a stream of air. Approximately 50-100µl of silylating reagent was added and then capped and heated at 66°C for one hour and analyzed by GC-MS upon cooling.\textsuperscript{136}

FTIR was also used for identification of inorganic compounds that contain

\textsuperscript{133} Since oils, resins, varnishes, and waxes are composed, in part, of carboxylic acids or esters, MethPrep II reagent was used to convert the carboxylic acids or esters to their methyl ester derivatives. Samples were transferred directly to a heavy-walled glass GC vial to which a solution of 100µl or less of 1:2 MethPrep II reagent (Alltech) in benzene was added. The vials were warmed at 66°C for one hour in a heating block and then removed and allowed to cool.

\textsuperscript{134} A sample volume (splitless) of 1µl was injected onto a 30mx250µm×0.25µm film thickness HP-5MS column (5% phenyl methyl solixane at a flow rate of 1.5ml/minute). The Agilent Technologies G1701EA GC/MSD ChemStation Control software was used with Winterthur RTLMPREP method with conditions as follows: inlet temperature was 320°C (splitless mode) with a nine minute solvent delay. The GC oven temperature program was 55°C for two minutes, then ramped at 10°C/minute to 325°C, followed by a ten minute isothermal period. The transfer line temperature to the MSD (SCAN mode) was 280°C, the source at 230°C and the MS quad at 150°C.

\textsuperscript{135} Pierce Chemical Company; 6N HCl constant boiling, sequenal grade.

\textsuperscript{136} Reagent used was MTBSTFA + 1%TBMCS, Pierce Chemical Co. For preparation method see footnote 91.
Chapter 4: Methodology

complex anions, such as carbonates, sulfates, and silicates. In general, absorption bands for inorganic material are broader and occur at lower wavenumbers than those for organic material due to their external and internal ion composition. Pigments, minerals, and clays often used in works of art are solids in room temperature and consist of a three-dimensional, crystalline lattice structure that restricts many molecular transitions, including some vibrational motions detected by FTIR to produce a spectrum. This can often result in split or "degenerate" vibrational bands. For this reason, data collected by FTIR had to be verified with Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM-EDS) and Raman spectroscopy.

A selection of cross sections were examined in Raman microspectroscopy to validate the identity of the pigments specified in FTIR. Samples were analysed with a Renishaw Invia Raman spectrometer in conjunction with WiRE 3.4 software with extended scans from 200-2200cm⁻¹, 50X objective lens, exposure time of 10 seconds per scan for 5 accumulations, and 1% laser power. SEM-EDS was then used to map the individual elements in

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137 Inorganic compounds that contain simple anions like oxides and sulfides cannot be identified with FTIR. Derrick, 118.
138 Ibid, 114.
139 The Raman spectrometer uses a 785nm diode laser.
the paint layers examined. Chosen cross sections were mounted to an aluminum stub with double-sided carbon tape adhesive. Carbon paint was applied on the side and top surfaces of the casting medium without covering the cross section itself to prevent charging. The samples were analyzed with a Zeiss EVO MA15 scanning electron microscope with LaB$_6$ source at an accelerating voltage of 20kV for the electron beam, stage height at approximately 11mm, and sample tilt of 0°. EDS data was collected with the Burker Nano X-flash detector 630 and analyzed with Quantax 200/ Esprit 1.9 software.

4.5 Color Matching

Once the original color scheme was identified, sections of the ceiling with the least damaged paint were selected for color matching on site. Due to limited availability of time and materials, colors were matched by eye using the Munsell system in order to identify the original colors of the decorative pattern.$^{140}$ Where colors were completely missing or faded, the Munsell color system is comprised of standardized color cards organized in a card catalogue format. Colors are based on a three-dimensional model where each color has three attributes: hue (the color itself), value (lightness to darkness), and chroma (color saturation or brightness). Munsell colors are labeled according to their hue, value, and chroma in a unique alphanumerical code such as 5YR 6/2, where 5 yellow-red is the hue, 6 is the value, and 2 is the chroma. Although the accepted standard for color measurement is typically done with a colorimeter or spectrophotometer, the Munsell system can provide a simple and effective way to communicate specific colors for restoration or reconstruction.
similar historic colors from the same period found elsewhere in the house were used for matching. To achieve the best results, colors were examined under north facing daylight in early afternoon hours. Munsell color chips were held atop the color in question and compared against other variables to provide the best match. The chosen colors were then verified on uncast samples and cross sections using a Leica stereomicroscope and daylight adjusted reflected light at low magnification. In order to generate a digital reconstruction of the ceiling, Munsell notations were converted to RGB model in which red, green, and blue are added together to produce a wide range of colors searchable in Adobe Illustrator.\textsuperscript{141} These RGB colors were compared to color matching results from 1980 in order to form a complete color palette for the ceiling design.

\textsuperscript{141} Munsell notations were converted to RGB with the WallkillColor Munsell Converter program.
5. FINDINGS

Interpretation

The decorative ceiling of the Stevenson Bedroom is unique in its use of elaborately detailed elements to adorn the bedroom, which was still a private living space during this time. An earthy color palette with bright red and salmon-pink accents are in keeping with the suggested color scheme set forth by pattern-books authors. The stylized, geometric pattern of the ceiling was laid by applying an overall stencil pattern relieved with hand painting, as described in the Architects’ Manual of Painting and Decorating of 1891. According to the literature, the original walls of the Stevenson bedroom would have been treated similarly with an overall stenciled pattern in the field, small figures or diaper patterns in the frieze, and stenciled dado topped with a band or “dado rail.” Similar colors would have been repeated on the walls and woodwork to create a harmonious effect with gold ornaments on the dado, freeze, and ceiling. The tripartite wall decoration could have been applied directly with paint or as wallpaper.

Interest in oriental motifs was a precursor to the Centennial exhibit. Yet, it

\[142\] Ibid, 27.
\[143\] Dresser, 23.
was not until Egyptian and Japanese furnishings, textiles, and pottery exhibited in Philadelphia in 1876 that United States citizens, particularly those unable to travel overseas, began to truly appreciate exotic patterns as interior ornaments for their homes. Decorative finishes at Maxwell Mansion clearly illustrate Victorians’ predisposition to live à la mode. It is quite possible that Howard Stevenson visited the Centennial International Exhibit and commissioned a local artist to execute a sophisticated design based on what he had seen.

Results of Scientific Analysis

Given the extensive damage, it is not surprising that the analysis of samples produced inconclusive results. Microscopical examination of cross sections revealed the stratigraphy of the painted scheme. A thick layer of distemper paint appears to be the original layer. A thin layer of size or adhesive material separates the plaster from the distemper. The thin decorative layer is highly disintegrated. Some of the colors recorded in Frank Welsh’s report are no longer visible and those that remain are

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145 This material was not easily retrievable, therefore it was not studied and any information provided is an assumption only. A possible theory is that it is an adhesive used to apply wallpaper on the ceiling during the Maxwell residency. Significant amount of aluminum and silica in this layer suggests this could be an alumina-silicate adhesive, although its application on a distemper ceiling is unclear.
actively flaking. Seven layers of paint covered the decorative layer in the following order: a yellow distemper layer immediately above the decorative painting, followed by a sequence of beige, off white, and light blue paint bound in oil, and two coats of white titanium modern paint.\footnote{These are also speculative based on previous reports and fluorescence microscopy. These layers were mostly scraped off in 1974.} The same sequence was observed on cross sections of the walls and mantel surround.\footnote{Cross sections of the walls and mantel were produced as part of the material seminar course on architectural finishes, HSPV 740, at the graduate program in historic preservation of the University of Pennsylvania in the spring of 2014.}
SEM-EDS analysis on sample SB.C.03 revealed yet another interesting phenomenon. While ultraviolet fluorescence of layer three resembles that of distemper paint, EDS results detected a considerable amount of
titanium in this layer. Given that the two samples examined are of different locations in the ceiling but have fluoresce similarly, it is possible to that all succeeding paint layers are titanium-based. However, the very nature of this ceiling lies in the inconsistencies in strata, therefore the idea that the titanium layer in sample SB.C.03 corresponds to layer six in the image above and that intermediate layers have flaked off cannot be overlooked.

Traces of titanium found in the decorative layer of sample SB.C.17 seem to support that notion. Since the chronology of layers varies throughout the
ceiling, a decisive interpretation of painting campaigns and alterations is a matter of speculation. In this instance, as well as in the sample discussed previously, instrumental analysis points to a modern, titanium-based paint directly applied on the decorative ceiling. This is significant since different paint formations could exacerbate flaking or peeling. Still, further analysis would be required in order to confirm the composition of the modern layers.

Instrumental analysis of cross sections provided information on the composition of the original and decorative layers, the former of which may have been used as a preparatory layer for the application of oil paint or as the original finish layer during the Maxwell tenancy. Raman spectroscopic analysis of this layer confirmed the presence of calcium carbonate, the main component in whiting commonly used in mixing distempers. Raman has also identified the blue pigment consistent in many of the samples as lazurite, of which ultramarine blue is made. Yet, there is no indication of whether this is natural or artificial ultramarine, which became commercially available in 1828.  

Dispersion of pigments in the decorative layer of sample SB.C.13 also revealed the use of ultramarine, derived from the semi-precious stone lapis lazuli.\textsuperscript{149} Used since antiquity, natural ultramarine pigment was expensive and considered a commodity used mainly in opulent commissions. There is no evidence of ultramarine used as a pigment until the beginning of the first millennia.\textsuperscript{150}

Ultramarine particles appear pale to deep blue and are translucent in


Lapis lazuli is a mixture of the blue mineral lazurite with calcite and iron pyrites.

\textsuperscript{150} Idem.
transmitted visible light; they are isotropic and have low refractive index of about 1.50. In crossed polarized light, ultramarine contains birefringent particles of calcite and iron pyrites.\textsuperscript{151} Natural ultramarine is unaffected by heat or alkalis but is decomposed by very dilute acids, a sensitivity often termed “ultramarine sickness,” in which ultramarine pigments turn gray.\textsuperscript{152} When used in oil, ultramarine pigments are subject to darkening as a result of the natural yellowing of the oil medium.

Other pigments identified with Raman spectroscopy are vermilion red and Mars orange, which is a synthetic iron oxide. Vermilion is a red mercuric sulphide (HgS) found in nature as the mineral cinnabar, the primary ore of mercury.\textsuperscript{153} It is a highly toxic, dense pigment with excellent hiding capabilities. Vermilion is known to be quite permanent, but tends to darken if used in tempera or watercolor rather than oil. Mars orange is artificial ochre made by precipitating ferrous sulfate and aluminum sulfate with an alkali or potash, resulting in a mixture of ferric and aluminum hydroxides with gypsum.\textsuperscript{154} The final product is Mars yellow, which upon heating turns to a variety of shades from orange to violet.

\textsuperscript{151} Idem.
McCrone, 1325.
\textsuperscript{152} Gettens and Stout, 166.
\textsuperscript{153} Gettens and Sout, 170.
\textsuperscript{154} Ibid, 129.
Figure 5.6: Dispersion of ultramarine particle seen in transmitted light, photomicrograph by author.

Figure 5.7: Dispersion of ultramarine particle seen in crossed polarized light, photomicrograph by author.
Figure 5.8: Sample SB.C.03 contains vermilion and mars orange pigments on the decorative layer, which is primarily green in color. The identity of the green pigments could not be identified, photomicrograph by author.

The identity of these pigments was confirmed with SEM-EDS analysis of samples SB.C.03 and SB.C.17. Elemental mapping in EDS reaffirmed the presence of titanium in the modern layers, and calcium in the original and decorative layers. Most importantly, all analytical techniques validated the assumption that lead pigments were not used on this ceiling.

Identification of the binder proved more complex. GC-MS of samples SB.C.14 and SB.C.17 confirmed the presence of drying oil markers, such as azelaic, palmitic, and stearic. Drying oils detected in these samples suggest the decorative layer was bound in oil, however it cannot be ruled out that oil binding medium was absorbed into the decorative layer from
later paint applications. Trace levels of proteins detected by the GC are thought to be from the original distemper layer, identified by FTIR. The absence of enough binding medium to be analyzed could be due to extreme oxidation of the oil in the decorative layer.

Since the results of analysis were unsatisfactory, the experiment in painting distemper and oil-bound paint helped determine which binder would be most appropriate for this type of decoration. The fast drying rate of the distempers required the use of a hot plate to reheat the gelatin between applications. This would be extremely inconvenient in a large-scale application. Distempers also proved to have very poor workability, confirming solid wall painting as the best application for this method. Oil-based paints, on the other hand, produced a more prominent color scheme and allowed for more precise rendering of details. When comparing distemper and oil painting tests, it seems unlikely that distempers would have been used. Oil paints are easier to prepare, possess better workability, are opaque and more enduring.
Figure 5.9: Mockup by author of a detail illustrating the different working characteristics of distemper and oil paints.

Because many of the remaining paint colors were missing or sufficiently damaged to prevent color matching, Munsell notations from the 1980 paint analysis by Frank Welsh were consulted. These references to color were used in conjunction with current colors to interpret change in the paint and provide a more comprehensive color palette for the ceiling. Examination of corresponding RGB colors to Munsell notations revealed a darkening effect of the paint. Where an exact match was not found, the closest color in RGB was used.

Where an exact match was not found, the closest color in RGB was used.
Nevertheless, the complete color palette is consistent with popular color choices of the Victorian era; the muted colors would have created a dramatic effect on the bedroom ceiling.

Paint analysis of the walls, doors, and windows conducted during the 2014 Interior Finishes Seminar, a requisite for the University of Pennsylvania’s master of historic preservation, provided a broader understanding of the relationship between the finishes on the ceiling and elsewhere in the room. Cross sectional analysis of samples from the walls and mantel revealed a similar stratigraphy to that of the ceiling, indicating that the walls were either scraped prior to repainting, or were never painted. Literature from the period reaffirms the possibility that the walls were wallpapered, although further analysis is required to confirm the residue of a size or adhesive on the walls. Analysis of the mantels confirmed the original faux marble scheme. A restored mantel from the library exhibits similar colors and could be used as a reference when treating the mantel in the Stevenson bedroom.

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156 The darkening seen in color matching results is only speculative. Color matching with the Munsell Color System is not a scientific method and is subjective to the eye of the beholder.
Figure 5.10: Color matching results from 2014 and those determined by Frank Welsh in 1980 showing the darkening of colors over the last thirty years, *illustration by author.*
Condition Assessment Findings

Assessment of the current condition of the ceiling revealed conditions that have compromised the integrity of the plaster and paint. Based on this assessment, approximately 90 percent of the ceiling is affected by either structural or superficial deterioration.

A network of orthogonal cracks greater than one quarter of an inch thick of varying orientations and depths has formed on the ceiling. These cracks are typically associated with acute deformation and deflection. Cracks that run the length of the ceiling are invariably corresponded with displacement of the plaster on either side of the crack. This is particularly true where cementitious renders were applied during previous interventions. A sub-network of interconnected minor or micro cracks apparently formed as a result of secondary detachment, key failure, or thermal movement. Cracks commencing on the west and north walls, which are more prone to water infiltration and fluctuation of relative humidity exhibit signs of biocolonization.\textsuperscript{157}

Two plaster repairs on the northeastern corner and western edge of the

\textsuperscript{157} The presence of biological activity is based solely on visual observation and should be verified prior to commencing any treatment.
ceiling were correlated to water infiltration and excessive dead loads originating in the attic and roof. Examination of the attic space directly above the Stevenson bedroom revealed severe cracking and failed repairs on the northeast corner, and wall-to-wall shelving units supporting China sets on the western wall, generating tremendous weight on the already compromised ceiling. A major crack along the border of the repair suggests that vibrational and shear movements have continued to occur after these repairs were completed.

Two types of detachment were noted in the condition survey: detachment of the plaster from the lath and intralayer detachment of the plaster itself. Cracking patterns and deformation suggest that many of the keys are broken or missing. The arrangement of cracks fragmented the ceiling into loosely bound plaster plates, significantly increasing the risk for complete detachment. This is also manifested in the deflection of many sections of the ceiling, particularly those adjacent major cracks.

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158 This hypothesis would have to be confirmed by removing some of the floorboards in the attic and examining the wooden lath from above.
The above-mentioned conditions have had a degenerative effect on the decorative painting. Sections of the ceiling immediately adjacent to the exterior walls, which are subject to more sunlight and moisture, have lost
most of the original design. Where the design is still present, soiling and flaking paint make the interpretation of details and color quite challenging. Sampling campaigns have left a series of marks on the ceiling, often removing the last trace of certain colors. Moreover, several samples taken during the 1970s and 80s were so large that they have become nesting places for biological activity.

Figure 5.12: Detailed images of deterioration, including large holes from sampling, flaking paint, and loss of original design, *photos by author.*
6. **CONCLUSIONS AND RECOMMENDATIONS**

6.1 **Conclusions**

Identification of the binding media in the pictorial layer was not resolved due to an insufficient amount of material for testing. Jaap van der Weerd outlined in a study titled “FTIR Studies of the Effects of Pigments on the Aging of Oil” the effects of certain pigments on the aging of drying oils, specifically the causative alteration of infrared spectra analysis.\(^{159}\) This quantitative analysis revealed that certain pigments can cause shifting and broadening of the carbonyl band due to the formation of carboxylic acids and catalysis of the hydrolysis of triglycerides.\(^ {160}\) For example, spectrum of thirty-year old vermilion paint showed that vermilion is not absorbed in the mid infrared region but cause “extensive scattering” while iron oxide spectra showed a strong absorption at 1000cm\(^{-1}\) wavenumber.\(^ {161}\) These shifts in spectral peaks could account for the absence of indicators of drying oil in the FTIR analysis conducted for this research.

Since only a small amount of drying oils was detected with GC-MS, it is not


\(^{160}\) Idem.

\(^{161}\) Ibid, 5-6.
possible to authenticate the binding medium at this time. Severe losses are noticeable on approximately ninety percent of the ceiling and any salvageable material is actively flaking and extremely friable. This caused difficulties not only in the sampling process, but also in the isolation of layers for testing and extraction of enough material for GC analysis. Further testing of larger, well-isolated samples will be required to confirm the binding media of the decorative layer as oil-based.

The aforementioned losses are manifested in severe structural and cosmetic defects. Given the rigorous scratch marks from previous interventions, solubility of the exposed polychromatic paint film, and comparison of distemper and oil painting techniques during the paint testing, it is believed that this layer was bound in oil, but the indelicate removal of subsequent paint layers in the past and continual exposure over the last thirty years have caused the oil media to deteriorate. Additional FTIR and Raman analyses are recommended in order to identify other pigments used in the decorative painting.

Schematically, the polychromed ceiling was one of possibly three decorative designs; the first from the Maxwell tenancy consisting of rectangular features in pastel shades of tan and blue, a second scheme
which is the focus of this study, and a third involving a dichromatic pattern of rich shades of gray and blue, likely dating from the turn of the century. While there is little evidence of an original decorative scheme, blue, tan, and yellow colors observed in the original layer of several cross sections suggests that such a pattern existed. On-site examination verified the third sequence through a series of blue and gray lines observed on the north quadrant. In addition, tan and blue colors appear in some of the cross sections, implying their presence only in certain locations was intentional.

Figure 6.1: Succession of colors in the third decorative scheme on the ceiling of the Stevenson Bedroom, including two shades of blue, tan, and gray, photo by author.

There is not enough evidence in the walls to sustain any hypotheses, however archival research disclosed several possibilities. Given that
exposure of some of the walls revealed no original material, and that wallpaper engulfed the walls of the first story, it is believed that the original walls of the Stevenson bedroom were wallpapered as well. Confirmation of adhesive on the walls is necessary to validate this theory. Another possibility is that a solid distemper layer was applied on the walls and removed prior to subsequent paint applications. Regardless, any remnants of the decorative schemes on the walls, including that corresponding to the decorative layer in the ceiling, were removed before the entire room was painted yellow.

Howard Stevenson’s original intent celebrated oriental influences in its use of exotic motifs and a serene yet somber color palette. Although bedrooms were still seen as private entities in the latter half of the 19th century, the detailed ornamentation on the walls, ceilings, and woodwork throughout the second story were certainly a spectacular sight. Where decoration differed dramatically from room to room, Stevenson united the spaces by carrying certain motifs and colors from one space to the next, which was extremely useful in determining the original appearance of the ceiling design.
6.2 Recommendations

Preservation Philosophy

Devising an appropriate treatment plan for interior finishes required careful consideration of the interior’s historical significance and physical condition. Given that the primary goal of this research was to determine the original appearance of the decorative design and that a treatment plan will not be implemented in the foreseeable future, recommendations focus on the feasibility of execution and alternative means of interpreting the space, relying on all available sources.

Recommendations for treatment of the decorative ceiling are twofold; first, structural elements supporting the ceiling must be stabilized. This includes the plaster since its detachment poses a risk to visitors. Secondly, a decision of whether to preserve or restore the decorative design must be made.

According to the Secretary of Interior’s Guidelines for the Treatment of Historic Properties, a preservation plan focuses on the retention of all historic fabric through conservation and maintenance. In this case, the ceiling would be conserved in its current state, allowing visitors to witness the effects of aged paint on the overall design. Restoration, on the other
hand, establishes the most significant time in the building’s history and allows for the removal of material from later periods.¹⁶²

Treatment Plan

Prior to implementing a treatment plan, the conservator must become familiar with the historic paints, their method of preparation, and issues that might arise as a result of previous interventions or deteriorative conditions affecting the stability of the ceiling. Exhaustive inspection of the condition of the lath by removing floorboards from the attic would inform adequate techniques for structural stabilization. No work on the decorative ceiling should be made until all structural elements are sound. Repairs to roof leaks and windows should also be made at this time.

Conservation

Conservation treatment for the decorative ceiling requires the following: (a) Repair of any damage to the structural system of ceiling and roof (b) stabilization of the plaster-to-lath contact and intra-layer detachment, (c) cleaning of the decorative paint layer, including the removal of dirt, biological growth, and remaining overpaint, (d) filling large losses caused

by previous interventions and sampling campaigns, and (e) protecting
the surface to prevent further deterioration of the plaster and paint film.

In-depth assessment of the condition of the exterior walls and roof directly
above the room will help determine the best course of treatment for
structural stabilization. An appropriate system of support, replacement,
and consolidation will need to be devised to secure the structure and
plaster.

Due to the delicate nature of the paint, flaking and powdery paint would
have to be re-adhered and consolidated prior to cleaning. This is not
always the best method, since dirt can often get permanently attached
to the paint through the consolidation process. A tremendous variety of
consolidants exists for the re-adhesion of loose paints. Tests for different
cleaning methods are the best way to determine the appropriate method
for use on this ceiling. Adhesives are used to penetrate the pores in the
paint film and create one intact entity. However, care must be given to
retaining the color and opacity of the paint, which is often dependant on
the porosity of the film.

Areas of loss can be filled with a compatible material, such as calcium-
based mortar made of lime or gypsum, or a similar material. Analysis of the plaster composition can inform the most adequate material for this application.

Restoration and Interpretation

The decorative ceiling of the Stevenson bedroom is a tremendously valuable decorative feature of the house, significant for its high craftsmanship and intricate design. While the level of sophistication is often associated with more affluent residences and civic institutions, this ceiling stands alone in presenting stylistic preferences of the prosperous middle class of the period.

Interpretation of this space in its current state must be based on fragments of a once dazzling design. Several approaches were considered to develop a comprehensive plan that would be economically viable while also recovering the ceiling’s original aesthetic character.

The first method involves the restoration of a wall-to-wall passage on the ceiling to emphasize the drastic difference between the damaged and freshly applied paint. As an educational tool, this method provides insight into deteriorative mechanisms imparted on the design, contrasted by the
intricacies of restoring such a dilapidated surface. This method offers a unique opportunity to showcase a compromised ceiling design in its authentically aged state. Restoration of one passage on the ceiling is also a more manageable technique of interpretation that does not require funds for a full-fledged restoration. This technique requires more precise methods for color matching, such as colorimetry, in order to ensure the authenticity of the design. Color matching with both Munsell and CIE L*a*b* notations matched to standardized modern color swatches by Benjamin Moore or Sherwin Williams would offer the opportunity to illustrate the color palette easily.

The second and third methods focus on more immediate ways of interpretation not requiring extensive conservation work. These methods are centered on a digital reconstruction of the decorative scheme using CAD, Adobe Illustrator and Photoshop. By converting Munsell notations to RGB, the main color system used in Adobe programs, a schematic representation of the original appearance of the ceiling was developed, as illustrated in figure 6.2. Since Illustrator utilizes vector data, the illustration can be enlarged to fit the size of the ceiling.
Figure 6.2: Digital reconstruction of the decorative scheme using AutoCAD and Adobe illustrator.

The digital illustration can be showcased in one of two ways: A full-scale print on canvas of the design can be adhered to the surface of the ceiling utilizing a reversible glue, which also consolidates the flaking paint and prevents further deterioration. Since structural problems are typically
the main source for plaster deformation, repair of structural malformations will prevent plaster movement in the future. The canvas will reinforce the plaster and cover any imperfections. Since so little historical fabric survives, this traditional method of repairing plaster is the most suitable, and provides a stable base to showcase the ceiling in its original grandeur.

The second option is to project the image from a desired position in the room to cover all or some of the ceiling. A projection allows the tour guide to incorporate the ceiling into public programming. Visitors will be able to witness the ceiling in its magnificence, and then experience the ceiling in its deteriorative state— a privilege not easy to come by. While more economical, this technique of interpretation does not offer any protection for the ceiling or the decorative design.

While both cases provide an absolute view of the schematic ceiling, the integrity of the plaster and paint must be considered as well. Moreover, decisions regarding the conservation of this ceiling should be sensitive to restoration efforts elsewhere in the room and the house. Whether to restore this room to complement other surfaces in the house or conserve it in its current state is a critical point in the decision making process, and
one that should not be taken lightly. Whereas one interpretation method provides cohesion and flow between all of the rooms of the house, the other presents a unique opportunity to showcase the ceiling as a complex accretion of cultural stylistic preferences and individual spirits that have left a mark on the built environment.

The Venice Charter specifies restoration as “a highly specialized operation [meant] to preserve and reveal the aesthetic and historic value of the monument based on respect of original material and authentic documents [and] must stop at the point where conjecture begins.”¹⁶³ Yet, absence of physical and archival evidence of interior ornamentation in middle-class residences is a common problem. It limits interpretation of the space and challenges decision makers to weigh the merits and liabilities of meeting the strict requirements of authenticity on the one hand versus expanding beyond site-specific evidence to allow for an informed interpretation on the other. This warrants the question of authenticity versus speculation, and how much supporting evidence is required to authenticate such speculations.

The decorative ceiling at Maxwell Mansion posed a stimulating dilemma. With over ninety percent of the color palette missing and not enough material evidence to authenticate the binding media, this thesis utilized a variety of sources to devise a treatment plan for the ceiling. Although conjectural in a sense, recommendations provided in this thesis incorporate raw data to create an authentic representation of a late 19th century interior, contributing to the historic interpretation of the site. The comprehensive approach to the research and conservation of the ceiling in the Stevenson bedroom proved that the integration of data from all available sources enables the reconstruction of a scheme. Although not authentic to the space in its entirety, is an accurate representation of the stylistic and technological aspects that influenced its design.
Figure 6.3: Digital reconstruction of the Stevenson bedroom utilizing SketchUp and Illustrator to showcase the finishes throughout the room.
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Atheneaum of Philadelphia
219 S. 6th Street
Philadelphia, PA 19106

Archives of Ebenezer Maxwell Mansion
200 West Tulpehocken Street
Philadelphia, PA 19144

Philadelphia Historical Commission
576 City Hall
Philadelphia, PA 19107
APPENDIX A
MASTER SAMPLE LIST AND
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<td>SB.C.26</td>
<td>JS</td>
<td>2/7/14</td>
<td>Dark brown</td>
<td>North Quadrant</td>
<td>Microscopy/Dark Brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SB.C.27</td>
<td>JS</td>
<td>2/7/14</td>
<td>Bright blue</td>
<td>North Quadrant</td>
<td>Microscopy/Bright Blue</td>
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<tr>
<td>SB.C.28</td>
<td>JS</td>
<td>2/7/14</td>
<td>Green-blue</td>
<td>North Quadrant</td>
<td>Microscopy/Green-blue</td>
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<td>SB.C.29</td>
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<td>2/7/14</td>
<td>Light gray</td>
<td>North Quadrant</td>
<td>Microscopy/Light Gray</td>
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<td>SB.C.30</td>
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<td>2/7/14</td>
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<td>North Quadrant</td>
<td>Microscopy/Dark Gray</td>
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<tr>
<td>SB.C.31</td>
<td>JS</td>
<td>2/7/14</td>
<td>Dark blue-green background</td>
<td>North Quadrant</td>
<td>Microscopy/Dark Blue-Green</td>
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<tr>
<td>SB.C.32</td>
<td>JS</td>
<td>2/7/14</td>
<td>Cornice-band 1</td>
<td>South Quadrant</td>
<td>Microscopy/Cornice</td>
<td></td>
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<tr>
<td>SB.C.33</td>
<td>JS</td>
<td>2/7/14</td>
<td>Cornice-band 2</td>
<td>South Quadrant</td>
<td>Microscopy/Cornice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SB.C.34</td>
<td>JS</td>
<td>2/7/14</td>
<td>Cornice-band 3</td>
<td>South Quadrant</td>
<td>Microscopy/Cornice</td>
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<td></td>
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<tr>
<td>SB.C.35</td>
<td>JS</td>
<td>2/7/14</td>
<td>Cornice-band 4</td>
<td>South Quadrant</td>
<td>Microscopy/Cornice</td>
<td></td>
<td></td>
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<tr>
<td>SB.C.36</td>
<td>JS</td>
<td>2/7/14</td>
<td>Cornice-band 5 (near wall)</td>
<td>South Quadrant</td>
<td>Microscopy/Cornice</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
South Quadrant Sample Locations

SB.C.01. Dark red border of inner circle  
SB.C.02. Blue-green inner circle  
SB.C.03. Yellow-green inner circle  
SB.C.04. Maroon inner circle  
SB.C.05. Green sage  
SB.C.06. Edge bright yellow  
SB.C.07. Orange outline  
SB.C.08. Mauve floral motif  
SB.C.09. Darkish green border near cornice  
SB.C.10. Yellow palm leaf  
SB.C.11. Maroon line motif  
SB.C.12. Beige background  
SB.C.14. Off white top coat  
SB.C.32. Cornice-band 1 (near ceiling)  
SB.C.33. Cornice-band 2  
SB.C.34. Cornice-band 3  
SB.C.35. Cornice-band 4  
SB.C.36. Cornice-band 5 (near wall)
SB.C.15. Dark green inner circle
SB.C.16. Grey inner circle
SB.C.17. Maroon inner circle
SB.C.18. Mauve floral motif
SB.C.19. Green-brown motif
SB.C.20. Dark green palm leaf border
SB.C.21. Orange floral motif
SB.C.22. Maroon geometric border
SB.C.13. Dark blue
SB.C.23. Light blue inner circle
SB.C.24. Maroon inner circle
SB.C.25. Sage green
SB.C.26. Dark brown border
SB.C.27. Bright blue
SB.C.28. Blue-green line
SB.C.29. Light grey background
SB.C.30 Dark grey background
SB.C.31. Dark blue-green background
APPENDIX B
MICROSCOPIC AND INSTRUMENTAL ANALYSIS
**SB.C.01**

**Location**

Visible UV

Sample Location: Dark red border inner circle

**Substrate** Plaster

**Camera** Nikon DS-Fi1

**Illumination** Reflected Quartz Halogen, Ultraviolet BV 1A

**Microscope** Nikon Alphaphot-YS2

**Magnification** 400X

**Data Analyzed** 23 January 2014

**Analyzed by** Johanna Sztokman
SB.C.02

Location

Visible

UV

Green decorative layer

Light blue original layer

Size layer

Plaster substrate

Sample Location  | Dark blue-green located in inner circle | Substrate  | Plaster
Camera         | Nikon DS-Fi1                  | Illumination | Reflected Quartz Halogen, Ultraviolet BV 1A
Microscope     | Nikon Alphaphot-YS2          | Magnification | 400X
Data Analyzed  | 23 January, 2014             | Analyzed by   | Johanna Sztokman
SB.C.03

Location

Sample Location | Yellow-green located in inner circle | Substrate | Plaster
--- | --- | --- | ---

Camera | Nikon DS-Fi1 | Illumination | Reflected Quartz Halogen, Ultraviolet BV 1A
--- | --- | --- | ---
Microscope | Nikon Alphaphot-YS2 | Magnification | 400X
--- | --- | --- | ---
Data Analyzed | 23 January, 2014 | Analyzed by | Johanna Sztokman
--- | --- | --- | ---

Comments:
Stratigraphy of this sample confirmed the yellow paint covering much of the design does not pertain to the original decorative scheme.
SB.C.04

Location

Visible

UV

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Maroon located in inner circle</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td>Magnification</td>
<td>400X</td>
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<tr>
<td>Data Analyzed</td>
<td>23 January, 2014</td>
<td>Analyzed by</td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>
SB.C.05

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Sage green</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td>Magnification</td>
<td>100X</td>
</tr>
<tr>
<td>Data Analyzed</td>
<td>23 January, 2014</td>
<td>Analyzed by</td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>

**Comments:**
Due to the difficulty in achieving a successful cross sectional representation of the sage green background, all samples of this color were analyzed in ultraviolet microscopy.
SB.C.06

Location

Visible UV

Sample Location

Substrate

Camera

Nikon DS-Fi1

Microscope

Nikon Alphaphot-YS2

Illumination

Reflected Quartz Halogen, Ultraviolet BV 1A

Magnification

400X

Data Analyzed

23 January, 2014

Analyzed by

Johanna Sztokman

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Bright yellow edge</th>
<th>Substrate</th>
<th>Plaster</th>
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</thead>
<tbody>
<tr>
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<td>Nikon DS-Fi1</td>
<td><strong>Illumination</strong></td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td><strong>Magnification</strong></td>
<td>400X</td>
</tr>
</tbody>
</table>

Plaster substrate

Yellow modern layer

Yellow original layer

Size

SB.C.06
S. QUADRANT
EDGE BRIGHT YELLOW

Bright yellow edge

23 January, 2014

Analyzed by Johanna Sztokman
SB.C.07

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Orange outline- geometric semi-circular bands</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Illumination    | Reflected Quartz Halogen, Ultraviolet BV 1A     | Magnification | 400X     |
|                 |                                                  |             |         |
| Data Analyzed   | 23 January, 2014                                | Analyzed by | Johanna Sztokman |

**Comments:**
Yellow modern paint incorporated in the decorative layer suggests the design was compromised prior to subsequent paint applications.
**SB.C.08**

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Mauve floral motif</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td>Magnification</td>
<td>400X</td>
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<tr>
<td>Data Analyzed</td>
<td>23 January, 2014</td>
<td>Analyzed by</td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>
**SB.C.09**

**Location**

Visible

UV

- White modern layer
- Green decorative layer
- Light tan original layer
- Size
- Plaster substrate

**Sample Location**  Border near cornice - darker green  **Substrate**  Plaster

**Camera**  Nikon DS-Fi1  **Illumination**  Reflected Quartz Halogen, Ultraviolet BV 1A

**Microscope**  Nikon Alphaphot-YS2  **Magnification**  400X

**Data Analyzed**  23 January, 2014  **Analyzed by**  Johanna Sztokman
SB.C.10

Location

Visible

UV

Yellow modern layer

Tan original layer

Plaster substrate

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Yellow palm leaf</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
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<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td>Magnification</td>
<td>400X</td>
</tr>
<tr>
<td>Data Analyzed</td>
<td>23 January, 2014</td>
<td>Analyzed by</td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>
SB.C.11

Location

Visible

Visible

UV

Maroon decorative layer

Light blue original layer

Size

Plaster substrate

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Maroon line motif</th>
<th>Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td>Plaster</td>
</tr>
<tr>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
<td></td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td></td>
</tr>
<tr>
<td>Magnification</td>
<td>400X</td>
<td></td>
</tr>
<tr>
<td>Data Analyzed</td>
<td>23 January, 2014</td>
<td></td>
</tr>
<tr>
<td>Analyzed by</td>
<td>Johanna Sztokman</td>
<td></td>
</tr>
</tbody>
</table>

Comments:
Large inclusions of vermilion and iron oxide pigments were found in the decorative layer.
SB.C.12

**Sample Location**  |  Beige background  |  **Substrate**  |  Plaster
---|---|---|---
**Camera**  |  Nikon DS-Fi1  |  **Illumination**  |  Reflected Quartz Halogen, Ultraviolet BV 1A
**Microscope**  |  Nikon Alphaphot-YS2  |  **Magnification**  |  400X
**Data Analyzed**  |  23 January, 2014  |  **Analyzed by**  |  Johanna Sztokman

**Comments:**
This sample does not represent the full strata of decorative schemes. It appears the decorative paint in this area was completely deteriorated before the yellow was applied.
**SB.C.13**

**Sample Location**
Dark blue

**Substrate**
Plaster

<table>
<thead>
<tr>
<th><strong>Camera</strong></th>
<th>Nikon DS-Fi1</th>
<th><strong>Illumination</strong></th>
<th>Reflected Quartz Halogen, Ultraviolet BV 1A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microscope</strong></td>
<td>Nikon Alphaphot-YS2</td>
<td><strong>Magnification</strong></td>
<td>400X</td>
</tr>
</tbody>
</table>

**Data Analyzed**
23 January, 2014

**Analyzed by**
Johanna Sztokman

**Comments:**
Pigments were scraped from this sample for polarized light microscopic analysis.
SB.C.14

Sample Location    Off white top coat

<table>
<thead>
<tr>
<th>Camera</th>
<th>Nikon DS-Fi1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
</tr>
<tr>
<td>Magnification</td>
<td>100X</td>
</tr>
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<td>Data Analyzed</td>
<td>2 February, 2014</td>
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Analyzed by Johanna Sztokman
**SB.C.15**

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Dark green- inner circle</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Camera</strong></td>
<td>Nikon DS-Fi1</td>
<td><strong>Illumination</strong></td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td><strong>Microscope</strong></td>
<td>Nikon Alphaphot-YS2</td>
<td><strong>Magnification</strong></td>
<td>400X</td>
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<tr>
<td><strong>Data Analyzed</strong></td>
<td>2 February, 2014</td>
<td><strong>Analyzed by</strong></td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>

Yellow original layer

Green decorative layer

Plaster substrate

Size

Visible

UV
SB.C.16

**Location**

Visible UV

**Sample Location**

<table>
<thead>
<tr>
<th>Grey inner circle</th>
<th>Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaster</td>
<td></td>
</tr>
</tbody>
</table>

**Camera**

Nikon DS-Fi1

**Illumination**

Reflected Quartz Halogen, Ultraviolet BV 1A

**Microscope**

Nikon Alphaphot-YS2

**Magnification**

400X

**Data Analyzed**

<table>
<thead>
<tr>
<th>Analyzed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>
SB.C.17

Location

Sample Location | Maroon inner circle | Substrate | Plaster
--- | --- | --- | ---
Camera | Nikon DS-Fi1 | Illumination | Reflected Quartz Halogen, Ultraviolet BV 1A
Microscope | Nikon Alphaphot-YS2 | Magnification | 400X
Data Analyzed | 2 February, 2014 | Analyzed by | Johanna Sztokman

Visible

UV

Yellow modern layer
Green decorative layer
Red decorative layer
Light tan original layer
Size
Plaster substrate
SB.C.18

Sample Location | Mauve floral motif | Substrate | Plaster
--- | --- | --- | ---
Camera | Nikon DS-Fi1 | Illumination | Reflected Quartz Halogen, Ultraviolet BV 1A
Microscope | Nikon Alphaphot-YS2 | Magnification | 400X
Data Analyzed | 2 February, 2014 | Analyzed by | Johanna Sztokman
SB.C.19

Location

Visible

UV

Green decorative layer

Yellow original layer

Plaster substrate

Comments:
Although the decorative layer is hardly visible in this cross section, the color of the distemper layer could indicate the layout of an original design.
SB.C.20

**Location**

N

Visible UV

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Dark green- palm leaf border</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td>Magnification</td>
<td>400X</td>
</tr>
<tr>
<td>Data Analyzed</td>
<td>2 February, 2014</td>
<td>Analyzed by</td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>
**SB.C.21**

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Orange floral motif</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td>Magnification</td>
<td>400X</td>
</tr>
<tr>
<td>Data Analyzed</td>
<td>2 February, 2014</td>
<td>Analyzed by</td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>

- **Location**
- **Visible**
- **UV**
- **Orange decorative layer**
- **Light tan original layer**
- **Size**
- **Plaster substrate**
SB.C.22

Sample Location | Maroon geometric border | Substrate | Plaster
--- | --- | --- | ---
Camera | Nikon DS-Fi1 | Illumination | Reflected Quartz Halogen, Ultraviolet BV 1A
Microscope | Nikon Alphaphot-YS2 | Magnification | 400X
Data Analyzed | 2 February, 2014 | Analyzed by | Johanna Sztokman
SB.C.24

Sample Location  | Maroon inner circle  | Substrate  | Plaster
---|---|---|---
Camera  | Nikon DS-Fi1  | Illumination  | Reflected Quartz Halogen, Ultraviolet BV 1A
Microscope  | Nikon Alphaphot-YS2  | Magnification  | 400X
Data Analyzed  | 2 February, 2014  | Analyzed by  | Johanna Sztokman
SB.C.25

Sample Location | Sage green | Substrate | Plaster
--- | --- | --- | ---
Camera | Nikon DS-Fi1 | Illumination | Reflected Quartz Halogen, Ultraviolet BV 1A
Microscope | Nikon Alphaphot-YS2 | Magnification | 400X
Data Analyzed | 2 February, 2014 | Analyzed by | Johanna Sztokman
**Sample Location**

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Dark brown border</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Camera</strong></td>
<td>Nikon DS-Fi1</td>
<td><strong>Illumination</strong></td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td><strong>Microscope</strong></td>
<td>Nikon Alphaphot-YS2</td>
<td><strong>Magnification</strong></td>
<td>400X</td>
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<tr>
<td><strong>Data Analyzed</strong></td>
<td>2 February, 2014</td>
<td><strong>Analysed by</strong></td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>
**SB.C.27**

**Sample Location** | Bright blue | **Substrate** | Plaster
---|---|---|---
**Camera** | Nikon DS-Fi1 | **Illumination** | Reflected Quartz Halogen, Ultraviolet BV 1A
**Microscope** | Nikon Alphaphot-YS2 | **Magnification** | 400X
**Data Analyzed** | 2 February, 2014 | **Analyzed by** | Johanna Sztokman
SB.C.28

Comments:
This sample illustrates the strata of modern layers, however is lacking two titanium white layers applied over the blue.
SB.C.30

Location

Visible

UV

White modern layer

Off white modern layer
Tan modern layer

Yellow modern layer

Brown decorative layer
Yellow original layer
Yellow Preparatory layer

Comments:
The distinctive fluorescence of the original and decorative layers of this sample were not observed anywhere else and would have to be further analyzed to determine their identity.
SB.C.31

Location

Visible

UV

Off white modern layer
Green decorative layer

Light blue original layer

Size
Plaster substrate

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Dark blue-green background</th>
<th>Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Nikon DS-Fi1</td>
<td></td>
</tr>
<tr>
<td>Illumination</td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
<td></td>
</tr>
<tr>
<td>Microscope</td>
<td>Nikon Alphaphot-YS2</td>
<td>Magnification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400X</td>
</tr>
<tr>
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<td>Analyzed by</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>
**SB.C.33**

**Location**

**Visible**

**UV**

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Cornice band 2</th>
<th>Substrate</th>
<th>Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Camera</strong></td>
<td>Nikon DS-Fi1</td>
<td><strong>Illumination</strong></td>
<td>Reflected Quartz Halogen, Ultraviolet BV 1A</td>
</tr>
<tr>
<td><strong>Microscope</strong></td>
<td>Nikon Alphaphot-YS2</td>
<td><strong>Magnification</strong></td>
<td>100X</td>
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<tr>
<td><strong>Data Analyzed</strong></td>
<td>2 February, 2014</td>
<td><strong>Analyzed by</strong></td>
<td>Johanna Sztokman</td>
</tr>
</tbody>
</table>

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*Image and table content describing the sample location, substrates, and analysis details.*
INSTRUMENTAL ANALYSIS
Fourier Transform Infrared Spectroscopy

SB.C.14
INSTRUMENTAL ANALYSIS
Fourier Transform Infrared Spectroscopy

SB.C.17

[Graph showing infrared spectroscopy results]
Comments:
SEM-EDS detected a significant presence of mercury, which appears lighter in the backscattered image, confirming the use of vermilion red pigment in the decorative scheme.
SB.C.03

Comments:
Elemental mapping of the decorative layer identified silica and alumina, which correspond to large particles of ultramarine blue. Titanium was detected in the modern layer.
INSTRUMENTAL ANALYSIS
Scanning Electron Microscope with Energy Dispersive Spectroscopy

SB.C.17
SB.C.17

Comments:
A significant amount of iron found in the decorative layer corresponds to Mars orange, an artificial ochre.
INSTRUMENTAL ANALYSIS
Raman Spectroscopy
SB.C.14
Instrumental Analysis
Raman Spectroscopy

SB.C.17

REFERENCE SPECTRUM mangan (MgO)
REFERENCE SPECTRUM calcite (CaCO3)
Instrumental Analysis
Raman Spectroscopy

SB.C.17
Instrumental Analysis
Gas Chromatography Mass Spectroscopy

SB.C.14

[Image of a graph or data presentation related to gas chromatography mass spectrometry.]
INSTRUMENTAL ANALYSIS
GAS CHROMATOGRAPHY MASS SPECTROSCOPY

SB.C.17

Abundance

TIC: SBC14Protein.D\data.ms

Time→
APPENDIX C
Condition Survey
## Condition Glossary

<table>
<thead>
<tr>
<th>Definition</th>
<th>Graphic</th>
<th>Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Cracking</strong></td>
<td><img src="image1.png" alt="graphic" /></td>
<td><img src="image2.png" alt="schematic" /></td>
</tr>
<tr>
<td>Cracks larger than 1/4” at varying orientations and depths, often occurring at acute angles as result of settlement and stress.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minor/ Micro Cracking</strong></td>
<td><img src="image3.png" alt="graphic" /></td>
<td><img src="image4.png" alt="schematic" /></td>
</tr>
<tr>
<td>Cracks smaller than 1/4” at varying orientations in the matrix of the plaster, resulting in loss of mechanical properties and breakage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Deflection</strong></td>
<td><img src="image5.png" alt="graphic" /></td>
<td><img src="image6.png" alt="schematic" /></td>
</tr>
<tr>
<td>Movement of detached plaster segments as a result of stress, particularly near major cracks, commonly indicative of broken keys.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Severe Detachment from Lath</strong></td>
<td><img src="image7.png" alt="graphic" /></td>
<td><img src="image8.png" alt="schematic" /></td>
</tr>
<tr>
<td>Failure of the scratch coat resulting in complete separation of the plaster from the lath.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Slight Detachment from Lath

Failure of the scratch coat resulting in partial separation of the plaster from the lath.

Intralayer Detachment

Separation of base and fine coats due to improper mixing or job conditions during application, or general weakening of the scratch coat.

Crack Overfill

Cementitious render used to fill major cracks.

Patching

Repairs or alterations to existing plaster, often with incompatible materials, resulting in complete loss of decorative design.

Presence of Decorative Design

Areas of moderate to high retention of the original design, either in shape or color.
Flaking Paint

Loss of flexibility and adhesion of the paint film, resulting in the physical separation of paint flakes from the substrate.

Biocolonization

Zones of biological activity resultant from infiltration of water and moisture through the walls and roof.

Damage from Previous Interventions/ Sample Locations

Indentations on the surface, usually 0.25”-0.5”, created by the extraction of material for sampling.
**Condition Mapping**

All Conditions. A breakdown of conditions according to structure, substrate, and surface follows.
Condition of Structure

Scale 1 1/2” = 1’0”

Major Craking

Deflection
Condition of Substrate

- Minor Cracking
- Severe Detachment
- Slight Detachment
- Intralayer Detachment
- Crack Overfill
- Patching

Scale 1 1/2” = 1’0”
**Condition of Surface**

- **Presence of Design**
- **Flaking Paint**
- **Biocolonization**
- **Sample Locations**

Scale 1 1/2” = 1’0”
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