

5-2017

# Choices of Contention: Decision Making Factors Leading to the Substitute Method Over In-Kind Repairs and Their Effectiveness at Lyndhurst Estate

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CHOICES OF CONTENTION: DECISION MAKING FACTORS LEADING TO THE  
SUBSTITUTE METHOD OVER IN-KIND REPAIRS AND THEIR  
EFFECTIVENESS AT LYNDHURST ESTATE

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A Thesis  
Presented to  
the Graduate School of  
Clemson University and College of Charleston

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In Partial Fulfillment  
of the Requirements for the Degree  
Master of Science  
Historic Preservation

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by  
Kirsten Anne Freeman  
May 2017

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Accepted by:  
Dr. Carter Hudgins, Committee Chair  
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## ABSTRACT

Lyndhurst Mansion, located in Tarrytown, New York is a masterpiece of American Gothic Revival architecture designed by Alexander Jackson Davis beginning in 1838. Since its acquisition by the National Trust in 1961, the property has carried out a number of repairs to the mansion and other buildings on the estate in which a substitute material was chosen over an in-kind material. Financial constraints appear to be the driving force behind these decisions. Other factors, durability of materials and preservation philosophy, also played a role. An aim of this thesis is to determine the role these factors played in choosing methods and materials used in these repairs. Another aim is to assess the success of the substitute method compared to in-kind repair. Research conducted in Lyndhurst's archives as well as interviews with current and past employees provided narrative data regarding the decision making process, while assessment of five case studies provided insight into the effectiveness of the decisions. Findings concluded that cost often outweighed the other considerations when choosing a repair method and materials. Substitute materials at Lyndhurst proved overall to be inferior to those of an in-kind replacement. The findings serve as an example of the financial challenges facing many historic sites.

## ACKNOWLEDGMENTS

Thanks to the entire staff of Lyndhurst for making me feel at home and appreciated during my internship. I am very grateful for a wonderful experience living and working on a beautiful site with remarkable buildings to admire and learn from. Thank you to Krystyn Hastings-Silver for your support, advice and for helping me reach this topic. A very special thank you to Thomas Richmond for bending over backwards to accommodate my access and information needs for this thesis, your knowledge and expertise helped me tremendously. Also, thank you to Eric Clingen and David Overholt for providing further information on repairs, the content for this thesis would have been insufficient without your willingness to help.

Thank you to my thesis committee, Carter Hudgins and readers Frances H. Ford and Stephanie Crette for helping me reach the full potential for this thesis. Thank you to Amalia Leifeste, for taking the time to meet and work through life-cycle cost scenarios with me multiple times even though you were not part of my committee. Thank you to the MSHP class of 2017 for making the last two years memorable. A special thanks to Jen Baehr, Cassie Cline and Caroline Darnell for making me laugh and keeping me sane throughout this process.

Lastly, thank you to my family and friends for your encouragement. To my mom and dad, thank you reading and providing feedback on parts of my thesis and for always supporting me in what I do.



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## CHAPTER ONE

### INTRODUCTION

Historic properties across the country grapple daily with the problems of keeping a significant building standing and in good condition. This can be difficult when financial limitations factor into the decisions of what needs to be done. Many historic buildings used methods of construction and materials which can be particularly costly to replicate and repair. Occasionally, architectural conservation means making changes to the historic fabric and introducing non-original materials when the funding for replicating original materials and methods is lacking. Lyndhurst Estate faces these challenges. Lyndhurst's mansion represents one of the most important American houses, yet it faces economic limitations much like those faced by other house museums nationally.

Since its acquisition of Lyndhurst in 1961, the National Trust for Historic Preservation has carried out numerous repairs on the mansion and other buildings on the estate. While most of these repairs can be described as normal maintenance, other more ambitious projects were necessary to ensure structural and aesthetic integrity of the buildings. Some of these projects resulted in the use of substitute materials rather than replacing historic fabric with in-kind materials. Monetary constraints appear to have driven decisions to use new methods and new materials. Doing nothing would have almost certainly resulted in further damage. The five case studies using substitute repairs are: historic mortar replaced with portland cement on the mansion, marble

replaced with cast concrete on the mansion, wooden finials replaced with cast polyurethane finials, glass replaced with corrugated aluminum paneling on the swimming pool building and wooden decorative brackets replaced with cast polyurethane brackets inside the bowling alley.

The use of substitute materials is a course of action that is not without controversy. This thesis traces the deliberations and discussions that preceded decisions at Lyndhurst to use substitute materials in a series of repairs to the mansion and two of its supporting buildings, the bowling alley and swimming pool building. Five case study conservation projects examine the role that preservation philosophy, material durability, and cost played in the conservation decisions at Lyndhurst. These case studies indicate that cost outweighed other considerations. The case studies also indicated that substitute materials proved inferior to in-kind replacements.

### History of Lyndhurst

Lyndhurst Estate is located in Tarrytown, New York, in the Hudson River Valley just north of New York City. Three families owned the property before the National Trust for Historic Preservation acquired it in 1961. Elements of the property and buildings changed according to the families' particular tastes as well as the styles of the time. William Paulding, former mayor of New York City originally owned the property. Paulding worked with architect Alexander Jackson Davis to design a country villa and a romantic park-like setting that surrounded it in 1838. The house, then called the

“Knoll,” was designed in the Gothic Revival style, a departure from the styles of most of the houses built at the time (See Figure 1.1).<sup>1</sup> A local resident named Philip Hone said this of the house in a diary entry dated July of 1841:

In the course of our drive we went to see Mr. William Paulding’s magnificent house, yet unfinished, on the bank below Tarrytown. It is an immense edifice of white or gray marble, resembling a baronial castle, or rather a Gothic monastery, with towers, turrets, and trellises: minarets, mosaics, and mouse-holes; archways, armories, and airholes; peaked windows and pinnacled roofs, and many other fantastics too tedious to enumerate, the whole constituting an edifice of gigantic size, with no room in it; great cost and little comfort, which, if I mistake not, will one of these days be designated as ‘Paulding’s Folly.’<sup>2</sup>

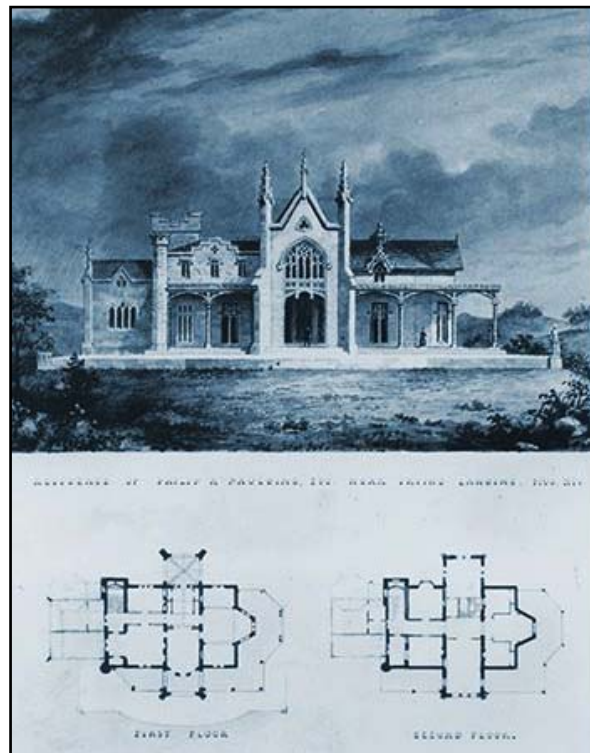


Figure 1.1: West elevation of Knoll, 1838 (Courtesy of Lyndhurst website).

<sup>1</sup> Lyndhurst, “History,” *Lyndhurst*, Lyndhurst Estate, <http://www.lyndhurst.org/about/history/> (accessed September 22, 2016).

<sup>2</sup> Edna Donnell, “A.J. Davis and the Gothic Revival”, *Metropolitan Museum Studies* 5, no. 2 (1936): 206-207.

The villa did not end up being a folly, instead it would in the future be regarded as a masterpiece of American architecture. In 1864, Davis doubled the cottage in size for new owner George Merritt, transforming it into the mansion that stands today (See Figure 1.2). An addition constructed on the north end included an impressive tower. Merritt renamed the house Lyndenhurst in reference to the linden trees that he planted on the property. Later, when the Gould family purchased the property, the estate was simply referred to as Lyndhurst.



Figure 1.2: West elevation of Lyndhurst, 1864-1865 (Courtesy of Lyndhurst website).

Jay Gould purchased the property in 1880 for use as a summer home. The Gould family owned the house the longest and their association with it is the source of much



of its historical significance. Jay Gould was a railroad developer who had gained control of Western Union Telegraph, New York Elevated Railway and Union Pacific Railroad at the height of his career. Gould was also notoriously known as one of New York's infamous robber barons. Gould used the property as a retreat from the city, especially when his health took a turn for the worse and he developed tuberculosis. Gould left the property to his daughter Helen, who, after her death in 1938, left it to her sister Anna. Anna, Duchess of Talleyrand-Perigord, took care of the estate until her death in 1961, then willed it to the National Trust for Historic Preservation.<sup>3</sup>

### Gothic Revival Style

The beginning of the Gothic architectural style reaches back to medieval Europe. The emergence of Gothic as a movement of the Romantic style began in the early eighteenth century, departing from the dominant classical aesthetic that ruled Europe at the time. This revival style was extravagant and whimsical, quite a change from the order and symmetry in the architecture before it. After about thirty years, however the style took a more serious turn and was highly influenced by the aesthetic ideals of English architect, A. W. N. Pugin who designed the Palace of Westminster. Religious principles and righteousness in design defined Gothic Architecture during this time.<sup>4</sup>

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<sup>3</sup> Lyndhurst, "History," *Lyndhurst*, Lyndhurst Estate, <http://www.lyndhurst.org/about/history/> (accessed September 22, 2016).

<sup>4</sup> Kathleen Mahoney, *Gothic Style* (New York: Harry N. Abrams, 1995), 10-11.

In America, the style began in the eighteenth century and started to fade away in the late nineteenth century. Shifting away from the conservative Colonial styles, the young nation had no historical style resources to pull from, so looked to England. America, still very much established in its puritanical values, made Gothic style a hard sell. Experimentation in design was encouraged in the Gothic revival style, although it veered more toward the picturesque than the whimsical design seen in Europe. The style itself is characterized by high vaulted ceilings and is known for the incorporation of light, usually flooding dramatically through stained glassed windows. Decorative details include pinnacles, turrets, tracery, crenellations and crockets. Architect Alexander Jackson Davis and landscape designer Alexander Jackson Downing adopted the style early on, becoming the trailblazers of the Gothic revival style in America. The two often exchanged ideas and worked together, even collaborated on three different books on architecture.<sup>5</sup>

### Alexander Jackson Davis

Considered one of the most innovative architects of his day, Alexander Jackson Davis began as an artist, differing from most architects of the time who had started as builders.<sup>6</sup> Having only a grammar school education, he eventually ended up studying at John Trumbull's art school, where he excelled at drawing and painting with watercolor.

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<sup>5</sup> Ibid, 167-168, 174.

<sup>6</sup> Amelia Peck, *Alexander Jackson Davis: American Architect 1803-1892* (New York: Rizzoli, 1992), 9.

Then in 1827, he became an architectural draftsman and opened an office in New York City. During this time, he did a number of illustrations for various publications. For about fifteen years, he partnered with another architect in New York in a firm called Town and Davis, before deciding to work independently.

Davis was versatile, working in the Tuscan, Classical and Swiss styles of the day and invented the American bracketed style. It is in the Gothic Revival style however, that he is considered to be a true pioneer in this country.<sup>7</sup> Although he designed a variety of buildings over his career such as universities, hotels, civic buildings and warehouses, it was private residences that made up the majority of his commissions.

### The National Trust for Historic Preservation

The creation of the National Trust for Historic Preservation occurred in 1949 after charter by Congress and was signed into public law by President Harry S. Truman.<sup>8</sup> Changes taking place in the United States after World War II helped in prompting the creation of the organization. This was a period of growth and hope, with the government and general public focused on building a better America. Development of suburban regions and highways, as well as the redevelopment of urban areas was rapid during this time. The destruction and replacement of the American architectural and

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<sup>7</sup> Donnell, "A.J. Davis and the Gothic Revival," 194.

<sup>8</sup> Robert E. Stipe, *A Richer Heritage: Historic Preservation in the Twenty-First Century* (Chapel Hill, NC: UNC Press, 2003), 322.

cultural legacy took place as a result of pursuing these changes, however.<sup>9</sup> In 1966, the National Trust was instrumental in shaping the National Historic Preservation Act, which produced the Advisory Council on Historic Preservation and built upon the National Register of Historic Places. Today the organization is viewed as the torchbearer of the private historic preservation movement. Its publication *Preservation News* (now *Preservation Magazine*), has been a paramount source of information on the developments in the field since its initial release in the 1960s.

With initiatives over the years such as the Main Street program, the HOPE Crew program and Preservation Green Lab, it has continued to stay relevant and knowledgeable on the up to date issues in preservation. The most successful and recognized of these programs has been the Main Street program, which was started in 1980 with the aim of revitalizing the downtown areas of cities and towns. This revitalization combined strategies such as renovation that is sensitive to the history of the location, business assistance, local funding and quality designs.<sup>10</sup> Statistics collected between 1980 and 2008 indicated that the program was among the top tools for economic development in the nation.<sup>11</sup> Other contributions included unmatched preservation programs over the years, such as consultation services, periodical and technical publications and regional conferences. Seminars have also been important

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<sup>9</sup> Elizabeth D. Mulloy, *The History of the National Trust for Historic Preservation*, (Washington DC: The Preservation Press, 1976), 3.

<sup>10</sup> Henry G. Cisneros, "Preserving Everybody's History", *Cityscape*, (1996): 87.

<sup>11</sup> Facca, Amy E., and J. Winthrop Aldrich. "Putting the Past to Work for the Future." *The Public Historian* 33, no. 3 (2011): 42.

for the development of preservation professionals, such as the Seminar on Preservation and Restoration cosponsored by Colonial Williamsburg in 1963. This seminar was extremely important due to its examination of the present state of preservation and the effectiveness of its efforts when looking toward the future.<sup>12</sup>

The National Trust originally received some funding from Congress, but funding over the years decreased until 1998 when it stopped altogether.<sup>13</sup> Even when receiving Congressional funding, repair and maintenance expenses routinely surpassed the financial resources of the Trust. Because of this, creative use of resources was often the solution and continues to be. Currently, the National Trust has a collection of twenty-seven museum properties under its care. As one of these properties, Lyndhurst raises its own operating costs from the endowment it receives, admission costs, donations and various other sources. Unfortunately, there is not always enough money to perform needed repairs. In the past, Lyndhurst has held events and programs to raise the funding needed to aid in maintenance costs for the property, such as wine tasting parties and auctions.<sup>14</sup> Today, these events are still common, as well as income from weddings, movie shoots, on site concerts and even rental of space in the greenhouse. These sources of income help make ends meet for Lyndhurst. They are by no means a major funding source to get every repair on the property taken care of promptly and consummately, however.

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<sup>12</sup> Mulloy, *The History of the National Trust for Historic Preservation*, 68.

<sup>13</sup> Stipe, *A Richer Heritage*, 325.

<sup>14</sup> Mulloy, *The History of the National Trust for Historic Preservation*, 149 & 155.

## Restoration Workshop

The National Trust for Historic Preservation created the Restoration Workshop in 1973 with the goal of establishing a training program for craftsmen to fill the widening void of skilled tradespeople resulting from modern building practices of the time.

Conceived by the National Trust, the program began with the idea that it could serve as a mutually beneficial undertaking for participants and the organization. Advantages for the Trust included a way to free their properties from outside contracts and the costly work that came along with it. Workshop participants received essentially an apprenticeship with on-the-job training at historic sites, under the supervision of an expert in the craft. The topic of restoration training had been circulating in preservation organizations such as the Trust and the National Park Service after the National Historic Preservation Act of 1966, but had yet to be implemented. Lyndhurst was the first property owned by the National Trust to accommodate the program. Given the variety of buildings on the property and number of repair opportunities, Lyndhurst seemed like an ideal place to try the program out.<sup>15</sup>

The first ten years of the program focused on the apprenticeship model, with the initial goals being to, “perform high quality restoration/preservation work on National Trust properties, and to train men and women to be restoration/preservation artisans with the necessary skills to carry out the work themselves. A third goal, was to develop new techniques for solving restoration problems and to disseminate such information to

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<sup>15</sup> Wesley Haynes, “The Restoration Workshop: A Plan for the Nineties,” (Report and Plan, Department of Stewardship of Historic Properties, National Trust for Historic Preservation, 1987), 4.

the preservation community.”<sup>16</sup> After this period however, the focus seemed to shift towards using the workshop for outside contracting jobs mainly on local historic buildings often owned by historical societies and eventually to National Register properties. Supporters of this shift found it to be great source of revenue outside the property system and thought it was good for participants to learn something of the business world. Some viewed this shift negatively, holding that the primary objective should be the work on National Trust properties and rewards and skills gained from an apprenticeship.

With the training component dwindling due to unestablished ways in providing for increasing outside contracts, the program no longer appealed to qualified apprentices. Eventually conclusions were made that work that was being carried out on the Trust properties could be done at an equal or lower cost by local contractors. The properties were also beginning to question why they should have to pay for training that ultimately ended with a lot of the journeymen abandoning the system. All work on properties of the National Trust by the Restoration Workshop therefore ceased in the mid 1980s.<sup>17</sup>

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<sup>16</sup> Ibid, 6.

<sup>17</sup> Ibid, 9, 11, 19, 12.



Figure 1.3: Restoration workshop participants, 1970s (Lyndhurst Archives).

### Definition of Terms: In-Kind vs. Substitute

The terms ‘in-kind’ and ‘substitute’ can be heard regularly in relation to repairs and replacements made to a historic building’s fabric. Although these are fairly common terms to hear and read in historic preservation publications and in the field, it is difficult to find an official definition in scholarly writings. A definition of in-kind can be found in Martin Weaver’s *Conserving Buildings: A Manual of Techniques and Materials* when describing the replacement of old timber. Weaver explains that, “Such repairs are usually referred to as ‘replacements in-kind.’ This term is often misused or not understood in all its implications.”<sup>18</sup> Within preservation it is understood ‘in-kind’ refers

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<sup>18</sup> Martin E. Weaver, *Conserving Buildings: A Manual of Techniques and Materials* (New York, NY: John Wiley & Sons, Inc., 1997), 40.



to the same material as the original. Weaver takes this further with replacement of timber by pointing out that the old and new wood should even match according to the criteria of: species, quality (first growth or second growth), cut (quarter sawn or flat sawn or mixed), color, grain direction and figure pattern, tool marks and finish.<sup>19</sup>

Merriam-Webster dictionary lists 'substitute' as a noun with the definition, "a person or thing that takes the place or function of another."<sup>20</sup> In the realm of preservation this means material other than that of the original. Often it is used with synthetic or non-traditional materials, but does not necessarily have to fall under this category.

### Introduction to Methodology

In order to examine this topic, it was necessary to access the archives of Lyndhurst and look through documents, photographs, proposals and correspondence for information. Research and analysis occurred for those specific projects falling into the confines of repairs using the substitute method. Project repairs using substitute materials included replacing failing stone with cast concrete, wooden finials and brackets with cast polyurethane, a glass roof on the swimming pool building with a corrugated metal one and straying from the original mortar mixture when re-pointing masonry. Interviews of Lyndhurst's past and present employees, as well as others who might have been involved in a project occurred when no written records or

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<sup>19</sup> Ibid.

<sup>20</sup> Merriam-Webster, "substitute," Merriam-Webster Dictionary, <http://www.merriam-webster.com/dictionary/substitute> (accessed January 14, 2017).

documentation existed for a specific project. Each such project was examined from a conservation perspective to assess the intent behind it and the impact it has had on the building. The projects were also examined for replaceability and weathering. Upon doing this, conclusions could be drawn as to whether or not the project was successful. Lastly, decision making factors were researched and analyzed. Decision making factors included cost, material durability for both original and substitute materials and preservation philosophy.

#### Significance of Topic

In analyzing the projects that Lyndhurst has undergone, evaluation of effectiveness of materials and methods may aid in providing to a wider knowledge of potential impacts on the physical structure and interpretation of historic buildings. Another important contribution of this topic would be the examination of the preservation community's moral views on what is right and what is wrong when dealing with historic building conservation issues. The use of substitute materials is often a result of the costs associated with repairs and the difficulty in finding the right craftsman to do the job well. Because of this, the substitute approach will often be considered by those who cannot pay for the ideal in-kind repair. More attention to this reality by the preservation community might be useful to provide cautionary advice and best practices for those that do choose this approach. Although this is by no means the model of approach to promote if one has the choice and financial means, it may be

better to educate rather than assume every repair will be done correctly and by set standards. Lastly, because this approach of repair is mainly seen as a last resort, it is not often studied and therefore this thesis might bring attention to the topic and add to a larger conversation in preservation.

## CHAPTER TWO

### LITERATURE REVIEW

#### General Historic Preservation Philosophy

The philosophy of historic preservation can be traced back to strong opinions formed in the nineteenth century Europe and most likely existed even before these noted cases. Theory of the treatment of historic buildings cannot be discussed in totality without the mention of two individuals with strong convictions on the subject. Eugène Emmanuel Viollet-le-Duc of France and John Ruskin of England.

Viollet-le-Duc was a French architect and theorist who was outspoken in his views of the proper care of medieval monuments. One of his most well-known theories called “stylistic restoration,” was controversial at the time and remains controversial today. This theory stated, “To restore an edifice means neither to maintain it or repair it, nor rebuild it; it means to reestablish it in a finished state which may in fact never have existed at any given time.”<sup>21</sup> He believed that an architect had the right and even a responsibility to replace original fabric that might be considered subordinate or to add to that fabric in the interest of providing a more complete presentation of a style or work. This view has attracted many critics since then, some saying that he bent others work to his own personal aesthetic preferences.

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<sup>21</sup> Steven W. Semes, *The Future of the Past: A Conservation Ethic for Architecture, Urbanism, and Historic Preservation* (New York: W. W. Norton & Company, 2009), 117.

Viollet-le-Duc is most famous for redesigning parts of Notre-Dame Cathedral in Paris which had been damaged during the French Revolution. He designed and rebuilt the spire on the cathedral and greatly elaborated on what the original model would have been. The statuary on the west elevation of the cathedral that had been damaged by mobs were also replaced under his supervision. Those against his alterations declared that his changes were a falsification of the historic building. Today there seems to be mixed feelings about Viollet-le-Duc, with some people totally against his actions and the ideals he stood for while others feel he is misunderstood and had good intentions. After the precedent set by this influential thinker, the preservation approach in France stayed more in the vein of a comprehensive view with the uninterrupted form being more important than the preservation of the material components. In fact, many of the chateaux and churches one sees today in France had at least some replacement material incorporated with the historic fabric.<sup>22</sup>

There was a very different theory than that of Viollet-le-Duc emerging in England around the same time. At the head of this particular view was John Ruskin who saw the destruction and alteration of historic buildings as blasphemous. He declared that restoration was nothing more than “a destruction accompanied with false description of the thing destroyed.” Ruskin’s view held that we had no right to touch and alter those objects and buildings that were designed and built by others. He insisted that the only way to honor these historic buildings was by using the non-interventionist approach,

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<sup>22</sup> Semes, *The Future of the Past*, 117-12.

which basically would not allow any intervention beyond maintenance.<sup>23</sup> Follower of Ruskin and fellow 'anti-scrape' movement supporter William Morris, created the Society for the Protection of Ancient Buildings, founded in 1877. The society released a manifesto in which it advised to "resist all tampering with either the fabric or the ornament of the building as it stands; if it has become inconvenient for its present use,... raise another one rather than alter or enlarge the old one."<sup>24</sup> Together, Ruskin and Morris introduced principles that are still in use today. For example, they stated that any new material introduced to a historic structure must differentiate from that of the original. This seemingly contradictory preservation reasoning notifies those who see it that a change has been made. While this practice is pretty widely accepted in the preservation world, some do argue that this takes away from seeing an object or building as complete.

The approach Ruskin developed in the "anti-scrape" movement has largely stood the test of time and some of its aspects have been widely adopted in preservation circles. There remains some criticism however, pointing out that such a limited view fails to take into account all the different conditions of historic buildings. One standard to be applied to every building seems to some critics a way to ensure that most buildings fall to ruin and destruction.<sup>25</sup>

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<sup>23</sup> Ibid, 122-123.

<sup>24</sup> David Lowenthal, *The Past Is a Foreign Country* (Cambridge, UK: Cambridge University Press, 1999), 280.

<sup>25</sup> Semes, *The Future of the Past*, 123.

In 1964 the Venice Charter, one of the most influential documents pertaining to modern global preservation was composed. The Venice Charter was based on the 1931 Athens Charter, but expanded the outlined conservation and restoration approaches. The document was created in response to some of the horrific practices used in the postwar reconstruction happening across Europe, both of monuments and cities.<sup>26</sup> It expresses that “People are becoming more and more conscious of the unity of human values and regard ancient monuments as a common heritage. The common responsibility to safeguard them for future generations is recognized. It is our duty to hand them on in the full richness of their authenticity.”<sup>27</sup> The charter emphasizes that replacements of any lost materials must “integrate harmoniously with the whole,” while being distinguishable from the historic materials. It also states that demolition, modification or any kind of new construction that would alter such characteristics as color and mass will not be allowed.<sup>28</sup> Overall, the document is closely related to the Ruskin-Morris ideals that came before it, while rejecting those ideals more closely related to Viollet-le-Duc. In terms of criticism associated with the Venice Charter, some have thought it silly that using salvaged materials from a bombed building constitutes a

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<sup>26</sup> Ibid, 135.

<sup>27</sup> Second International Congress of Architects and Technicians of Historic Monuments, *International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter 1964)*, [https://www.icomos.org/charters/venice\\_e.pdf](https://www.icomos.org/charters/venice_e.pdf) (accessed September 23, 2016), 1.

<sup>28</sup> Ibid, 2-3.

violation of the charter, when many of these buildings were in fact restored and reconstructed using this very method in the past.<sup>29</sup>

The most authoritative set of guidelines for the field of historic preservation in the United States is the Secretary of Interior's Standards, which can be described as, "common sense historic preservation principles in non-technical language."<sup>30</sup> These standards were created as best practices aimed at ensuring the protection of the cultural resources of the nation. After the passing of the National Historic Preservation Act in 1966, the Secretary of Interior was tasked with establishing standards to be used by professionals when preserving historically significant properties. After a series of steps leading up to this, eight general standards were finally created in 1976. These standards were to apply to the established treatments with some additional standards for specific treatments. In producing these standards, a number of sources were examined and consulted, including the National Park Service administrative procedures, policies of the American Institute of Architects and the Venice Charter of 1964.<sup>31</sup> Then in 1977, the *Secretary of Interior's Standards for Rehabilitation* was drafted as an aid to Tax Reform Act of 1976 in terms of preservation projects included under the act. The purpose of the act was to issue tax incentives for privately owned National Register

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<sup>29</sup> Semes, *The Future of the Past*, 136.

<sup>30</sup> National Park Service, "Technical Preservation Services: The Treatment of Historic Properties," National Park Service, <https://www.nps.gov/tps/standards.htm> (accessed January 14, 2017).

<sup>31</sup> National Park Service, "Technical Preservation Services: A History of The Secretary of Interior's Standards," National Park Service, <https://www.nps.gov/tps/standards/history-of-standards.htm> (accessed January 14, 2017).



properties that rehabilitated their buildings.<sup>32</sup> After a series of variations and revisions on the *Standards of Rehabilitation*, in 1995 the *Secretary of Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings* was developed to further provide recommendations for what should and should not be done to a historic property.

In terms of restoration, there are different concepts and recommendations than the other treatment categories in the *Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*. The National Park Service defines restoration as, “the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period.” In total, there are ten standards listed for the restoration of historic buildings. One standard says that features and materials that are from the period of restoration should be retained and preserved, while removal or alteration of these should not be done. Other notable standards stress documentation if work is needed to stabilize or conserve materials. Materials used in repairs are required to be visually and physically compatible, while distinguishable when inspected closely. It is suggested in the standards that fine examples of craftsmanship marked by prominent construction techniques, features and materials that help to characterize the period of restoration

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<sup>32</sup> Semes, *The Future of the Past*, 137.

should be preserved. Another important standard is number six which states, “Deteriorated features from the restoration period will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials.” Finally, one of the other striking standards states that missing features on a building that are replaced shall be done only when they are substantiated with evidence such as physical or documentary proof.<sup>33</sup>

#### Historic Preservation Philosophy Related to Substitution Methods

The alteration and replacement of historic fabric has deep roots in history with differing views on what was the proper method in doing so. Again, this clearly goes back to the nineteenth century, to the French school of Viollet-le-Duc vs. the English school of Ruskin and Morris. The anti-scrape movement called for those modern day alterations to be made to stand out from the original materials. This approach called for differentiation of colors and textures between the new and the old. Notable historian David Lowenthal examined this in his influential book *The Past is A Foreign Country*, stating a drawback of this movement was that, for some, it “detracted from the aura of antiquity... destroyed its unity of character.” Lowenthal further pointed out that at the time when the book was written (in 1985) the approach had become more balanced,

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<sup>33</sup> National Park Service, “Technical Preservation Services: Standards for Restoration,” <https://www.nps.gov/tps/standards/four-treatments/treatment-restoration.htm> (accessed January 14, 2017).

with the new integrating more with the old. This integration in appearance was such that only an expert would be able to differentiate the two. He pointed out that restoration, “still generates passionate dispute”<sup>34</sup> among those in the field of preservation. Generally however, when it comes to the larger public, they love reconstructions and restorations as it helps them to better draw meaning and interpret the site they are visiting.<sup>35</sup>

Lowenthal describes duplicates or facsimiles as products that aim to reproduce esteemed relics. He puts duplicates into “three distinct types: copies imitating existing or lost originals; forgeries pretend to be the originals; replicas reproduce well-known prototypes in other locales.”<sup>36</sup> Although this process can also be controversial, it is not all that uncommon, especially in cases meant to protect originals. Examples of this are common in Europe and sometimes in the United States, where replicas that are displayed for public view while the originals are kept safely elsewhere to avoid any harm that might come to them. Another positive view of the production of duplicates holds that if it is produced in the same way as the original, it is no less authentic. On the other hand, negative views of this practice point out that all replicas although trying to mimic that authenticity ultimately fail because they lack the actual history of being at a specific

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<sup>34</sup> Lowenthal, *The Past Is a Foreign Country*, 280.

<sup>35</sup> *Ibid*, 280-282.

<sup>36</sup> *Ibid*, 290.

place at a specific time. It is also not seen as desirable since replicas may “persuade us that antiquities should look complete and ‘new’.”<sup>37</sup>

When it comes to copies, Lowenthal says they “Like duplicates...celebrate or call to mind aspects of the past; unlike duplicates, they aim at no strict fidelity to their models, and often intentionally depart from them in scale, materials, dimension, or form.”<sup>38</sup> In pointing out the negatives of copies, Lowenthal said that copies lead to mass production which leads ultimately to the loss of the original’s significance. Lowenthal further said that inaccessibility and undersupply are what sets a masterpiece apart from a cliché. Although, this can be seen as a negative result from the use of copies, there also seems to be good things that copies of a work can provide us. An example being that a copy of an original work can bring it to the attention of those who would not otherwise be able to see it in person or not have the chance to travel and see it in its context, such as with a piece of art in a museum or a specific building on a site.<sup>39</sup>

As for a more recent view on the use of replicas, Tyler insists that well done restoration should make every attempt at using the original element, even if it may be in an inferior condition. A replica he argues, is not the way to go, especially if the replication is based purely on speculation and no real documentation. If there is no evidence of the original composition, it should not be included at all. He refers to Viollet-le-Duc when bringing up this point, reinforcing the idea that his practices are still

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<sup>37</sup> Ibid, 291, 293.

<sup>38</sup> Ibid, 301.

<sup>39</sup> Ibid, 306-307.

controversial today.<sup>40</sup> Tomlan seems to have mixed feelings about replication especially when in the form of reconstruction, saying it, “often has the least authenticity because it depicts an historical period using new materials.” However, he then defends reconstructions like that of Colonial Williamsburg, because of its useful educational role.<sup>41</sup>

On why we change the past, Lowenthal says that “we alter the past to become a part of it as well to make it our own,”<sup>42</sup> but notes that mainly we alter it because we desire to improve it. As his chapter on changing the past comes to a close however it is clear that he is very much against we as humans trying to alter it to our wants and needs, “Enlarged or diminished, embellished or purified, lengthened or abbreviated, the past becomes more and more a foreign country, yet also increasingly tinged with present colors. But in spite of its modern overlay the altered past retreats from the present more rapidly than the untouched past, and suffers earlier extinction. Only the continual addition of more recent history prevents the past we revise from becoming marooned in ever remoter antiquity.”

Preservation briefs put out by the National Park Service are highly regarded by preservation professionals seeking guidance on various issues. Preservation Brief 4, published in 1978, covers the topic of roofing for historic buildings. On the subject of

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<sup>40</sup> Norman Tyler, Ted J. Ligibel Ph D, and Ilene R. Tyler. *Historic Preservation: An Introduction to Its History, Principles, and Practice* (New York: W. W. Norton & Company, 2009), 195.

<sup>41</sup> Michael A. Tomlan, *Historic Preservation: Caring for Our Expanding Legacy* (New York: Springer, 2014), 237.

<sup>42</sup> Lowenthal, *The Past Is a Foreign Country*, 331.

substitute materials used in replacing historic elements of roofing, it says that it can be considered if the portion of the roof being replaced is not visible from the ground. This practice is also applied to the case for finding the right craftsman who will be able to effectively reproduce the historic details; if no one is going to be able to see it, there is no need to spend additional money. If absolutely necessary, the brief stated it is also allowable only if the substitute material is a very close match to that of the original.<sup>43</sup>

In Preservation Brief 16: The Use of Substitute Materials on Historic Building Exteriors, written in 1988, the topic is examined due to a rise in the use of substitution materials in architecture during this time. Recognizing that it was happening in preservation, the National Park Service states that in “limited circumstances” it can be considered an acceptable practice. There are many cautionary notes in the brief however, such as the issue of the loss of integrity if one carries the practice too far.<sup>44</sup> It also pointed out that repairs are always preferable to replacement, regardless if the replacement is a synthetic substitute or an in-kind material. The brief lists four circumstances that would justify the use of substitute materials, “1) the unavailability of historic materials; 2) the unavailability of skilled craftsmen; 3) inherent flaws in the original materials; 4) code-required changes (which in many cases can be extremely

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<sup>43</sup> Sarah M. Sweester, “Preservation Brief 4: Roofing for Historic Buildings,” National Park Service, Department of Interior, 1978, <https://www.nps.gov/tps/how-to-preserve/briefs/4-roofing.htm> (accessed October 1, 2016), 6-7.

<sup>44</sup> Sharon C. Park, “Preservation Brief 16: The Use of Substitute Materials on Historic Building Exteriors,” National Park Service, Department of the Interior, 1988, <https://www.nps.gov/tps/how-to-preserve/briefs/16-substitute-materials.htm> (Accessed October 1, 2016), 1.

destructive of historical resources).”<sup>45</sup> Cost is also listed as a determining factor, but does not make it to the final list of circumstances according to the author. Another take away from the best practices given in the brief was that substitution repairs should be planned and executed in such a way that if failure of the substitute material occurred, it would not affect the historic material around it. It was also necessary that documentation be a part of the process, as this would serve as a record for future owners and ensure maintenance and the appropriate care of the materials going forward.<sup>46</sup>

Reinforcing the belief that the substitution method was common in the 1980’s, Thomas Fisher’s *The Sincerest Form of Flattery* directly pointed to its application as a reflection of cost or rarity of original materials. He notes that there was a stigma associated with the practice, but it happened just the same. At the time, it was also apparently a requirement that substitution materials look like the original; rejecting the notion that changes must be differentiated from the original materials.<sup>47</sup> Mary Dierickx went in an unexpected direction when she advocated for the use of substitution, encouraging the replacement of wood with another species of wood as another perspective on what constitutes in-kind vs. substitute. She argued that, “Wood, even a different species, has similar properties, saves the structural and ornamental system,

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<sup>45</sup> Ibid, 3

<sup>46</sup> Ibid, 8

<sup>47</sup> Thomas Fisher, “The Sincerest Form of Flattery,” *Progressive Architecture*, Published November 1985, 1.

and encourages the continuation of the carpentry craft.”<sup>48</sup> She listed her own set of circumstances in choosing substitution materials, “Special circumstances dictate the choice of substitute materials: the type of system being repaired; the extent of the repair; how much money there is to spend; and how much maintenance will be given to the building in the future.”<sup>49</sup> Finally, John Fidler took on the topic in 1982 in *Glass-Reinforced Plastic Facsimiles in Building Restoration* and then again in 2002 with *Plastic Dreams: Weathering of Glass-Reinforced Plastic Facsimiles*. In both pieces Fidler was clearly against the use of the substitution method, reasoning that integrity was lost through the falsification of historical material and also that substitute materials were innately inferior in every other way.<sup>50</sup>

### History of Substitution Method

The history of substitution can be traced all the way back to the first century B.C. in Rome. The Temple of Vesta, also known as the Round Temple by the Tiber had ten of its twenty Corinthian columns replaced one-hundred and fifty years after it was built. These columns were replaced using a slightly different marble and with a variation in design so as to distinguish the old from the new.<sup>51</sup> During the Middle Ages it was not an

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<sup>48</sup> Mary B. Dierickx, “Substitute Materials for Wooden Buildings: The System or the Artifact?,” *Bulletin of the Association for Preservation Technology* 18, no. 3 (1986): 5.

<sup>49</sup> *Ibid*, 4

<sup>50</sup> John Fidler, “Plastic Dreams: Weathering of Glass-Reinforced Plastic Facsimiles,” *APT Bulletin* 33, no. 2/3 (2002): 5-6.

<sup>51</sup> Semes, *The Future of the Past*, 115.



uncommon practice to make copies either, as craftsmen and artists regularly copied the work of various masters of the time with no concept the originality was of importance.<sup>52</sup>

The specific use of less expensive or more common materials used in imitating that of more expensive and scarce materials has a long tradition as well. For instance, even at Mount Vernon, George Washington had ashlar stone imitated by using sand-impregnated paint on wood. During the nineteenth century it was not uncommon for dry-tamp cast stone and even cast concrete to be used in the place of quarried stone.<sup>53</sup> It is also during this time that a range of materials considered less expensive and easily fabricated were becoming available to emulate more expensive ones. Some of these substitute materials used are not what we normally associate with the term today, “Many of the materials used historically to imitate other materials are still available. These are often referred to as the traditional materials: wood, cast stone, concrete, terra cotta and cast metals.”<sup>54</sup> Artificial stone, also known as “cast stone,” “concrete stone,” and “cut cast stone” was used quite a bit in substitution for real stone during the nineteenth century. By the twentieth century it was widely accepted as a substitute material for natural stone because of its economic incentives. Due to its extensive use during this time, it can be considered a meaningful historic material in its own right,

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<sup>52</sup> Lowenthal, *The Past Is a Foreign Country*, 303.

<sup>53</sup> Park, “Preservation Brief 16: The Use of Substitute Materials on Historic Building Exteriors,” 1.

<sup>54</sup> *Ibid*, 2.

requiring its own preservation solutions.<sup>55</sup> The development of portland cement also had a hand in the use of cast stone, as they were often used together.<sup>56</sup>

*Preservation Brief 16*, written in 1988, points out that in the few decades before new synthetic materials such as epoxy resins, fiberglass and acrylic polymers had been developed and used in architectural applications, what are now known as traditional materials often filled this role. Wood, cast metal, terra cotta and concrete are examples of materials that were once used to imitate other materials, but are now considered traditional in their own right. The brief says the development of these newer substitute materials may be, in part, to due to the historic preservation movement.<sup>57</sup> Thomas Fisher points out that modern architects often used these materials, but were not always open about it, “The stigma against imitation simply meant that architects, until recently, didn’t pay much attention to substitute materials, and didn’t talk about it if they did.”<sup>58</sup>

### Considerations When Using Substitution Method

#### *Positives of Substitution Method*

Although, mainly held as a last resort, the substitution method does have some positive attributes listed in related literature. First, in *Preservation Brief 16*, Sharon Park

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<sup>55</sup> Richard Pieper, “*Preservation Brief 42: The Maintenance, Repair and Replacement of Historic Cast Stone*,” National Park Service, Department of the Interior, 2001, <https://www.nps.gov/tps/how-to-preserve/briefs/42-cast-stone.htm>. (accessed October 1, 2016), 1-2.

<sup>56</sup> *Ibid*, 3.

<sup>57</sup> Park, “*Preservation Brief 16: The Use of Substitute Materials on Historic Building Exteriors*,” 3.

<sup>58</sup> Fisher, “*The Sincerest Form of Flattery*,” 1.

points out that substitute materials can often have successful results, “Growing evidence indicates that with proper planning, careful specifications and supervision, substitute materials can be used successfully in the process of restoring the visual appearance of historic resources.” She points out that if done correctly and carefully they can produce a pleasing and accurate facsimile and often times in less time than replacing something in-kind.<sup>59</sup> Other advantages depending on the substitute material selected is that they often weigh less than the original material. For those replacements that are non-structural this can be a desirable characteristic. Some substitute materials need less maintenance than the original materials, which can also be a plus, especially if they are located in areas that are difficult to access for regular upkeep.<sup>60</sup>

Another argument often used in defense of using substitute materials is that some original materials are hard to find for in-kind repair and replacement. Along those same lines, a craftsman who is skilled in some of the techniques needed to successfully perform some of these repairs may be difficult to come by.<sup>61</sup> Of the substitutes that are successful Fisher writes, “If they offer a convincing imitation of a nearly obsolete material, at a lower price, without damaging the building in any way, why not use them?”<sup>62</sup>

Of most of the substitute materials, it seems that cast stone is less controversial than others. Theodore Prudon was an early advocate of its use, asking that it be used to

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<sup>59</sup> Park, “Preservation Brief 16: The Use of Substitute Materials on Historic Building Exteriors,” 1.

<sup>60</sup> Ibid, 5-6.

<sup>61</sup> Fisher, “The Sincerest Form of Flattery,” 1.

<sup>62</sup> Ibid, 5.

replace terra cotta that had been damaged on the Woolworth Building in New York City. He praised its production potential, structural effectiveness and the fact that it had a long history of use.<sup>63</sup> Preservation Brief 42, covers the use of cast stone and outlines ways of taking care of it. Published in 2001, this brief clearly states that this material has had a long history of being used as a substitute. The author, Richard Pieper, points out that cast stone can be particularly believable at imitating fine-grained stones such as sandstone. Similar to others like Thomas Fisher, Pieper reinforces that cast stone is a good option when it comes to the historic material being unavailable; in this case stone matching that of the original.<sup>64</sup> Finally, it is interesting to note at the end of the brief it discusses the appropriateness of replacing deteriorating cast stone with Glass Fiber Reinforced Concrete (GFRC). Even substitute materials can be replaced by other substitute materials. GFRC at the time, had some clear advantages over traditional cast stone when weight was a concern.<sup>65</sup>

### *Negatives of Substitution Method*

Overall within related literature, there seems to be more negative associations with the substitution method than positive. Preservation Brief 16 warns the reader of the downfalls of using substitute materials by first addressing the issue of authenticity

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<sup>63</sup> Ibid, 2.

<sup>64</sup> Pieper, "Preservation Brief 42: The Maintenance, Repair and Replacement of Historic Cast Stone," 4.

<sup>65</sup> Ibid, 14.

and an overall change that can occur in a buildings appearance and character.<sup>66</sup> Many of the substitute materials that are used for repairs and replacements are relatively new, or at least when compared to a historic material. Because of this one must exercise caution, as some of these newer materials have not been tested extensively under different conditions.<sup>67</sup> Thomas Fisher agrees with this assessment in *The Sincerest Form of Flattery*, adding that this lack of information means a lack of performance standards.<sup>68</sup> Preservation Brief 16 agrees with this standpoint, noting that although some of these materials may seem promising initially, “they are often difficult to integrate physically with the porous historic materials and may be too new to have established solid performance records.”<sup>69</sup> A reality one should consider when installing a substitute material, is that the new material will likely expand and contract at a differing rate than that of the surrounding historic materials. This difference can be extremely problematic as it can cause damage to the weaker of the two materials as well as other issues. Other concerns brought up by Park in the brief are issues such as susceptibility to water penetration and ultra-violet degradation.<sup>70</sup>

Fidler points out failures caused by ultra-violet radiation as well, saying it causes the breaking down of “molecular carbon-carbon bonds” in glass reinforced plastic (GRP), in his 1982 article. A typical rule of thumb is that as the fire resistance gets better in

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<sup>66</sup> Park, “Preservation Brief 16: The Use of Substitute Materials on Historic Building Exteriors,” 1.

<sup>67</sup> Ibid, 6.

<sup>68</sup> Fisher, “The Sincerest Form of Flattery,” 2.

<sup>69</sup> Park, “Preservation Brief 16: The Use of Substitute Materials on Historic Building Exteriors,” 3.

<sup>70</sup> Ibid, 1 & 6.

these materials, the resistance to ultra-violet radiation gets worse.<sup>71</sup> On GRP, he concludes that the product is not durable and does not perform well aesthetically either. GRP does not weather the way historic building materials would, causing it to stand out from its surroundings over the years and look out of place. A plastic like sheen is also commonly seen which differs from the matte appearance of the other building materials.<sup>72</sup> Fisher also points out a difference in appearance from one material to the next, by writing that discoloration can come about just from being wet. The example given is that cast stone will appear darker than materials such as terra cotta after being exposed to rain.<sup>73</sup>

### Economic Considerations

Overall, there seems to be little written about cost considerations in deciding to use the substitution method for replacement and repairs on historic buildings. There are however, a few writings on the economic factors related to buildings in general that might inform this topic. One book written by Robert Johnson, entitled *The Economics of Building: A Practical Guide for the Design Professional* raises some of these considerations. In his chapter, The Decision Process in a Changing Context, Johnson explains that the process of decision making can fall into a continuum at some point between two categories: highly structured and highly unstructured. Structured

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<sup>71</sup> Fidler, "Plastic Dreams: Weathering of Glass-Reinforced Plastic Facsimiles," 4.

<sup>72</sup> Ibid, 22.

<sup>73</sup> Fisher, "The Sincerest Form of Flattery," 3.

decisions are described as continuous and routine, while unstructured decisions are described as harder to solve due to difficulty in identifying the source or because they have not occurred before. He goes on to describe what the characteristics of the two types of decisions are, “Operational decisions tend to be more structured and defined; strategic decisions tend to be complex, ill-defined, and consequently more difficult to formulize. As one moves toward strategic decisions, the problem domain becomes less specific, and potential solutions begin to cut across disciplines.”

On the topic of value and how it affects our decisions, Johnson defines value as, “the intrinsic property of an object which has the capacity to satisfy.” He points out that it can be hard to measure this intrinsic quality of satisfaction, so this can be problematic. It is also pointed out that what might be of value to one person, does not necessarily carry the same value to another person. In relation to economics, the book describes money as the primary system driving our decisions on value. The incentive for a person to buy something is just as much about cost as it is about the perceived satisfaction. With this in mind, Johnson writes that the measure of value can be figured out by looking at the ratio of benefits (outputs) and the projected costs (inputs) going into a decision.<sup>74</sup>

In the last Chapter of *Economics of Building*, Johnson covers a tool for decision making when it comes to buildings called Life-Cycle Costing (LCC). He lists three factors that must be included when using the life-cycle analysis to aid in decision making: first,

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<sup>74</sup> Ibid, 14-15, 20, 23.

there has to be more than one alternative; second, the only relevant comparisons to be made are economic factors; and last, these economic factors must be presented in the form of costs.<sup>75</sup> The National Institute of Standards and Technology defines life-cycle cost analysis as, “an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and ultimately disposing of a project are considered to be potentially important to that decision.” A LCCA is a measure of long-term performance or profitability and therefore is the opposite of another method of economic analysis called Payback, which emphasizes the rate at which an initial investment is recovered. A LCCA is a useful tool for agencies or facilities with more than a few capital investment projects that need prioritization due to inadequate funding.<sup>76</sup> Life-cycle cost analyses are mainly used for large scale building projects or systems, but they can also be used for smaller applications. To perform a simple life-cycle cost analysis the information needed is: the initial cost; expected life (in years); expected yearly maintenance, operation and repair (average); maintenance costs that occur less often than annually (averaged time between occurrences) and any residual value. If some of this information is unknown, it is usually possible to find pricing in literature published by manufacturers and if this is not possible it is advisable to contact the

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<sup>75</sup> Ibid, 214.

<sup>76</sup> Sieglinde K. Fuller and Stephen R. Petersen, *NIST Handbook 135: Life Cycle Costing Manual for the Federal Energy Management Program* (Washington: US Government Printing Office, 1996), 1.



manufacturer or supplier directly.<sup>77</sup> Useful to know is that a life-cycle cost has very little value on its own, it calculated for several alternatives that can perform an identical function in order to be a helpful tool.<sup>78</sup>

## Conclusions

Although theory related to preservation probably did not start in the nineteenth century, it was during this time in Europe that there were very strong philosophies being recorded. With Viollet-le-Duc in France and Ruskin and Morris in England it was clear that people were thinking about the right and wrong way to restore and repair architecture. Although there always seems to have been differences in opinion, it seems that Ruskin's anti-scrape approach has had a more lasting impression on modern historic preservation theory. Its influence can be discerned in the guidelines from the Venice Charter to Secretary of Interior Standards.

As for philosophies related to the use of substitution, it seems that it was fairly divided in the past as to whether it should be allowed or not. Based on the writings found, it seems that it was more accepted as an option in the 1980's although still controversial. After the 1980's there seemed to be less and less written about it, but generally it is understood from what is found that it is to be avoided unless there is no

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<sup>77</sup> United States Forest Service, "Life-Cycle Cost Analysis for Buildings Is Easier Than You Thought," United States Department of Agriculture, <https://www.fs.fed.us/t-d/pubs/htmlpubs/htm08732839/page01.htm> (accessed October 21, 2016), 5.

<sup>78</sup> Sieglinde K. Fuller and Stephen R. Petersen, *NIST Handbook 135: Life Cycle Costing Manual for the Federal Energy Management Program* (Washington: US Government Printing Office, 1996), 2.

other option. Despite going in and out of favor by professionals, it seems that substitution has been used going back to ancient times and continues to be used by some. This long history may indicate that despite its obvious controversies, it will continue to be used at least to some degree.

In terms of the positives and negatives of using the substitution method, opinions about both have been reported. The positive aspects of substitution include that sometimes they are easier to find than historic materials, usually have a lower cost and sometimes are quite successful in their purpose according to some of the authors. Negatives seem to dominate the opinion on substitute materials however, with professionals writing about durability issues, lack of authenticity and the fact that the newer substitute materials have not been in use long and therefore do not have a performance record to reference.

Economic factors relating to the decision to employ the substitute method, seem to be mentioned briefly in almost all writings, however there is not a lot of information given about it otherwise. The little information found related more toward the larger picture of building and construction rather than to repairs and replacement. This however has some cross over to take into consideration when it comes to repairs. The decisions made about which repair option or material to choose can be traced to the value we place on those options. Value is seen as directly related to cost usually, which is not a surprise. Lastly, life-cycle cost analysis can be a good tool in evaluating whether the initial savings outweigh the life-cycle of the building system. There is no information

in assessing whether this would be helpful in assessing substitute materials, but it seems that it could help in this decision making process.

## CHAPTER THREE

### METHODOLOGY

In order to understand what led to the decision to use substitute materials over in-kind materials and whether the choice was successful, a three tiered approach was used. The three tiers were archival research, assessment of repair projects and analysis of decision making factors. Archival research was completed in two stages on site at Lyndhurst in August and December of 2016. Project assessments consisted of four categories to determine the success of a repair: 1) craftsmanship (as compared to the original), 2) replaceability, 3) impact on surrounding materials, and 4) weathering (as compared to the original). Finally, decision making factors contributing to the use of substitute materials for repairs were analyzed. The three decision making factors identified were: cost, material durability and preservation philosophy.

The first tier in the methodology process was archival research. To evaluate the use of the substitute method employed by Lyndhurst on the selected projects, it was first imperative to access property records located on the estate. In August of 2016, the process of accessing and examining the contents of records located in the workshop office and bottom floor of the laundry building began. Primary sources such as photographs, architectural drawings, documents, bids, reports and correspondence found relating to these projects were scanned and organized for later inspection. This process was time consuming given the volume of information located in these spaces

and in some cases because of improper filing and labeling, or no labeling at all. It seems that over the years, the downsizing of the Lyndhurst staff resulted in less time to properly organize, categorize and label some of the paperwork. It should be noted that an attempt to organize records, a number of years ago, resulted in a small part of the collection being easy to navigate. It is likely that not all documents were located and time limitations did not permit inspection of all materials. Current photos of the substitute repair projects chosen for evaluation were taken in August 2016, with the expectation that more would be obtained during a follow-up visit.

Based the archival findings in August of 2016, five projects using substitute materials for repairs were identified and selected for the purpose of this thesis. The time period of the selected projects using the substitute method ranged from the late 1960s to 2016. Although five repair projects in total were chosen for analysis, there have been likely more over the years at Lyndhurst. The first chosen project occurred either in the late 1960s or early 1970s (there is no documentation pointing to a specific year) and involved the use of portland cement in repointing areas where historic mortar had been lost on the mansion. These repairs were scattered in numerous areas on the mansion's exterior. The second project dating from 1984, entailed the replacement of failing marble on the porte cochere as well as other scattered stones located on the mansion. The marble had been cut incorrectly, which led to delamination and the decision to replace these defective stones with cast concrete. This work was carried out by the Restoration Workshop, a training program established by the National Trust in

1973 and first implemented at Lyndhurst Estate. The third project examined, also took place in 1984 and involved the restoration of the swimming pool building, which was built in 1911. As part of this project, corrugated metal panels replaced all of the glass components of its skylight roof. Project number four completed in 2012, consisted of deteriorated wooden mahogany roof finials on the mansion being replaced with replicated finials cast in a urethane resin called Smooth-Cast 300.<sup>79</sup> The fifth and final project using the substitute method was completed in 2016 by summer interns. This project consisted of casting seven small and two large decorative brackets missing from the interior of the bowling alley building on the property. These original brackets were carved poplar wood, but the replacements for missing brackets were cast in the same urethane resin as the mansion's roof finials.

The second tier of the methodology process were condition assessments of the five projects. A conditions assessment tailored to the specific substitute projects was created and a survey form was drafted to aid in the process. The intent of the condition assessments was to look closely at each repair and determine the success of each project. These assessments were carried out on site at Lyndhurst in December of 2016. The assessments were divided up into four main categories: 1) craftsmanship (as compared to the original), 2) replaceability, 3) impact on surrounding materials, and 4) weathering (as compared to the original). Each category within the conditions

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<sup>79</sup> Smooth- Cast 300 Series. MSDS No. 402A; Smooth-On, Inc.: Macungie, PA. [https://www.smooth-on.com/msds/files/SC\\_300\\_300Q\\_320\\_380\\_45D\\_60D\\_61D\\_65D\\_66D\\_ONYX.pdf](https://www.smooth-on.com/msds/files/SC_300_300Q_320_380_45D_60D_61D_65D_66D_ONYX.pdf) (accessed on April 16, 2017).

assessment had questions or subcategories to help in its evaluation. Each question or subcategory had the ratings of 'good', 'fair' and 'poor' to choose from. Once all of these categories were rated, each rating was added up to assess whether it could be considered successful or not. By examining the actual materials and their applications in person, a better understanding of intent, process and impact was evident. Some of these project assessment categories were difficult to translate into data, as they were somewhat intangible and subject to opinion and interpretation. In these instances, a thoughtful analysis of the essential components adding to the category topic created an evaluation tool in the form of questions and subcategories to aid in assessment.

The first project criteria category to be evaluated to determine if a substitution method is successful or not was craftsmanship. In this category, the questions established were meant to be compared to the original craftsmanship and its character defining features. In order to come to a reasonable conclusion of the craftsmanship involved in a particular project the following criteria were evaluated in relation to the original:

- 1) Is it aesthetically pleasing?
- 2) Was the process of producing it labor intensive?
- 3) Was skill required to make it?
- 4) Are the basic dimensions the same as the original?
- 5) Were similar construction techniques used?
- 6) Are the details of the original present in the replacement?

Once these questions were answered for each project, a conclusion about the craftsmanship of the project was drawn and later contributed to the overall assessment of each repair.

The second category to be evaluated was replaceability. This category addressed the intention of the project, specifically asking the question of whether it was installed with the option of later removal. To answer this question there was an assessment of research based conclusions and an assessment based on the physical examination of the substitution repair. To evaluate this, the specifics of the installation needed to be researched and examined in person. Physical examination concluded whether the replaced material could be removed or deconstructed in the future without harming any of the surrounding original building materials.

The third category was impact on surrounding materials. To evaluate impact, it was necessary to closely examine the projects for visible signs of deterioration or wear on the adjacent materials. Deterioration can be present in many forms, but specific types included in the assessment were based upon how they apply to the project and materials. In this category, the deterioration subcategories assessed were:

- 1) Biological
- 2) Chemical
- 3) Mechanical
- 4) Anthropogenic

Common examples of these include cracking, delamination, efflorescence and rot. The type of deterioration present, if any, depended partly on the properties of the



substitute material and the surrounding materials. Original materials surrounding substitute materials included wood, marble and brick. Substitution materials included wood, cast concrete, metal and polyurethane. Other factors that can have an impact on deterioration are environment, maintenance, construction methods and installation methods.

The fourth category evaluated was weathering. Weathering is the gradual breaking down of the appearance, structure or texture of something from exposure to the elements. It is further described as, “the process of weathering by sun, wind and rain is defined as the breaking-down and alteration of materials by mechanical and chemical processes. Mechanical or physical weathering includes the action of frost and extreme temperature changes, whilst chemical weathering includes the dissolution of materials into solution, carbonation (dissolution by weak carbonic acid formed by the combination of water with atmospheric carbon dioxide), oxidation (chemical combination of atmospheric oxygen), hydration (chemical combination with water) and the breakdown of chemical bonds.”<sup>80</sup> To evaluate the extent of weathering, the creation of subcategories allowed comparison of the substitute material to the original:

- 1) Coloring
- 2) Surface Texture
- 3) Biological Growth

Two of the projects required an additional component of evaluation in the form of a surface water permeability test. These projects were the substitution of portland

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<sup>80</sup> Watt, *Building Pathology*, 107.

cement in place of the historic mortar mixture and the substitution of cast concrete in place of marble. A RILEM water penetration test was attempted on both projects, however it was ultimately successful only on the marble and cast concrete. A RILEM<sup>81</sup> tube test measures the volume of water absorbed by stone or brick within a set time. This test is designed to test the water permeability of a material and points to the amount of weathering a material has undergone. The RILEM test performed to the porte-cochère repair project measured the permeability of the original marble and the substitute cast concrete. The aim of performing this test was to show the differences in water penetration between the substitute materials and original materials.

The third tier of methodology was decision making factors contributing to the use of substitute materials at Lyndhurst. The first decision making category for evaluating the substitute projects was financial in nature. Although the initial intention was to assess the financial outlook at Lyndhurst during the time of repairs and perform a life-cycle cost analysis for each material, specific pricing could not be located for all projects forcing this analysis to be discarded. In lieu of a life-cycle cost analysis, the financial well-being of Lyndhurst from the time period of the first repair in the late 1960s/early 1970s through the last repair occurring in 2016 was solely analyzed. Accounting paperwork accessed on the next trip to Lyndhurst in December of 2016 supported the analysis of the state of Lyndhurst financially during this period.

Documents examined included meeting minutes, development plans, financial

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<sup>81</sup> RILEM, "International Union of Laboratories and Experts in Construction Materials, Systems and Structures, Publications," *RILEM*, <http://www.rilem.org/gene/main.php> (accessed April 16, 2017).

strategies and property budgets. The close examination of these documents pointed to patterns and overall trends for the financial state of Lyndhurst over the years being examined.

The second decision making category was durability of materials, both original and substitute materials used in the selected repair projects. Research of each material informed this factor of the repair projects. Insight into the properties and deterioration potential associated for each material helped in identifying the durability of each material. After this, each project's original material and the substitute material which replaced it were compared to each other. Another factor included in this category of analysis were specifics of the particular repair and the material's application. This was taken into consideration, because superior durability was not always a positive in every project's particular context.

The final decision making category for analyzing the substitute repair projects was preservation philosophy. Specifically, Lyndhurst's preservation philosophy over the years needed examination to identify consistency or changes over time. To determine the philosophy over time it was necessary to access documents such as meeting minutes, development plans, historic structure reports and other sources providing information. Because it was often difficult to find clear information relating to organizational philosophy, interviews played an important role in filling in the gaps of information on Lyndhurst's preservation philosophy.

Interviews played an important part in all aspects of the process of collecting information on all categories of analysis. Past and present Lyndhurst employees and those who worked on the particular projects being assessed provided valuable information and insight into these substitute repairs and replacements as well as context for these substitution projects. Current and past employees interviewed were: former Restoration Workshop participant Eric Clingen, former Restoration Project Manager David Overholt, current Restoration Project Manager Thomas Richmond and current Associate Director Krystyn Hastings-Silver. These interviews also helped in providing an idea of what Lyndhurst's preservation philosophy has been over the years. Where no information was located in the records at Lyndhurst regarding the decisions, pricing and challenges associated with these repairs, interviews provided answers in some cases.

Once all steps were completed overall conclusions began to form about the use of substitute materials chosen instead of in-kind materials for these projects. Project assessments pointed to conclusions about the success of the repair projects, while analysis of financial factors, durability of materials and preservation philosophy pointed to why these repairs occurred the way they did.

## CHAPTER FOUR

### ANALYSIS

#### **PART ONE: BACKGROUND, ASSESSMENT & ANALYSIS OF CASE STUDY REPAIR PROJECTS**



Figure 4. 1: East Elevation of Mansion (Photo by author).

#### Mansion

The mansion at Lyndhurst was the first of a series of buildings constructed on the Estate in 1838 by the original occupant, former Mayor of New York City William Paulding. Alexander Jackson Davis, considered a true innovator of the Gothic Revival style in America, designed the cottage. An addition to the building, again designed by Alexander Jackson Davis in 1864, was built by the next owner, George Merritt. The addition doubled the size of the mansion and brought notable architectural features

such as the tower and the current porte-cochere. The mansion remains the main attraction and source of income for Lyndhurst.

### Mansion Exterior- Historic Mortar Replaced with Portland Cement

#### *Background and Description of Historic Mortar*

The original mortar used in pointing the masonry on the mansion at Lyndhurst was described in A.J. Downing's *The Architecture of Historic Country Houses* as two parts angular sand mixed with one part lime binder.<sup>82</sup> When the historic mortar was analyzed in the early 2000s by separating a sample in three parts: the acid soluble fraction, the fines (clay, pigment or cement residue) and the aggregate.<sup>83</sup> it was described as, "a moderately soft mortar of fine composition." Analysis of the mortar also showed that white was the original mortar color and it is a "common lime mortar." Aggregate found in the mortar is light in color and its size is described as fine.<sup>84</sup>

#### *Repointing Using Portland Cement*

There is no documentation in the records at Lyndhurst pointing to the exact year of the portland cement replacement of historic mortar. However, the application was not long after the National Trust for Historic Preservation acquired the property. The repair probably happened in the late 1960s or early 1970s, based on meeting minutes

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<sup>82</sup> Andrew J. Downing, *The Architecture of Country Houses* (New York: Dover Publications, 1969), 64-65.

<sup>83</sup> Jablonski Berkowitz Conservation, Attachment 9, "Method of Analysis," 9.

<sup>84</sup> Jablonski Berkowitz Conservation, Attachment 9, "Characterization of Historic Masonry," 5.

mentioning the need for repair and later minutes confirming its application in the past. Meeting minutes of the Lyndhurst Council in September of 1971 mention research being conducted at the time in an effort to pinpoint the original colors and conditions of the stone and mortar. In an effort to restore the exterior of the mansion, it was said that, “every joint will be opened and resealed carefully and expertly.”<sup>85</sup> Assessment of the mortar campaigns with portland cement on the exterior of the building shows this work never took place, even though the document suggested it would take place. It seems the original intention was to repoint the whole building, but cost was an obstacle or a reassessment of needs occurred because not all joints needed replacement. No other correspondence exists to provide more information on the repointing to the mansion with portland cement. In an interview conducted with Lyndhurst’s former Project Manager, David Overholt, he stated that the portland cement was still present on the mansion during the time he worked there from 1987 to 2003. When asked if there was ever an intention to remove the cement, he replied there was not as it would have been hard to do. Mr. Overholt also added that in the 1970s, when this likely took place, it was “also very common back in those days that masons were comfortable using portland mortar for pretty much everything.”<sup>86</sup>

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<sup>85</sup> Lyndhurst Council Meeting Minutes, “Meeting of the Lyndhurst Council, 3:00pm,” (Council Meeting, Lyndhurst, Tarrytown, NY, September 21, 1971), 2.

<sup>86</sup> David Overholt, interview by author, January 13, 2017.

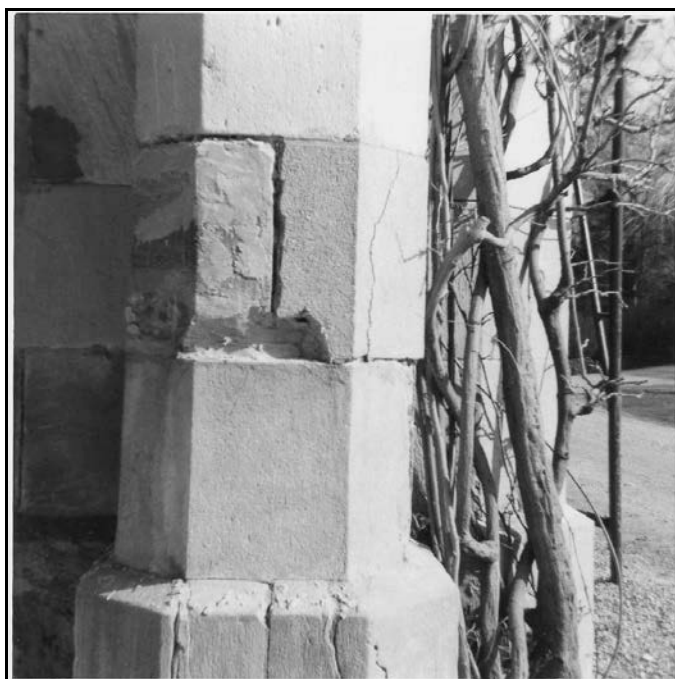


Figure 4.2: Condition of joints, 1965 (Lyndhurst Archives).

### *Getty Grant Testing and Findings*

In 2004, Lyndhurst was awarded an architectural investigation grant from the Getty Foundation to do investigation and testing on the mansion that would ultimately lead to recommendations for repairing and maintaining the building. Jablonski Berkowitz Conservation, Inc. of New York City was chosen to complete the testing by the National Trust for Historic Preservation. One of the areas assessed was the exterior stonework and mortar. The investigation and mortar analysis uncovered the historic mortar mixture from the period of 1864-65, with the completion of the addition to the original building. Once the original mixture and coloring was established the recommendations were given that the majority of the mansion be repointed with ASTM



Standard Type O mortar. This mortar type is then described “as a soft mortar suitable for general use in exposed masonry above grade.” For a few other areas such as the chimneys and parapet walls, the firm recommended that ASTM Standard Type N since it was more durable and would hold up nicely. Type N is described in the report as, “a medium mortar suitable for general use in exposed masonry above grade, specifically recommended for parapets, chimneys and exterior walls subjected to severe weathering conditions.”<sup>87</sup> These mortar mixtures represent an attempt to replicate the historic mortar using those modern materials available with consideration to the historic mixture’s strength, texture and color.<sup>88</sup> Although, the findings from the Getty grant were extremely helpful in assessing the various conditions present at the mansion, most of the recommendations could not be implemented due to the costs. This is the case for the exterior stone and mortar recommendation repairs.

*Conditions Assessment and Findings, December 2016*

On the second visit to Lyndhurst in December of 2016, one objective was to conduct an assessment on the replacement of the historic mortar with portland cement. The criteria were the same being used on the other four projects addressed in this thesis and consisted of the four categories of: craftsmanship, replaceability, impact on surrounding materials and weathering. An additional criterion of a RILEM water absorption test was also added for both the portland cement (See Figure 4.3)

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<sup>87</sup> Jablonski Berkowitz Conservation, Attachment 9, “Characterization of Historic Masonry,” 5-6.

<sup>88</sup> Ibid, 10.

replacement of historic mortar (See Figure 4.4) and for the cast concrete replacement of marble repair projects.



Figure 4.3: Original mortar (Photograph by author).



Figure 4.4: Portland cement (Photograph by author).

Under the category of craftsmanship results ranged from ‘good’ to ‘poor.’ The repair project rating was ‘good’ under the two questions of: 1) was the process labor intensive; and 2) were similar construction techniques used? The rating of ‘good’ fit in these instances, because the production and construction process was most likely very comparable with what was employed for the historic mortar originally. The rating of ‘fair’ given under the craftsmanship category addressed the questions of: 1) was skill required to make it; and 2) are the basic dimensions the same as the original? The ‘fair’ rating reflects some skill and knowledge of the material was required to make the mixture and the repointing dimensions were mostly not unlike the original. Lastly, under the rating of ‘poor’ two questions qualified: 1) is it aesthetically pleasing and 2)

are the details of the original present in the replacement? The rating of 'poor' applying to the first question is due to the color not matching the original mortar which was lighter in color and also seemed to be applied in a more haphazard way than the original. Also, because the color difference was so noticeable, the details of the original looked very different than the replacement.

The second category of replaceability asked one question: Was it installed with the option of later removal? Both a research based and examination based conclusion helped determine this rating. Research provided no information on this category since no documentation or correspondence on the project could be found in the archives at Lyndhurst. Therefore, no rating was given to this subcategory and it was removed due to lack of information. Physical examination of the portland cement showed that it would be extremely hard to remove without damaging the stone around it. Therefore, the subcategory received a rating of 'poor.'

The third category is impact on surrounding materials and includes the four subcategories of: biological, chemical, mechanical and anthropogenic. The rating of these overall subcategories ranged from 'good' to 'poor.' The only subcategory to receive the rating of 'good' was chemical impacts, of which none could be identified. Only the subcategory of biological received a 'fair' rating. Although some mold or algae was present on the portland cement and surrounding materials, it was only found in certain areas. This occurrence points to other factors at play, such as location on the building rather than just a result of materials. Under the subcategory of mechanical, the

rating of 'poor' is due to cracking that was evident in some areas (See Figure 4.5). The cracking is most likely a result of the conflicting thermal expansion and contraction of the different materials and perhaps also the moisture that may be getting in. Lastly, under the subcategory of anthropogenic the rating was 'poor.' This rating is low because of the fact that portland cement was chosen for repointing. Because something softer and closer to the original mortar was not chosen, a negative impact inflicted by humans is evident.



Figure 4. 5: Detail of portland cement and resulting material loss and cracking (Photo by author).

The final category under the criteria for evaluating the success of the repair project which replaced historic mortar with portland cement is the category of

weathering. This category required a comparison of the original material to the replacement material. Under this category, the ratings again ranged from 'good' to 'poor.' The only subcategory given the rating of 'good' under weathering was biological growth. Although there was biological growth present in the form of a brown or green mold or algae (See Figure 4.6), this could be seen on areas of both the historic mortar and the portland cement. The subcategory of surface texture's rating of 'fair,' was higher because both mortars were finely grained and similar in feel when touched. However, the portland cement was noticeably harder than the original. Under the subcategory of coloring, the repair received a rating of 'poor.' The original mortar is light gray, while the portland cement is much darker and stands out from the original.



Figure 4. 6: Portland cement with surrounding patching of material loss and biological growth (Photograph by author).

Finally, the assessment included a RILEM water penetration test on both the historic mortar and the added portland cement mixture. The test was an attempt to find out the differences between the two materials. The test effort failed unfortunately, as the adhesive putty used to attach the RILEM measuring tube to the mortar mixtures could not form a tight enough bond. After several attempts were made, the water continuously escaped out the sides, making the test impractical. Therefore, this category was discarded as non-contributing to the overall project score.

After compiling all of the assessments for the portland cement which replaced historic mortar, a conclusion could be made about the overall success of the repair project. The project received four ratings of 'good,' three ratings of 'fair' and six ratings of 'poor.' The conclusion can be drawn that that this repair cannot be considered successful.



## Mansion Porte-Cochère- Sing Sing Marble Replaced with Cast Concrete

### *Description of Porte-Cochère and Early Stone Repair*

A porte-cochère is defined as a, “porch large enough to admit wheeled vehicles,” in *Pevsner’s Architectural Glossary*.<sup>89</sup> Additionally, a porte-cochère is a partial enclosure functioning to provide shelter for people exiting a wheeled vehicle or a carriage which can be accommodated through its large opening. A porte-cochère was part of the initial design of the building dating back to 1838, but was later enclosed and made into a vestibule.



Figure 4. 7: Front of porte-cochère (Photo by author). Figure 4.8: Side of porte-cochère (Photograph by author).

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<sup>89</sup> Yale University Press, *Pevsner’s Architectural Glossary* (New Haven: Yale University Press, 2011), 100.

The construction of the current porte-cochère was part of the 1864 additions to the mansion.<sup>90</sup> Sing Sing marble quarried by inmates of the famous prison in Ossining, New York covers the exterior of the port-cochère.<sup>91</sup> Each stone is somewhat roughly cut and unpolished. Limited maintenance had been done to the stone prior to the Restoration Workshop in the 1980s. However, a series of proposals and bills from Nicholson & Galloway, Inc., in 1965 suggests that the preservation & restoration firm intended to do repairs and treatments on the exterior stonework. These treatments included resetting of displaced stones using dowels, application of a product called “Deckosit” to repair fractured stones and finally silicone coating application treatments for all of the exterior stone to prevent further deterioration. The price quoted to complete this work is listed as \$26,500.<sup>92</sup> It is unclear what actual work was done and to what degree, as later correspondence stated that there was only \$10,000 worth of work completed due to budget limitations. There was also no specification on the work that had been completed.<sup>93</sup> Correspondence from the property manager Pierre G. T. Beauregard, to Nicholson & Galloway three years later acknowledged that all of the proposed work did not take place due to “budget problems” and he stated interest in continuing the work although, “we have so many areas at Lyndhurst that need repairs,

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<sup>90</sup> Theodore H. M. Prudon, “Lyndhurst” (report, Columbia University, 1972), 55.

<sup>91</sup> Ossining Historical Society, mailed list to author of Sing Sing Marble Sources, July 18, 2016.

<sup>92</sup> Nicholson & Galloway, proposal letter to Brinton Sherwood, March 4, 1965.

<sup>93</sup> Getty Conservation Institute, “Project Work Plan: History” section, 2.



that I am not sure how soon we would be able to continue the stone restoration as originally contemplated.”<sup>94</sup>

In a 1971 memorandum directed to potential bidders, Lyndhurst’s Director of Restoration Robert Hatch, outlined the scope of work for exterior masonry work needed on the mansion. This includes replacement and patching of stone as needed, sealing of hairline cracks and removal of all mortar not matching the original.<sup>95</sup> Universal Restoration, Inc. submitted a bid for this job with an outline of the work required and pricing.<sup>96</sup> There is no documentation to demonstrate that this work happened, however. Other than the repairs done by Nicholson & Galloway, Inc., there is little evidence to point to additional work completed on the exterior stonework except that of the Restoration Workshop.



Figure 4.9: State of porte-cochère marble, 1984 (Lyndhurst Archives).

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<sup>94</sup> Pierre G. T. Beauregard, letter to John P. Nicholson, October 1, 1968.

<sup>95</sup> Robert Hatch, memorandum to all bidders, April 9, 1971.

<sup>96</sup> Universal Restoration, proposal to Pierre G. T. Beauregard, April, 19 1971.

*Description of Porte-Cochère Stone Replacement and Repair by Restoration Workshop*

Deterioration of the exterior stonework on the mansion was always an issue, but repair was often deferred at Lyndhurst for reasons unknown. In meeting minutes from 1983, the Lyndhurst Council discussed the poor condition of the stone on the mansion and expressed that the stabilization and conservation of it was the next big project on the property. The staff informed everyone that the projected timeframe for the work would be 36 weeks and that the Restoration Workshop would take on the project using one or two master masons with a group of apprentices. The porte-cochère is the area of stone with the most structural issues according to the document.<sup>97</sup> The marble used on the mansion as well as the porte-cochère contains problems caused by the stone being cut incorrectly, resulting in the bedding of the stone being perpendicular to the compression of the stacked masonry units (See Figure 4.9). This resulted in the gradual delaminating of some of the layers of stone due to pressure. This problem was the case for some but not all stones, as the majority received correct installation and cutting. Another factor that seems to have resulted in the majority of the failing stone was it being located on the east side of the building, where the porte-cochère is located.<sup>98</sup> For some reason the degradation of stone seems to be most severe on this orientation, perhaps due to longer or more pronounced exposure to the elements. This degradation

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<sup>97</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council, 3:00pm," (Council Meeting, Lyndhurst, Tarrytown, NY, April 5, 1983), 2.

<sup>98</sup> Eric Clingen, interview by author, September 6, 2016.

was eventually leading to penetration of moisture through the exposed stone and ultimately through to the interior of the building in some cases.<sup>99</sup>

In order to remedy the problems with the exterior, replacement needed to be done for some and patching for the other stones in salvageable condition. Another decision dictated that the replacement units and patching repairs would use concrete, instead of original or comparable materials. The Restoration Workshop, now established at Lyndhurst for ten years, would take on the project. A master mason and a small team of Workshop participants gathered together to complete the job. There were many areas on the exterior in need of repair, but the porte-cochère was the first area the Restoration Workshop worked on.



Figure 4.10: Eric Clingen removing stone from porte-cochère, 1984 (Lyndhurst Archives).

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<sup>99</sup> Getty Conservation Institute, “Project Work Plan” section, 2.

This decision was probably a mistake according to Workshop participant Eric Clingen, who says it would have been a better idea to start in, “the most inconspicuous areas.” It is in the porte-cochère where he feels that the worst work occurred, due to the fact that the concrete stands out from the stone. For the participants of the project it was the first time doing work such as this, so they became better as they progressed. The process for the replacement stones consisted of casting the replica’s form by pouring the concrete mixture into a wooden form (See Figure 4.11) with the aid of clay and sand. After becoming more comfortable with the process, the Workshop began experimenting with mason’s coloring and swirling techniques to recreate the details found in the marble.

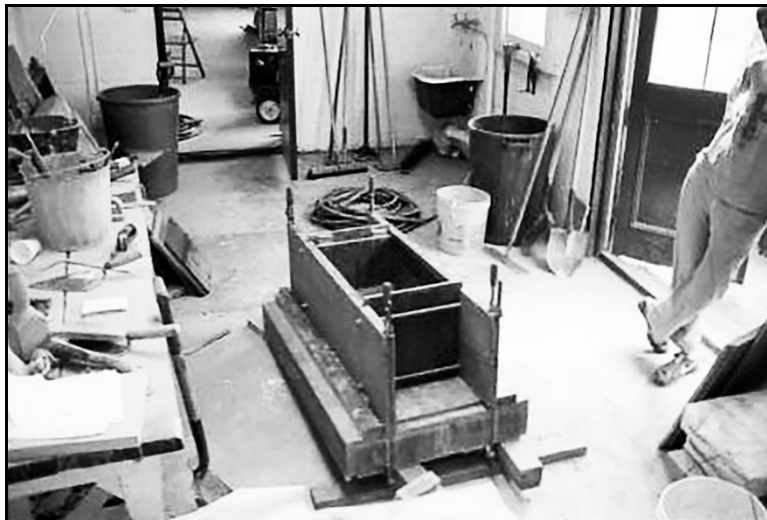


Figure 4.11: Wooden mold for casting concrete, 1984 (Lyndhurst Archives).

The installation of the concrete units was not an easy task and at times required the use of a metal beam for supporting the columns while insertion of the stones took

place. Eric estimates that the Workshop replaced about a third of the porte-cochere's stones. The stones that were in poor shape, but not deteriorated enough for replacement, received patching on the surface. The same mixture employed for the cast units served for patching the stones. A masonry drill used on the surface of the stone made it more irregular for better adherence of the patching material. Once this was done and somewhat dry, the newly applied surface received tooling using a float or trowel to make faint striations to the surface.<sup>100</sup>



Figure 4.12: Removed Stone (Lyndhurst Archives).



Figure 4.13: Installation of concrete (Lyndhurst Archives).

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<sup>100</sup> Eric Clingen, interview by author, September 6, 2016.

*Getty Grant Testing and Findings*

One of the areas subject to investigation through the Getty grant was the exterior stone on the mansion. Testing conducted on the stone consisted of petrographic analysis, water vapor transmission, total water absorption, compressive strength and surface water absorption. The report divides stone into four types according to color and characteristics (See Figure 4.14). Two color categories were gray and the others white, with each color having the two characterization categories of diagonal foliation and vertical tools with inclusions. Other categories within the type included orientation and visible condition. Within the two colors each had a visible condition of granular and good, while orientation had each stone at one of the four cardinal directions. Characterization of the stone by taking core samples and testing them provided the desired conclusions. Core samples extraction occurred from a parapet wall and chimney stack on the mansion.

	<b>Sample 1</b>	<b>Sample 2</b>	<b>Sample 3</b>	<b>Sample 4</b>
<b>Water Vapor Transmission</b>	similar to limestone	similar to granite	similar to granite	similar to limestone
<b>Total Water Absorption</b>	very high	acceptable	acceptable	very high
<b>Compressive Strength</b>	Little compressive strength	high compressive strength	high compressive strength	little compressive strength

Figure 4.14: Table of marble sample testing, Getty grant exterior investigation (Lyndhurst Archives).

Both the total water absorption testing and compression testing used the extracted core samples. According to the total water absorption testing, “The two core samples with little visible weathering (samples 2 and 3) had acceptable water absorption percentages, while Samples 1 and 4 absorbed water greatly in excess of the standard specification.” These standards come from ASTM C 97-02 “Standard Test Methods for Absorption of and Bulk Specific Gravity of Dimension Stone” and ASTM C 503-98 “Standard Specification for Marble Dimension Stone (Exterior),” which states that structural marble not exceed .20%. The compressive strength test which was based on ASTM C 170-90 (1999) “Standard Test Method for Compressive Strength of Dimension Stone,” concluded that the two samples that were a lot more weathered fragmented under little pressure while the other two samples performed better than the requirements associated with the test. Petrographic analysis of the stone samples uncovered that all four were, “dolomitic marble containing both dolomite (magnesium carbonate) and calcite (calcium carbonate) grains.” All of the samples appear to be Inwood Marble, coming from the New York quarries of the areas Tuckahoe/White Plains or Ossining.

The water surface absorption test failed to come to any overall conclusions in regards to color of stone, surface weathering and even location. Overall, the absorption rate was low in comparison to other historic buildings constructed with like masonry materials.<sup>101</sup> Finally, a RILEM test to determine the water absorption rate of the stones

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<sup>101</sup> Jablonski Berkowitz Conservation, Attachment 9, “Characterization of Historic Masonry,” 3-5.

was performed. Findings revealed that neither the location nor the color of the stone determined the rate of absorption. Another conclusion drawn showed that the stone on the exterior of Lyndhurst had an acceptable rate of water absorption.<sup>102</sup>

*Conditions Assessment and Findings, December 2016*

Careful inspection of the exterior stone was conducted at Lyndhurst in December 2016. The evaluation of cast concrete units was applied under the same criteria used on the other selected repair projects. In addition to the four categories of craftsmanship, replaceability, impact on surrounding materials and weathering the cast concrete was also given a RILEM water absorption test, as was the original marble.

The craftsmanship assessment results ranged from 'good' to 'poor.' The questions receiving the rating of 'fair' were: 1) is it aesthetically pleasing; 2) was the process labor intensive; 3) and was skill required to make it? The stone is more aesthetically pleasing from a distance as it tends to blend in with the marble better this way. On closer inspection, one can readily see the difference in the marble and the cast concrete. Moisture seems to further highlight the differences, as some saturation in the cast concrete makes it visibly darker. Although cast concrete requires skill and is somewhat labor intensive, when compared to the skill and labor needed for the cutting and installing the original marble it does not match. Under the craftsmanship questions of: were similar construction techniques used and are the details of the original present

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<sup>102</sup> Ibid, 21-23.



in the replacement the rating was 'poor.' This rating points to the construction techniques, because these were totally different between the stone and process for casting the concrete. In terms of details between materials the color, texture and luster found in the original stone are incomparable in the cast concrete replacements. Last, under the craftsmanship category only the question of: Are the basic dimensions the same as the original received a rating of 'good,' because the units were cast to be the exact dimensions needed to fit the area where the failing stones were removed.



Figure 4.15: West side of south porte-cochère column (Photo by author).



Figure 4.16: North side of south porte-cochère column (Photo by author).

The category of replaceability asked only one question: Was it installed with the option of later removal? To answer this question, both a research based and

examination based conclusion contributed, where both rated as 'poor.' No evidence is present either in project documents found in the archives or upon physical examination of the area to indicate the intention of this to be a temporary solution with the option to remove the concrete units.

The next criteria category for the cast concrete stones was impact on surrounding materials. The deterioration and wear present on surrounding materials needed division into the subcategories of: biological, chemical, mechanical and anthropogenic. The subcategory of biological received a rating of 'good,' as there were very few signs that the cast concrete was causing any biological growth on the surrounding stone. There were areas of biological growth present on the stone, but it was on both areas next to cast concrete and areas surrounded by the original stone. This finding prevents any definite conclusion about the correlation of the cast concrete and biological growth. No signs of deterioration from chemical factors are evident, so the rating given was 'good'. The mechanical category under impact on surrounding materials received a 'poor' rating, as many areas show stone loss has occurred where the stone is adjacent to the cast concrete. Parging is evident on some of these areas, which was probably as past effort to prevent further deterioration of the area (See Figure 4.17). In the category of anthropogenic the rating was 'fair,' due to the fact that the decision to use cast concrete next to stone was not the best decision in the first place.



Figure 4.17: Detail of cast concrete and surrounding marble (Photo by author).

The final category under the criteria for evaluating the success of the project of replacement of failing marble with cast concrete is the category of weathering. Under this category, coloring received a rating of 'poor,' due to the fact that the cast concrete does not contain the color variation or luster that the marble offers (See Figures 4.18 and 4.19). The original stone has variations in color ranging between white and a light gray. Under the next category of surface texture, the rating given was 'poor' also. The original stone has a slightly rough and unpolished surface, while the cast concrete is smoother and includes small holes providing a different texture. Biological growth is the third category under the weathering criteria and received the rating of 'poor.' This



rating was low because many of the original stones have small amounts of moss or algae, none of the cast concrete units present biological growth, which further illustrates the noticeable differences in the weathering of both materials.



Figure 4.18: Detail of marble texture  
(Photograph by author).



Figure 4.19: Detail of concrete texture  
(Photograph by author).

Finally, a RILEM water penetration test provided information on both the marble and the cast concrete and their differences. Testing which lasted a period of thirty minutes, resulted in dramatic differences between the two materials. Both the stone and the cast concrete units started at the top measuring mark of zero, but the marble absorbed water much faster than the concrete did. After thirty minutes the marble's RILEM test tube measured at 5.5, while the concrete's tube measured just below zero showing it barely absorbed any water. This difference again shows another way in which these two materials are not similar.

Once the completion of the project assessments and the RILEM water penetration test occurred, clear conclusions about the success of the repair project emerged (See Figures 4.20 and 4.21). For the overall score the project received three ratings of 'good,' four ratings of 'fair' and nine ratings of 'poor.' Therefore, although there were successful parts of the repair project, overall the project was unsuccessful.



Figure 4.20: RILEM permeability testing of marble (Photograph by author).



Figure 4.21: RILEM permeability testing of concrete (Photograph by author).

## Mansion Roof Finials- Wood Replaced with Cast Polyurethane

### *Description and Background of Wooden Roof Finials*

Nine finials border the roof line of the veranda on the south side of the mansion wrapping onto part of the east and west sides (See Figure 4.22). The shape is often described by Lyndhurst staff as being similar to a Hershey Kiss candy. Original colorplates provide evidence and point to installation in 1864, when the building addition occurred. A color plate from 1838 depicting the original cottage known as “Knoll” includes the veranda, but ornamentation is minimal compared to what is present on the building today (See Figure 4.23).



Figure 4.22: Location of mansion roof finials on south elevation (Photograph courtesy of Lyndhurst website and altered by author).

A colorplate from 1865 depicting the additions that transformed the building into a mansion confirm that the finials were present at that time (See Figure 4.24). When Alexander Jackson Davis designed the addition to the building, he seems to have added more elaborate ornamentation to complete his vision.



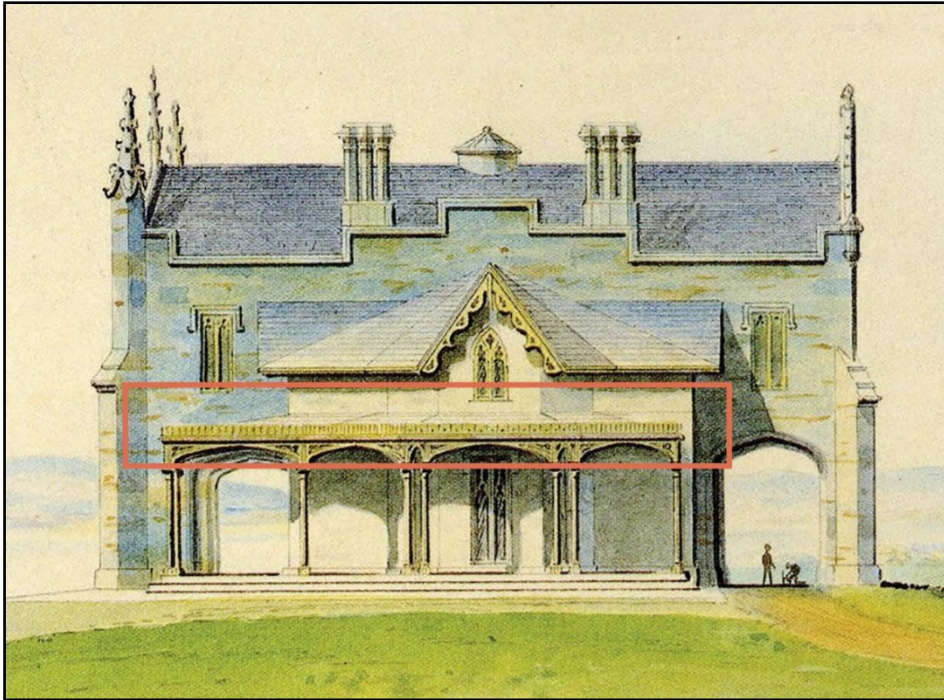


Figure 4.23: Colorplate of southern elevation of Knoll, 1838 (Courtesy of Alexander Jackson Davis: American Architect 1803-1892 by Amelia Peck, altered by author).

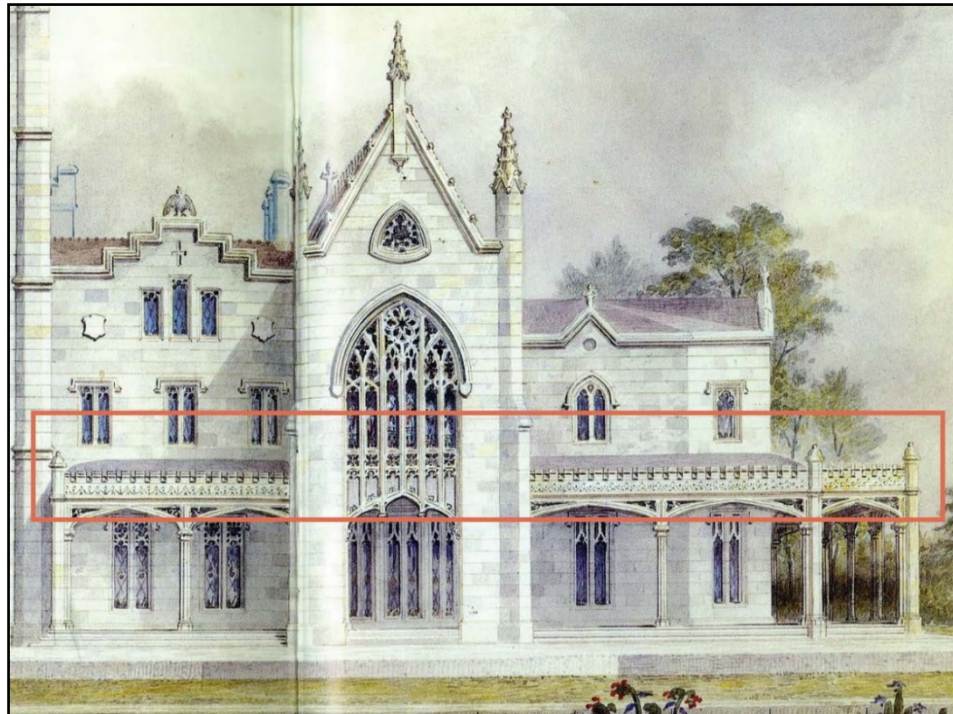


Figure 4.24: Colorplate of west elevation of Lyndhurst, 1865 (Courtesy of Alexander Jackson Davis: American Architect 1803-1892 by Amelia Peck, altered by author).

The original finials were made of wood, although there is no information pointing to exact species. Eventually the Lyndhurst staff decided these finials needed replacement due to their extremely deteriorated state. The Restoration Workshop received the task of recreating the finials to replace the originals on the mansion roof. No information in the archives at Lyndhurst reveals the exact year this was accomplished, but judging by similar work done for ornamental roof elements, it most likely occurred in the 1970s. Photos labeled with the year 1976, document the Workshop creating wooden elements such as crockets and pinnacles. According to Krystyn Hastings-Silver, current Associate Director of Lyndhurst, these second generation finials created by the Workshop were mahogany.<sup>103</sup> Depending on the original wood species of the finials, this might have been a departure from a true in-kind replacement. The second generation roof finials created by the Restoration Workshop remained in place for over thirty years when the determination was again made that they should be replaced due to their deteriorated condition.

#### *Replacement of Second Generation Wooden Roof Finials with Cast Polyurethane*

The replacement of the mahogany wooden finials created by the Restoration Workshop in the 1970s with cast polyurethane roof finials took place in 2012. Photos obtained from Lyndhurst show the extent of the deterioration on the second generation finials before the replacement occurred. Other than a few other photos depicting parts

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<sup>103</sup> Krystyn Hastings-Silver, interview by author, February 8, 2017.



of the casting process, no documentation provides information on this repair to the mansion. An interview conducted with the current Assistant Director of Lyndhurst, Krystyn Hastings-Silver provided insight into the project. Ms. Silver took part in the staff decision to install the cast replicas. She stated that although the intention was to create a report detailing the process after completion, understaffing and lack of time to devote to the document lead to the delay of a report again and again.



Figure 4.25: Original mansion roof finial (Photograph by author).

Although the staff at Lyndhurst initially wished to replace the deteriorated finials with replicas made from the same material, carved finials proved to be very expensive.

When presented to a craftsman for an estimate of the cost to reproduce each finial in wood, he returned a quote from seven-hundred and fifty to one-thousand dollars. Inquiry into alternative materials resulted from this high cost estimate. The staff sought an alternate replacement that required less cost, engineering and maintenance over time. Ms. Hastings-Silver consulted with the Smooth-On company to inquire about its performance and limitations. She discussed possible performance impacts such as exposure, conditions on site and climate. One area of concern that arose was heat created by reflection from the lead coated copper roof and the effect of the generated heat on the polyurethane. Ultimately the staff at Lyndhurst decided to give Smooth-Cast 300<sup>104</sup> a try and monitor it closely, especially since the product was only about a five-hundred dollar investment.

The process of creating the plastic finials was comparable to the casting process completed for the bowling alley brackets in 2016 and used the same products. A one to one mixture of Rebound 25<sup>105</sup> created the mold using an original second generation roof finial that was still intact. A mold release applied to the finial allowed the removal of the mixture once set and left the object unharmed. Next, the flexible mold needed a brace for support while the polyurethane mixture was poured and allowed to fully cure.

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<sup>104</sup> Smooth-Cast 300 Series. MSDS No. 402A; Smooth-On, Inc.: Macungie, PA. [https://www.smooth-on.com/msds/files/SC\\_300\\_300Q\\_320\\_380\\_45D\\_60D\\_61D\\_65D\\_66D\\_ONYX.pdf](https://www.smooth-on.com/msds/files/SC_300_300Q_320_380_45D_60D_61D_65D_66D_ONYX.pdf) (accessed on April 16, 2017).

<sup>105</sup> Rebound 25. MSDS No. 823A; Smooth-On, Inc.: Macungie, PA. [https://www.smooth-on.com/msds/files/BD\\_DS\\_Eco\\_Equ\\_EZB\\_EZS\\_Psy\\_MS\\_OOMOO\\_Reb\\_ST\\_SS\\_Soma\\_Sol\\_Sorta.pdf](https://www.smooth-on.com/msds/files/BD_DS_Eco_Equ_EZB_EZS_Psy_MS_OOMOO_Reb_ST_SS_Soma_Sol_Sorta.pdf) (accessed April 16, 2017).

A fiber filled resin product called Plasti-Paste<sup>106</sup>, another product manufactured by the Smooth-On company, provided the structure for the mold during the pouring. Using the mold, the Smooth- Cast 300 mixture was poured into the mold and allowed to set. Casting produced eight polyurethane finial replacements for installation, while an extra wooden mahogany finial was installed at the same time on the west side of the building. This wooden finial had been carved ten years prior, but sat protected inside the shop as the staff could not spend the money to replicate the rest of the finials in wood. The cast polyurethane and single wooden finial were primed with Rust-oleum automotive primer<sup>107</sup> and then painted with Benjamin Moore floor and patio, low sheen latex enamel.<sup>108</sup> Krystyn Hastings-Silver explained that they used the cast finials in an experiment to compare their service life with that of the wooden finial. This experiment is ongoing, with staff occasionally monitoring the materials. If the replacement castings survive in good condition without any problems, they will consider their placement a permanent solution.

Installation of the finials occurred once they were primed and painted to look like the second generation finials they were replacing. The same fittings and methods used to attach the wooden finials informed the installation of the replicas. Ms.

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<sup>106</sup> Plasti-Paste. MSDS No. 402A; Smooth-On, Inc.: Macungie, PA. <https://www.smooth-on.com/msds/files/Plasti-Paste.pdf> (accessed April 16, 2017).

<sup>107</sup> Rust-oleum Automobile Primer. MSDS No. SRT-34; Rust-oleum Corporation: Vernon Hills, IL. [https://www.rustoleum.com/~media/DigitalEncyclopedia/Documents/RustoleumUSA/TDS/English/CBG/Stops%20Rust/SRT-34\\_Stops\\_Rust\\_Automobile\\_Primer\\_TDS.ashx](https://www.rustoleum.com/~media/DigitalEncyclopedia/Documents/RustoleumUSA/TDS/English/CBG/Stops%20Rust/SRT-34_Stops_Rust_Automobile_Primer_TDS.ashx) (accessed April 16, 2017).

<sup>108</sup> Benjamin Moore Latex Floor & Patio Low Sheen Enamel. MSDS No. N122; Benjamin Moore & Co.: Montvale, NJ. file:///C:/Users/labuser/Downloads/20140908\_N122\_TDS\_US\_OKF.pdf (accessed April 16, 2017).

Hastings-Silver feels that the finials have worked out well and are determined to be a success so far based on their performance over the past five years. She also noted that they have never needed to be painted nor maintained during this period of time.<sup>109</sup>

*Conditions Assessment and Findings, December 2016*

Assessment and examination of the replicated roof finials on the mansion veranda took place in December of 2016. The assessment included the same categories covered by the other projects examined in this thesis. The four categories for assessing the success of the mansion roof finial replacement are: craftsmanship, replaceability, impact on surrounding materials and weathering.

In the category of craftsmanship, the results ranged from 'good' to 'poor.' The questions within the category with the rating of 'good' included: 1) is it aesthetically pleasing, 2) are the basic dimensions the same as the original; and 3) are the details of the original present in the replacement? Because the replacements are nearly exact replicas of the second generation finials they replaced, they are almost as aesthetically pleasing as the wooden ones, the only difference being the lovely grain and color variations of the wood not present in the castings. Also, due to the fact they are replicated castings, the dimensions and details of the original are present in the reproductions. The rating of 'fair' applied to the question: was skill required to make it? In comparison to the previous generation of finials carved from wood, a lesser skill set

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<sup>109</sup> Krystyn Hastings-Silver, interview by author, February 8, 2017.

produced the cast finials. The last rating of 'poor' applied to the questions of: was the process of producing labor intensive and were similar construction techniques used? Because this question requires comparison to the original, the conclusion can be made that the process is not as laborious as carving the finial from wood. Similarly, the construction techniques used are very different.

The next category of replaceability asked only the question: Was it installed with the option of later removal? Subcategories within the question lead to two ratings of 'fair.' The two subcategories are: research based conclusions and physical examination based conclusions. Research based conclusions in the form of an interview pointed out that the finials could be removed fairly easy, but likely will not happen due to the money saved with this solution. Because of this, the research based subcategory received the rating of 'fair.' The rating of 'good' also applied to the physical examination based conclusion due to the fact that the finials seems pretty securely attached when examined and no specific means of attachment was readily apparent.

The category of impact on surrounding materials produced the rating of 'good' for all subcategories. The subcategories created relating to deterioration and wear are: biological, chemical, mechanical and anthropogenic. The subcategories of chemical and anthropogenic received the rating of 'good' because no visible evidence pointing to inflicted conditions resulting from the polyurethane were apparent. In the subcategory of biological small amounts of algae or mold were evident in some depression areas

receiving little sunlight, but nothing significant. In the category of mechanical, the fasteners offered no indication of harmful impacts on the surrounding materials.



Figure 4.26: Wooden roof finial (Photography by author). Figure 4.27: Polyurethane finial (Photograph by author).

The final category of weathering contains the subcategories of: coloring, surface texture and biological growth. The intent of the subcategories is to compare the replica with the second generation finials which it replaced (See Figures 4.26 and 4.27). Ratings within the category fell under both 'fair' and 'poor.' The subcategories of coloring and biological growth received the ratings of 'fair.' Coloring of the second generation finial is slightly dull, while the replicas cast in polyurethane are still bright and new looking compared to the original. The wooden finial showed no signs of biological growth, while the substitute finials seemed to have a mold or algae growing in the cracks and recesses receiving little light as possibly collecting moisture. Finally, the subcategory of surface texture received the rating of 'poor.' While the wooden finial was somewhat distressed

looking with cracked paint, the substitute finials looked very much pristine, as if painted recently.

After adding up the rating for the mansion roof finial replacement project an overall score could be determined. The ratings of the project amounted to seven ratings of 'good,' five ratings of 'fair' and three ratings of 'poor.' The final scoring therefore concludes that at this time the project is successful. It is unclear if the substitute materials will continue to perform well, but at this time they are doing an overall good job fulfilling their purpose without causing problems to the building.



Figure 4.28: South elevation of swimming pool building (Photograph by author).

### Swimming Pool Building

Lyndhurst's swimming pool building sits on the northern part of the property just east of the estate's conservatory. Lyndhurst commissioned the New York City architectural firm of Crow, Lewis & Wickenhoefer to design the building for the pool (See Figure 4.29). After being constructed in the years 1910 to 1911, it was described by the New York Times on October 10<sup>th</sup> 1910 as, "140 feet long and 60 feet wide. It will be of brick, with Indiana limestone trimmings. The pool will be 70 feet long by 35 feet wide, lined with mosaic and roofed with glass. Lounging and dressing rooms will be handsomely fitted up, and with the shower baths will make it one of the finest swimming pools in the country."<sup>110</sup> The building, designed in the Classical Revival style,

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<sup>110</sup> Victoria Fox, "The Bowling Alley and the Swimming Pool at Lyndhurst," (report, Vassar College, 1979), 17.



was extremely fashionable during that time and used a Roman atrium interior design. This Pompeiian inspired architectural style was very popular in the early twentieth century for pools throughout the country.

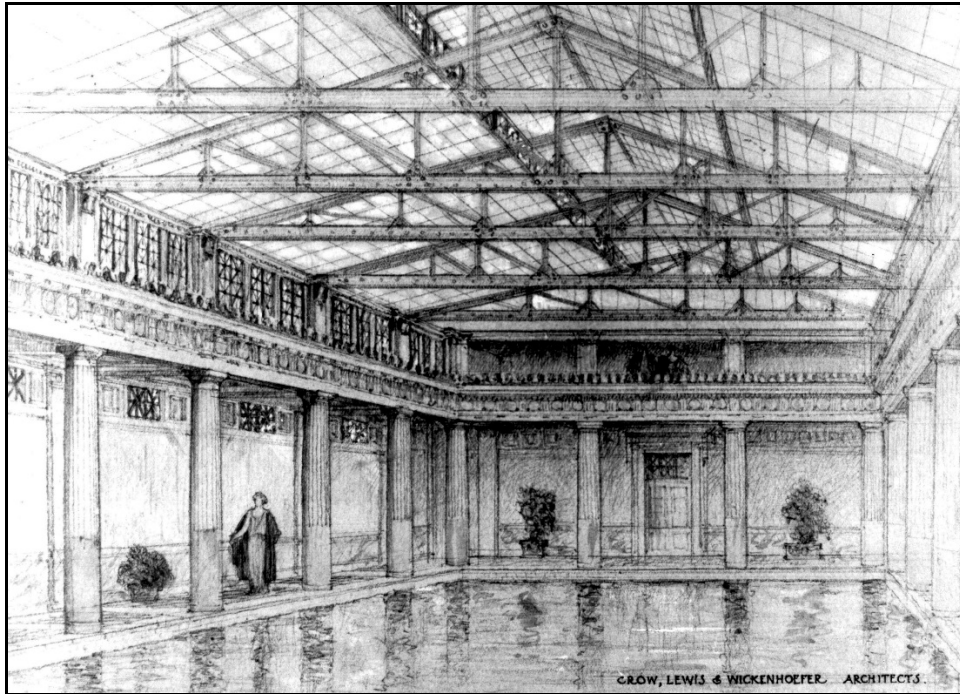


Figure 4.29: Rendering of swimming pool building interior by Crow, Lewis & Wickenhoefer (Lyndhurst Archives).

Lyndhurst's example stood out from most however, in that it was an autonomous structure standing in a secluded part of the property, as opposed to being attached to the main house as was often the custom. The building would be the last of the foremost buildings constructed on the property.<sup>111</sup>

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<sup>111</sup> Barbara M. Hammond, James Diermeier, Anne-Marie Demetz, "Swimming Pool Building," (Historic Structures Report, 1988), 1.



Figure 4.30: Gould and Shepard family, interior of swimming pool building, c. 1920 (Lyndhurst Archives).

### Swimming Pool Building Roof- Glass Replaced with Corrugated Metal Paneling

#### *Description of Roof Replacement*

When the National Trust acquired the property in 1961, the swimming pool was in fairly good condition.<sup>112</sup> The original plan for the building was to implement an adaptive reuse and several potential plans were drawn. The unused structure deteriorated rapidly after this reuse never happened due to unknown reasons. Photos taken eight years after acquisition by the National Trust in 1970 show the fragile state of the building (See Figure 4.31). Highlighted problems mentioned in a 1979 property

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<sup>112</sup> Ibid, 25.

development plan included, “a leaking roof, broken skylight glass, water damage to the walls and floors, unusable mechanical systems and rusted steel beams.”<sup>113</sup> The National Trust considered demolition of the building, but ultimately decided instead to save and stabilize it. In 1984, the Planned Parenthood of Westchester and Rockland donated fifteen thousand dollars to stabilize the building. Planned Parenthood leased the building for five years, in exchange for this monetary support.<sup>114</sup> The work on the building consisted of a demolition of the interior and the restoration of the flooring and roof. The roof restoration was not true however, the repair was not back to any specific time period before, which would have meant installing a glass roof. Instead, corrugated aluminum panels were installed as a cover.



Figure 4.31: Interior of swimming pool building, 1970 (Lyndhurst Archives).

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<sup>113</sup> *Ibid*, 12.

<sup>114</sup> *Ibid*, 25, 10.

The corrugated aluminum roof cost \$23,400 and in August of 1984 installation took place (See Figure 4.32).<sup>115</sup> According to David Overholt who was the Restoration Project Manager for Lyndhurst from the years 1987 to 2003, the roof had little to no maintenance during that time and was never in need of replacement. The aluminum roof was not a permanent solution according to him, but a measure to stabilize the building to prevent further damage and water from getting inside.<sup>116</sup> A Historic Structure Report done in 1988 of the Swimming Pool Building pointed to the intention of starting the process of restoring the exterior of the building seven years later, but does not mention the roof specifically.<sup>117</sup>



Figure 4.32: Corrugated aluminum roofing installation, 1984 (Lyndhurst Archives).

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<sup>115</sup> Westal Contracting Corp., invoice to National Trust for Historic Preservation, August 29, 1984.

<sup>116</sup> David Overholt, interview by author, January 13, 2017.

<sup>117</sup> Hammond, et al, "Swimming Pool Building," (Historic Structures Report, 1988), 26.

In November of 2003, Lyndhurst applied for a Historic Sites Fund Grant through the National Trust for Historic Preservation within the category of “Corrective Maintenance & Capital Improvement” under project type and the category of “Emergency” under grant type. The requested amount for the work was \$35,000 for masonry stabilization. According to the written portion of the grant, brick parapet walls were close to collapsing and about 75% of the building needed to be repointed due to erosion. No mention was made of the aluminum corrugated roof, but the report does disclose that water was getting into some areas of the building. It does not list any work done on the building since the stabilization process that occurred in 1984.<sup>118</sup> An award of \$15,000 presented in a matching grant to Lyndhurst was received, but on the condition that the money would not be used for masonry stabilization. Instead, it stipulated a thorough conditions assessment and study of the building to develop a preservation plan.<sup>119</sup> The absence of a report in the records accessed at Lyndhurst makes it unclear whether this work actually took place.

David Overholt confirmed that during his time at Lyndhurst from 1987 to 2003, there was no replacement of the roof.<sup>120</sup> It is then fair to conclude that during the four years between its installation and the time David Overholt began working on the property, this roof would still have been in good working condition. Another interview

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<sup>118</sup> Lyndhurst Estate, Historic Site Fund application to National Trust for Historic Preservation, November 12, 2003, 1.

<sup>119</sup> National Trust for Historic Preservation, notice of Historic Sites Fund Grant award to Lyndhurst Estate, April 7, 2004.

<sup>120</sup> David Overholt, interview by author, January 13, 2017.

conducted with the current Restoration Project Manager for the property, Thomas Richmond confirmed that no changes to the roof were performed while he has been there, nor during the time prior to his appointment.<sup>121</sup> Because of this, it is fair to assume that the corrugated metal roof that currently sits on the swimming pool building at Lyndhurst is the same one installed in 1984 with the intention of stabilizing the structure.

*Conditions Assessment and Findings, December 2016*

Upon returning to Lyndhurst in December 2016, additional research and a physical inspection of the materials on the Swimming Pool Building roof provided additional information for an assessment. Due to the fragile nature of the building and its materials, a thorough up close investigation of the roofing and surrounding materials was not an option. Instead, extensive photos zooming in on materials and conditions was adopted. On the interior of the building, photos were taken from the ground and on the exterior photos were taken from the lower flat roof located on the south wing at the front of the building. This portion of the roof offered its own limitations, as some areas were not safe to walk on due to water penetration and degradation of materials. From the vantage points available, the assessment included inspection of materials with accompanying photos taken. Despite these limitations, a conditions assessment was

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<sup>121</sup> Thomas Richmond, interview by author, January 20, 2017.

done within the four categories of craftsmanship, replaceability, impact on surrounding materials and weathering.



Figure 4.33: Interior of swimming pool building, 2016 (Photograph by author).

In the category of craftsmanship, the results for the roof ranged from ‘good’ to ‘poor.’ The replacement was rated as ‘good’ under the question of: Are the basic dimensions the same as the original? Although examination up close was limited due to safety, this conclusion could be made because the roof dimensions are most likely the same. The roof rating of ‘fair’ was applied to the question: Was the process labor intensive? The only somewhat laborious component related to the roof was the installation of the paneling, while the material itself was machine made. The project received ‘poor’ ratings under the following questions related to craftsmanship: 1) is it aesthetically pleasing; 2) was skill required to make it; 3) were similar construction



techniques used; and 4) are the details of the original present in the replacement? The metal paneling is clearly not an aesthetically pleasing choice and glass and metal are two totally different and incomparable materials. Construction and skill behind the materials is also very different. Similar details cannot be considered, because of the transparent properties of the glass and the undulating characteristics of the metal paneling (See Figure 4.34).



Figure 4.34: Detail illustrating condition of corrugated aluminum roofing, 2016 (Photograph by author).

The assessment category of replaceability asked the question: Was it installed with the option of later removal? Two subcategories within the question were created to reach a conclusion. These two categories are: research based conclusions and



physical examination based conclusions. The rating for both of the categories behind the question was 'good.' Research behind the project clearly points out that the metal roofing was chosen as a way to stabilize the building until further work could be done to fix the various problems affecting the structure. Observation of the materials and work done to install the roofing also clearly points to the intention of impermanence.

Under the category of impact on surrounding materials the ratings given were 'fair' and 'poor.' The deterioration and wear subcategories are: biological, chemical and anthropogenic. The fourth category of mechanical was not included due to the inaccessibility of the roofing and surrounding materials for close examination. Only the biological subcategory received the rating of 'fair.' The last two subcategories of chemical and anthropogenic received the rating of 'poor.' Biological factors affecting the materials are the access points in which plants and animals are able to enter the building. In several areas where the metal paneling reaches the plywood exterior supports or brick of the original structure, openings can be found. Plants and vines can clearly be seen on some areas of the interior, while the openings also suggest the straightforward entry inside for small animals such as squirrels and birds (See Figure 4.35).

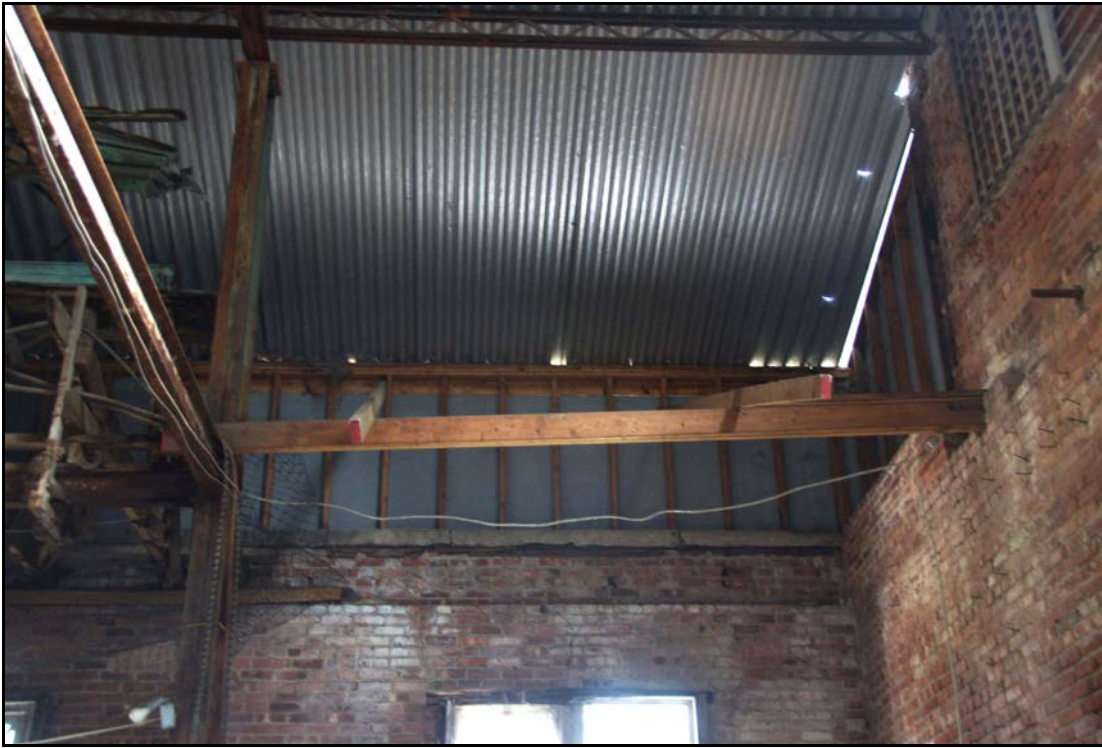


Figure 4.35: Detail of openings present in roofing, 2016 (Photo by author).

The final category of weathering was ultimately left out of the scoring of the project, as again, the roof and surrounding materials could not safely be accessed for close inspection. After adding up the overall rating numbers, the project received three ratings of 'good,' two ratings of 'fair' and five ratings of 'poor.' The scoring clearly indicates that this project cannot be considered successful. It should be noted however, that it was meant to be a temporary solution and remains unchanged due to unavailable funding which would provide the appropriate replacement of the corrugated metal roof paneling with glass or at least a more protective option.



Figure 4.36: West elevation of swimming pool building, 2016 (Photograph by author).

### Bowling Alley

Lyndhurst's bowling alley sits on the western edge of the estate close to the Hudson River. Built in 1894 at the request of Helen Gould, the sport became very fashionable toward the end of the nineteenth century and was an acceptable sport for women to participate in. The building is an example of the Shingle style and is likely the first regulation sized bowling alley in the United States. The alley contained two lanes for bowling and large reception rooms on the north and south ends for Helen to receive guests when entertaining.<sup>122</sup> The north room also served as the Lyndhurst Sewing School through the early 1900s. A second story contained rooms above the reception areas, probably once used as sitting areas, and a crawlspace above the alleys between the two rooms, which allowed ventilation when windows were opened. During World

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<sup>122</sup> Victoria Fox, "The Bowling Alley and the Swimming Pool at Lyndhurst," (report, Vassar College, 1979), 7.

War II, Helen set up the clubhouse on the property as a place for wounded sailors to recover, while allowing them to access the bowling alley for playing billiards and bowling.<sup>123</sup> At some point after this period the bowling alley was no longer in use and went into a gradual decline.



Figure 4.37: Drawing from Leslie's Popular Monthly, 1895 (Lyndhurst Archives).

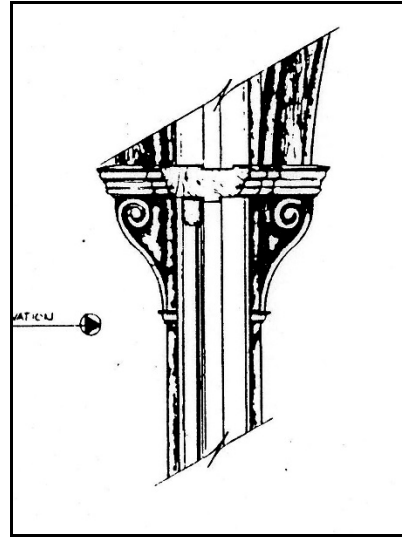


Figure 4.38: HABS detail of large brackets (Lyndhurst Archives).

### Bowling Alley Decorative Brackets- Wood Replaced with Cast Polyurethane

#### *Bowling Alley Restoration Background*

When the Trust took over the Estate in the 1960s, the bowling alley was already in bad shape (See Figure 4.39). Time and money dictated when the completion of repairs occurred during this period. The restoration of the bowling alley started in the mid 1990's. The efforts of research, investigation and documentation took precedent

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<sup>123</sup> Victoria Fox, "The Bowling Alley and the Swimming Pool at Lyndhurst," (report, Vassar College, 1979), 21.

during this time in preparation for the repairs to the building.<sup>124</sup> A new shingle cedar roof was among the first of the priorities, which happened in 1995.<sup>125</sup> It was not until 2009 however that other priorities were addressed when limited funding provided a chance to start on the restoration.<sup>126</sup> The second phase of the restoration received funding from a combination of sources. According to Thomas Richmond, the current Restoration Project Manager, a combination of private donors and state grants funded the last phases. Mr. Richmond oversaw the final phases of the building restoration, which started during the summer of 2014 and was finally completed in July of 2016 with the help of interns (See Figure 4.40).<sup>127</sup>



Figure 4.39: Interior of bowling alley before restoration (Lyndhurst Archives).

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<sup>124</sup> Thomas Richmond, interview by author, January 20, 2017.

<sup>125</sup> Dave McMahon, "Revitalizing History," *Bowler's Journal International*, November, 1999.

<sup>126</sup> Laura Joseph Mogil, "Bowling for History at Lyndhurst," *New York Times*, March 2009, *New York Times* website, <http://www.nytimes.com/2009/03/15/nyregion/westchester/15bowlingwe.html> (accessed February 12, 2017).

<sup>127</sup> Thomas Richmond, interview by author, January 20, 2017.

### *Description of Decorative Bracket Replacement*

Two sizes of decorative brackets are part of the original features adorning the inside of the bowling alley. Of these, two large and seven small brackets were missing or in an unusable condition. The large brackets sit at the ends of large wooden arches equally spaced, framing the two bowling lanes from start to end. The arches ended at a column on their east side which contains two smaller brackets attached to the columns on each side. These small brackets frame the column in the top corner of the north and south ends. Both of the bracket types are hand-carved and incorporate a spiral design. The wood type of the brackets is poplar, according to Thomas Richmond. The brackets are fairly simple, but charming and add to the overall aesthetic quality of the bowling alley interior. Because of this, the brackets are character defining features of the building.



Figure 4.40: Interior of bowling alley, 2016  
(Photograph by author).

The decision to replicate the brackets by casting them came only after receiving a quote on the pricing to replicate them in wood. Initially, Lyndhurst approached the same person who recreated the mantel piece in the north parlor about replicating the missing brackets. According to the quote given, the small brackets would cost eight-hundred and fifty dollars, while the large brackets would cost one-thousand, one-hundred and fifty dollars each to replicate in wood. Since this was a large expense for Lyndhurst, the staff decided to try replicating them in a different material by casting.<sup>128</sup> The product Smooth-On 300 was already on hand at Lyndhurst, because of its use previously for the mansion finials located on the mansion veranda's roof. In the summer of 2016, Thomas Richmond and four summer interns took on the replication of the brackets using this product. The effort resulted in two large and seven small polyurethane replicas of the brackets.

The process consisted of first making a mold of an intact example of each bracket size using Rebound 25, a product also manufactured by the same company as Smooth-On 300. The application of the Rebound 25 one part to one-part mixture occurred after the spraying of the original bracket for easy removal after setting. The completed mold then needed support to prevent the distortion of the form, constructed consisted of scrap wood. The pouring of a one part to one-part mixture of Smooth-Cast 300 into the supported mold occurred next. Once allowed to set up, priming and staining of the replica completed the preparation before installation into the bowling

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<sup>128</sup> Thomas Richmond, interview by author, January 20, 2017.



alley. The use of stainless steel screws to attach the brackets to the interior of the bowling alley marked the completion of the project in July of 2016 with the help of summer interns.



Figure 4.41: Large brackets (Photo by author).



Figure 4.42: Small brackets, casting in white (Photo by author).

#### *Conditions Assessment and Findings, December 2016*

Assessment and examination of the replicated brackets in the bowling alley took place roughly six months later at Lyndhurst. Assessment conducted covered the same four categories as the other projects examined in this thesis. The four categories for assessment of the bowling alley brackets are: craftsmanship, replaceability, impact on surrounding materials and weathering.

In the category of craftsmanship, the results ranged from ‘good’ to ‘poor.’ Questions receiving a rating of ‘good’ included: 1) is it aesthetically pleasing; 2) are the basic dimensions the same as the original; 3) and are the details of the original present



in the replacement? The replacement brackets are exact replicas of the original bracket form and therefore are nearly as aesthetically pleasing as the originals in wood (See Figures 4.43 and 4.44). The dimensions and details of the replica and original are the same because of the precision that casting allows. The rating of 'fair' applied only to the question: Was skill required to make it? Although casting requires skill and a certain amount of work and practice to master, it is a very different skill set than wood working. The last rating of 'poor' applied to the questions of: 1) was the process of producing labor intensive; 2) and were similar construction techniques used? Because this question required comparison to the original it can be concluded that the process is not as laborious as carving the bracket from wood. Similarly, construction techniques used are very different.



Figure 4.43: Original wooden bracket (Photo by author).



Figure 4.44: Polyurethane bracket (Photo by author).

The assessment category of replaceability asked the question: Was it installed with the option of later removal? Two created subcategories within the question helped to reach a conclusion. These two subcategories are: research based conclusions and physical examination based conclusions. Research based conclusions in the form of an interview pointed to the definite possibility of the brackets removability; however, it is likely that this will not happen due to cost of the replacing in-kind and its place on the list of priorities in terms of repairs at Lyndhurst.<sup>129</sup> Because of this, the research based subcategory received the rating of 'fair.' The rating of 'good' applied to the physical examination based conclusion due to the fact that the brackets would simply need to be unscrewed for replacement.

The category of impact on surrounding materials produced the ratings of 'good' and 'fair.' The subcategories created relating to deterioration and wear are: biological, chemical, mechanical and anthropogenic. The three subcategories of biological, chemical and anthropogenic received the 'good' rating. Because the brackets are located on the interior of the bowling alley building, the possibility of biological attack is greatly reduced, but can't be ruled out completely. At this time however, there is no evidence of biological related deterioration, perhaps attributed to the short time of installation. Similarly, no indications of chemical or anthropogenic deterioration are visible at this time. Lastly, in the subcategory of mechanical, the project received the

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<sup>129</sup> Thomas Richmond, interview by author, January 20, 2017.

rating of 'fair.' The screws used to attach the brackets to the surrounding wood penetrate the wood enough to cause an impact, however not a tremendous one.

The final category of weathering considered the subcategories of: coloring, surface texture and biological growth. Ratings within the category ranged from 'good' to 'poor.' The subcategory of coloring received a rating of 'poor,' because of the staining applied to the cast polyurethane. When compared to the original brackets the difference is quite striking, as the natural aging process of the wood produces fading in some areas while the replicas look much newer. Under the subcategory of surface texture, the project received the rating of 'fair.' Although both the original and the replacement are smooth, the feel and look of the wood grain is distinct, differing from the ultra smooth finish of the polyurethane. The last subcategory of biological growth received the rating of 'good,' because none was present when examined.

After adding up the ratings from all of the categories for the bowling alley bracket replacement project an overall score could be determined. The ratings of the project amounted to eight ratings of 'good,' four ratings of 'fair' and three occurrences of 'poor.' The final scoring concludes that at this time the project is determined to be successful. At the time of the assessment the project was only six months old. Because of this, it is uncertain if this scoring conclusion will stay the same. At this time however the replacement seems to be working out well.

## **PART TWO: FINANCIAL ANALYSIS**

### General Financial Outlook (1968-1996)

Identifying an overall financial summary of Lyndhurst relied on the evaluation of various documents from the property's archives. Meeting minutes, development plans, financial strategies and budgets helped identify patterns from the late 1960s up through the mid 1990s. Financial information after this period of time ultimately proved to be inaccessible despite efforts requesting information from Lyndhurst and the National Trust for Historic Preservation. Although material for the time period around the projects occurring in 2012 and 2016 was inaccessible, it is possible to draw conclusions based on correspondence, interviews and general observation. Several trends based on content found in the accounting files emerge over the years. Although there seem to be years when income increased, Lyndhurst seemed to operate with the need for the National Trust providing extra funding to help ease the deficit.

Beginning with the year 1968, the speculated time period when repointing occurred with portland cement on portions of the mansion, there was mention of approval of a budget with a sizeable deficit. Presented was a plan with a goal to eliminate this deficit over a period of five years.<sup>130</sup> The following year in 1969, the financial situation seems worse with a budget review noting that the National Trust was experiencing a major loss of income due to a Federal appropriations cut-back. The

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<sup>130</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council, 3:00pm," (Council Meeting, Lyndhurst Guest Cottage, Tarrytown, NY, December 3, 1968), 2.

result of this was a curtailment of the planned repairs and improvements for the property that year. Despite this setback, the committee suggests a plan to request federal funds with an even larger amount than solicited the previous year.<sup>131</sup>

Early in the 1970s under the heading of Capital Work List, meeting minutes of the Lyndhurst Council stated that restoration of the buildings on the property would cost approximately \$5,000,000. The meeting minutes go on to note that the Trust received roughly six percent of the \$5,000,000 amount from the federal government. Half of this was to go toward the department of properties, and of this, seventy percent awarded to Lyndhurst for use in restoration and rehabilitation projects.<sup>132</sup> This report puts into perspective the property's needs and what realistically it could secure in terms of outside funding. Later that year, another set of meeting minutes outlining the combined deficit for all National Trust properties pointed out that nearly one half of the deficit belonged to Lyndhurst alone.<sup>133</sup> In response to this deficit, the National Trust announced a reduction of different components of the budget. The following year at another meeting, the council discussed that Lyndhurst's intention to claim a large portion of the Trust's funds for needed operation and restoration was problematic.<sup>134</sup> This trend continued going forward in the 1970s, eventually leading to a decrease in

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<sup>131</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council, 3:00pm" (Council Meeting, Lyndhurst Guest Cottage Conference Room, Tarrytown, NY, March 12, 1969), 2.

<sup>132</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council, 3:00pm" (Council Meeting, Lyndhurst Mansion, Tarrytown, NY, March 3, 1970), 2.

<sup>133</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council, 3:00pm" (Council Meeting Lyndhurst Mansion, Tarrytown, NY, June 30, 1970), 2.

<sup>134</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council, 3:00pm" (Council Meeting, Lyndhurst Mansion, Tarrytown, NY, March 2, 1971), 2.

funds for overall operation of the site, the reorganization of staff and even cutbacks to staffing.<sup>135</sup>

Around this time, the first mention of the Restoration Workshop occurred and the hope that it could offset some of these financial burdens facing the property and the National Trust.<sup>136</sup> A meeting between all property council chairmen held at the Trust's site of Chesterwood in 1976, addressed the strains placed on the Trust by its house museum properties. It was noted that too much of the funding received by the Trust was going to these properties when the money was needed to further the organization's mission of providing educational materials, grants and technical assistance to advocate for preservation across the country. Because of these funding concerns, a goal emerged that properties currently owned, as well as future acquisitions, were to reach a level of self sufficiency so that the Trust could pursue its national goals. There was some dissent to this proposal at the meeting, however. One attendee noted that it was unrealistic and even treacherous to assume that all properties were capable of self-sufficiency. Reiterated later, was the importance of these sites, "the museum properties are extremely valuable assets which require special attention, since they are, in effect, important cells in the body of the National Trust, capable of furthering the purposes of preservation and the National Trust and stabilizing local historic preservation

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<sup>135</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council, 3:00pm" (Council Meeting, Lyndhurst, Tarrytown, NY, September 19, 1972), 2.

<sup>136</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council, 3:00pm" (Council Meeting, Lyndhurst, Tarrytown, NY, December 5, 1972), 2.

communities.”<sup>137</sup> Identification of Lyndhurst as being more problematic than other Trust properties occurred later in the meeting, specifically in terms of the number of buildings needing repair and maintenance.<sup>138</sup>

In the 1980s, the drafting of several development strategies occurred in response to economic troubles marking the previous years of Lyndhurst under the care of the National Trust. One listed a goal of budget reductions for both the National Trust and its properties. Lyndhurst and Cliveden were listed as sites needing major cutbacks and having the most troublesome program, preservation and economic problems.<sup>139</sup> A budget strategy for lowering the property deficit at Lyndhurst called for reductions including decreasing the grounds and building maintenance. Outlined was the idea that there should be a focus on interpretation, conservation and restoration of the property by the staff and continued efforts to secure alternate sources of income. The document named the National Trust headquarters as being responsible for overseeing future rehabilitation and restoration on the property.<sup>140</sup> Restoration projects presented to begin in the near future were the mansion and bowling alley. Alternatively, the swimming pool building was identified as a future rehabilitation project. The recommendation was that fundraising for these projects begin immediately.<sup>141</sup> A major goal listed in another development plan for the 1980s was fundraising, while another

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<sup>137</sup> Council Chairmen Meeting Minutes, “Meeting of Council Chairmen” (Council Chairmen Meeting, Chesterwood, Stockbridge, MA, August 16-17, 1976), 4.

<sup>138</sup> *Ibid*, 6.

<sup>139</sup> Lyndhurst Development Strategy, 1981, 1.

<sup>140</sup> *Ibid*, 2.

<sup>141</sup> *Ibid*, 4.

expanded goal outlined in the plan claimed that Lyndhurst should aim for 75-80% of costs associated with operation to be supported by revenues generated directly from the property, by 1986.<sup>142</sup> Under a section entitled management, a recommendation stated that the salaries for maintenance staff be more competitive with those in the surrounding area of Westchester County. Additionally, the document suggested that Lyndhurst could function with less staff if those employed were more qualified and had a high level of skill. Lastly, outlined in this section, the National Trust's involvement with Lyndhurst again: "Resources of the National Trust will never be adequate to meet fully ideal staffing requirements for an estate such as Lyndhurst. The properties staff must expand its programs to attract volunteer support for the property."<sup>143</sup>

Later in a 1983 council meeting, the target of self-sufficiency was deemed unrealistic, which suggests that even growth in donations and operating income was likely never to offset the deficits acquired by Lyndhurst. Identified need was that increased endowment is essential for meeting standards for maintenance on the property. Listed as one of three primary sources of income, the endowment assisted in funding the operations along with program earned income and annual giving funds.<sup>144</sup> Expressed as being negligible, the contribution of the endowment fell short when compared to the site's expenses for operation.<sup>145</sup> A table of Lyndhurst's finances from

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<sup>142</sup> Summary Recommendations: Lyndhurst Development Plan, 1980, 7.

<sup>143</sup> Ibid, 9-10.

<sup>144</sup> Lyndhurst Financial Strategy: 1983-1987, 1-2.

<sup>145</sup> National Trust for Historic Preservation Headquarters, correspondence letter to Wayne Crosby, January 20, 1982.



the year 1977 to 1982 showed endowment income as changing considerably from year to year, sometimes as much as a ten-thousand dollar difference.<sup>146</sup> Another financial statement showed the endowment down almost twenty-thousand dollars in 1984 from what it was in 1982.<sup>147</sup> During this time, estimated deferred maintenance on the property stood at approximately six million dollars.<sup>148</sup> Development of the bowling alley and swimming pool building were presented as income generating solutions, however this work does not start for decades to come and in the case of the swimming pool building, it never occurred.<sup>149</sup>

In the mid 1990s, the financial outlook for Lyndhurst had not changed for the better. One-third of Lyndhurst's income disappeared resulting from the loss of half of total Congressional funding for the Trust.<sup>150</sup> Creation of a five-year plan occurred during this time in preparation for total withdrawal of federal funding and with the goal of eliminating the need for funds from the National Trust. The document listed that in the past the Trust provided twenty-nine percent of the operating budget for the property, which over the years decreased to twenty-three percent and finally to seventeen percent. Projected income needed by 2001 stood at nearly twice of that produced in

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<sup>146</sup> Financial Overview paperwork 1977-1982, Exhibit A, 1.

<sup>147</sup> Lyndhurst Council Meeting Minutes, "Meeting of the Lyndhurst Council" (Council Meeting, Lyndhurst, Tarrytown, NY, March 6, 1984), 2.

<sup>148</sup> Lyndhurst Financial Strategy, 1983-1987, 4.

<sup>149</sup> National Trust for Historic Preservation Headquarters, correspondence letter to Wayne Crosby, January 20, 1982.

<sup>150</sup> Wrightson, Karolyn, "Historic Sites Cope with Budget Cuts," *Lifestyles*, Gannett Suburban Newspapers, January 20, 1996.

1995 when the budget was drafted.<sup>151</sup> The end of the plan recommended increasing the endowment considerably, by \$7,000,000 to be specific.<sup>152</sup> A council meeting held after the development of the five-year plan concluded that the seven million dollars was a low estimate. Realistically, another \$4,000,000 would be required to meet existing needs according to the meeting minutes.<sup>153</sup>

### Financial Analysis

Although there are specific years during the 1980s when Lyndhurst seems to be doing better financially than in previous years in terms of income, the overall trend from 1968 to 1996 points to Lyndhurst being continuously behind financially and operating at a deficit. The poor financial state of Lyndhurst during this period is attributable to a number of factors. The first is the number of buildings on the property and the already declining condition of a number of them. Had the buildings been in a better state at the beginning of ownership, it is likely it would have been easier on the National Trust and staff at Lyndhurst to keep up with the needs to maintain the buildings in good condition. However, records reveal that the recreation building (bowling alley), carriage house and swimming pool building were in varying states of less than perfect condition. Instead, the staff was already starting out with the setback of deferred maintenance. Other factors in reports and minutes of council meetings repeatedly pointed to the reduction

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<sup>151</sup> Lyndhurst in 2001: A Five Year Plan for Self Sufficiency, 1.

<sup>152</sup> Ibid, 3.

<sup>153</sup> Lyndhurst Council Meeting Minutes, "Lyndhurst Property Council Meeting, 5:00pm" (Council Meeting, Lyndhurst Great Room, Tarrytown, NY, December 6, 1995), 2.

of congressional funding and an inadequate endowment. Congressional funding seems to have been cut back periodically until it was eliminated completely, ending an important part of funding for the site. Every decade contains meeting minutes mentioning the endowment as being too low. It is unclear if the endowment amount received from year to year was dictated by need or simply by the amount of money available at the time. Regardless, it is clear that the endowment is a problem during these years and most likely since then.

Trends in operational income generated by the site itself are another factor affecting the property's financial posture. Repeatedly expressed is the inability of the site to generate enough money to cover their operation expenses. Within this vein, a definite take away identified in meeting minutes and development plans is the push for Lyndhurst to become self-sufficient and phase out funding by the National Trust for Historic Preservation. Despite this goal, the site is clearly never in the position to eliminate aid from the Trust or other outside sources. To this day, Lyndhurst is at least partially dependent on help from the National Trust. Always on the agenda throughout these years, is the need to start or complete rehabilitation and restoration projects at Lyndhurst. The idea behind this discussion is that with completion of projects such as the bowling alley and swimming pool building, these buildings could serve the function of useable space generating income. The aim was to use these areas for events or other income creating purposes. The reality is the bowling alley restoration completion occurred in 2016 and the swimming pool building is yet to start any kind of

rehabilitation process without significant funding. Financial setbacks made the aim of repairing these buildings out of reach for years and years. Although financial information could not be accessed for the years after 1996, it is clear that similar financial constraints existed based on the lack of completion of these goals. Currently, the property faces a budget that often requires the need to set priorities and postpone work that is not urgent.<sup>154</sup>

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<sup>154</sup> Krystyn Hastings-Silver, interview by author, February 8, 2017.

### **PART THREE: MATERIAL DURABILITY ANALYSIS**

An important component in analyzing the use of substitute materials used at Lyndhurst for the selected repair projects is understanding the durability of materials. Research of both original materials and substitute materials used for replacement provides a basis on which to compare the two materials. It is also important to understand the context into which the material is placed, as it is not always desirable to have the most durable material for certain applications. Only by understanding the material properties and opportunities for deterioration as well as the details of their overall context in a repair, is it possible to draw conclusions on which material is desirable for a particular application.

#### Portland Cement

Many different materials used as adhesives or binders fall under the category of cement. However, portland cement is the most widely used. Portland cement is a type of cement containing, “a closely controlled chemical combination of argillaceous materials (silica, alumina) and calcareous materials (lime) with iron oxide and small amounts of other ingredients, to which gypsum is added in the final grinding process to regulate the setting time of the cement.”<sup>155</sup> Portland cement is a hydraulic cement, that is, it hardens and sets when mixed with water. Portland cement also will not

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<sup>155</sup> Caleb Hornbostel, *Construction Materials: Types, Uses and Applications* (New York: Wiley-Interscience, 1991), 149.

disintegrate in water. These characteristics make it ideal for application in marine, subterranean, hydraulic structures or other applications where lime mortars would break down. The basic attribute of this material is, “the ability upon hydration to form with water relatively insoluble bonded aggregations of considerable strength and dimensional stability.”<sup>156</sup>

The creation of portland cement is comparable to the creation of lime, however it requires the addition of reactive clays and a higher temperature. Portland cement will set quickly with the addition of water and will result in a much harder material than lime. This hardness also results in a material that has a very high compressive strength and low permeability in comparison to lime. Thus, portland cement is a very durable material. Cracking can occur with portland cement, however, as the material is not flexible.<sup>157</sup> In addition, the extreme hardness of the material can destroy masonry units around it during the expansion and contraction associated with hydration and dehydration.<sup>158</sup> The strength and durability associated with portland cement lead to the creation of concrete.<sup>159</sup>

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<sup>156</sup> Encyclopedia of Chemical Technology, Fourth Edition. (New York: John Wiley & Sons, 1993), s.v “Cement”

<sup>157</sup> Jessica Snow, and Clare Torney. *Short Guide to Lime Mortars in Traditional Buildings* (Edinburgh: Historic Scotland, 2014), 6.

<sup>158</sup> Weaver, *Conserving Buildings*, 136.

<sup>159</sup> Watt, *Building Pathology*, 63.

### Historic Mortar (Common Lime Mortar)

A common historic mortar mixture consisted of just lime, sand and water. This mixture is referred to frequently as common lime mortar. The ways in which this mixture is composed and its specific measurements varied from region to region and largely on one's own preference. Although the mixture may vary, it is important to get the right amount of each ingredient for an effective mortar, because "If an excess of sand is used the bond is poor. If too little sand is used, the mortar will shrink and crack. If too little lime is used the paste is made thin." Once the common lime mortar has been mixed it will remain workable for a few hours. If it is not used during this time, it will likely have to be wasted. Once it has lost its plasticity, the mortar should have set. Even so, it can often take up to years for it to reach its maximum strength.<sup>160</sup>

Traditional mortars made of lime have the characteristics of being flexible and somewhat permeable in contrast to cement mortars. Lime can never be totally weatherproof even with the aid of modern materials due to its porosity.<sup>161</sup> Due to its great thermal resistance, lime mortar works well as an insulation material. Historic houses are often pointed with lime mortar because it serves well as a sacrificial material instead of historic building fabric. This means it will be necessary to repoint these joints periodically, as it will be less durable than the surrounding material. Strength of mortar will depend on the various ingredients added such as aggregate characteristics and how

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<sup>160</sup> Harley J. McKee, *Introduction to Early American Masonry: Stone, Brick, Mortar, and Plaster*. (Washington: The Preservation Press, 1980), 64-65.

<sup>161</sup> Pat Gibbons, Scottish Lime Centre, and Historic Scotland, *Preparation and Use of Lime Mortars: An Introduction to the Principles of Using Lime Mortars* (Historic Scotland: 1995), 2.

is it prepared. Although lime mortar serves as the sacrificial layer “correctly specified, properly applied and well cured, lime mortars will be durable.” Durability will also depend on the skill of the person applying the mortar to the joints. If done correctly, well prepared mortars will set in a period of about a week and should hold up well to the elements.<sup>162</sup>

### Concrete

Concrete consists of an amalgamation of coarse to fine aggregate, portland cement and water. The creation of a variety of concretes for differing purposes can transpire by changing the aggregate type in the mixture.<sup>163</sup> A number of factors contribute to the durability and performance of concrete. The success and durability of concrete usually depend on three factors: the environment of placement, the quality of the components added to the mixture and proper technique and proportions when creating the mixture. Of particular importance to the durability of concrete is the quality of the mixture and the materials added to the mixture. Achieving this requires a proper cement to water ratio making the resulting mixture workable and able to be fully compacted. Once concrete has cured, its permeability will determine how resistant it is to chemical attack and the effects from frost. Unlike building stone, concrete will sometimes take days, weeks or months to reach its strength and capacity to self-support. This characteristic slow curing makes it vulnerable to weathering throughout

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<sup>162</sup> Ibid, 4, 45.

<sup>163</sup> Simpson, Horrobin, *Weathering and Performance of Building Materials*, 41.



its life, but particularly in the early stages. Those who study concrete state that the quality of concrete does not need assessment before a ten-year period. Before this time, the mixture may still be reaching its full potential.<sup>164</sup>

Concrete durability is attributable of its, “ability to resist deterioration processes that may occur as a result of weathering action or reactions that may occur between the constituent materials or their reaction with internal contaminants present. The deterioration is largely the result of physical (cracking, frost, attrition and fire) or chemical phenomena (ingress of aggressive fluids, gases and ions, e.g. sulfate, acid, chloride from sea water) occurring on or through the concrete surface. Concrete is porous naturally, but may vary depending on mixture specifics. Because of this, durability factors include diffusion and permeability characteristics of a particular mixture. A table from the *Sustainability of Construction Materials* demonstrates the internal and external considerations that can have an effect on the durability of concrete (See Figure 4.45).<sup>165</sup>

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<sup>164</sup> Ibid,42-43, 67.

<sup>165</sup> J. Bai, “Durability of Sustainable Concrete Materials,” in *Sustainability of Construction Materials* (Cambridge: Woodhead Publishing, 2009), 240.

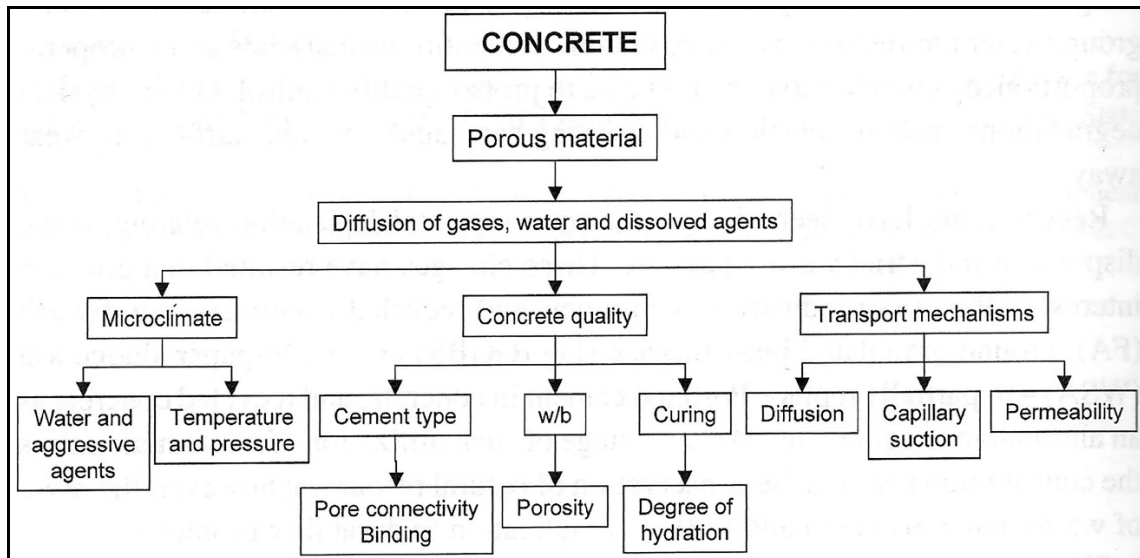


Figure 4.45: Nature of concrete durability (Courtesy of Durability of Sustainable Concrete Materials in *Sustainability of Construction Materials*, pg. 240).

Structures built by the Romans over 1,800 years ago help demonstrate the durability that concrete can achieve, an example of this being the Pantheon. Today, portland cement is a component of concrete that adds to its durability and ability to resist deterioration, even in harsh environments.<sup>166</sup> The addition of supplementary materials along with portland cement can be unpredictable however, in terms of durability. These mixtures therefore require testing before use in buildings. In general however, almost any construction material made with portland cement is expected to have a successful service life.<sup>167</sup>

<sup>166</sup> M.R. Shirlaw, "Concrete, the Durable Building Material," in *Durability of Building Materials and Components 8*, Vol. 1, ed. M.A. Lacasse and Dana J. Vanier (Ottawa: NRC Research Press, 1999), 448.

<sup>167</sup> Ibid, 449, 452.

## Marble

The durability of building stone is mostly dependent on the chemical and physical characteristics of the stone. Additionally, weathering can be due to man-made and natural conditions placed on the stone.<sup>168</sup> Weathering rates are mainly determined by moisture, temperature, carbon dioxide, organic acids and even by average rainfall. Specifically, limestone and marble which are carbonate stones are especially susceptible to weathering from acid pollutants occurring in both in the air and rain.<sup>169</sup> Rainfall enters through the pores of the stone and in turn increases the weathering rate. Marble will commence a chain of oxidation reactions over time when exposed to acidic atmospheres, which leads to degradation of the material.<sup>170</sup> Temperature contributes greatly to environmental weathering of stone and whether the location climate is arid or humid. A table from *Laboratory Evaluation of Building Stone Weathering* provides a table depicting five stone types and their life expectancy based on climate (See Figure 4.46).<sup>171</sup>

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<sup>168</sup> Seymour A. Bortz and Bernhard Wonneberger, "Laboratory Evaluation of Building Stone Weathering", in *Degradation of Natural Building Stone* (Reston, VA: American Society of Civil Engineers: 1997), 85.

<sup>169</sup> Ibid, 86.

<sup>170</sup> B. Grek, C. Christiansen, B. Schouenborg and K. Malaga, "Durability of Marble Cladding- A Comprehensive Literature Review," *Journal of ASTM International*, 4, no. 4 (2007): 15.

<sup>171</sup> Bortz, Wonneberger, "Laboratory Evaluation of Building Stone Weathering," 88.

Stone Type	Climate	Lifetime
Acid (Light-colored igneous granite)	tropical semi-arid	65 to 200 years
	tropical humid	20 to 70 years
	temperate humid	41 to 250 years
	cold humid	35 years
Metamorphic (Marble, slate, etc.)	temperate humid	33 years
Basic (Dark-colored igneous granite)	temperate humid	68 years
	tropical humid	40 years
Ultrabasic	tropical humid	21 to 35 years
Sedimentary	arid-semiarid	50 to 100 years
	all others	highly variable

Figure 4.46: Mean lifetime of 1mm (1/31 in.) of unweathered stone (Courtesy of Laboratory Evaluation of Building Stone Weathering in *Degradation of Natural Building Stone*, 88).

In terms of limestone and marble, there have been studies with “observations that 10mm (13/32 in) of a limestone surface has been lost over a 300-year period of weathering, with about the same loss of a marble surface over a 150-year period.”<sup>172</sup>

Additionally, the data for a test developed by Wiss, Janney, Elster Associates, Inc. testing laboratory for evaluating stone durability appears in the text as a table. Marble tends to vary with white Carrara marble having the most extreme cases of strength loss. Marble from Vermont and Georgia show a lesser loss of strength, but also show that samples tested parallel to the bedding plane in most cases have more loss of strength than samples tested perpendicular to the bedding plane (See Figure 4.47).

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<sup>172</sup> Ibid, 89.

White Marble from Carrara, Italy after 15 years of exterior exposure	32 mm (1 1/4 in.) polished	64.0 wet (911)	38.0 wet (540)	41%
			41.4 wet (589)	35%
			59.7 wet (849)	7%
Georgia Golden Vein Marble	25 mm (1 in.) honed	79.0 dry    (1,124) 104.3 dry ⊥ (1,484)	a. 74.6 dry    (1,061)	a. 6%
			b. 76.4 dry    (1,087)	b. 3%
Marquis Gray Danby Vermont Marble	30 mm (1 3/16 in.) honed	60.5 dry    (861) 99.5 dry ⊥ (1,415)	a. 96.6 dry ⊥ (1,374)	a. 7%
			b. 97.3 dry ⊥ (1,384)	b. 7%
White Carrara Marble	25 mm (1 in.) honed	154.4 dry (2,196)	54.1 dry    (769)	11%
			46.1 dry ⊥ (656)	5%
White Carrara Marble	25 mm (1 in.) honed	154.4 dry (2,196)	112.0 dry (1,593)	27%
			90.6 dry (1,289)	41%

Figure 4.47: Portion of the summary of durability test results of various dimension stones (Courtesy of Laboratory Evaluation of Building Stone Weathering in *Degradation of Natural Building Stone*, 95).

The Stone Test Wall of the National Institute of Standards and Technology provides a unique source used to illustrate weathering of stone over time. Originally located in a site in Washington D.C., the wall eventually moved to its current location in Gaithersburg, MD. The wall contains 320 stones from foreign locations, 2,032 domestic stones from 47 states, totaling 2,352 samples of stone. The wall provides a comparative study of the weathering of different stone types by placing them in the same location and therefore under the same climatic conditions. The wall presently is approaching 70 years of existence, after the original construction in 1948. In addition to the samples placed on the wall, each stone has a duplicate specimen placed in a humidity and temperature controlled indoor location, so that weathering changes on the wall can be

compared to the control samples. Upon the fiftieth anniversary of the test wall, the creation of a database of images of the stones occurred. This database includes images of each stone specimen on the wall and an image of the same stone archived indoors.<sup>173</sup>

Upon inspection of the online database, the same marble used on the portecochere of the mansion of Lyndhurst was found. The Sing Sing marble entry, wall specimen number 11B24, contains a picture of the stone located on the wall, however the website states that a picture of the archival stone is unavailable. Both pictures would be helpful for comparison and drawing conclusions, unfortunately the indoor sample is not accessible. The photo of the Sing Sing marble on the wall seems to be different in appearance in terms of color and veining than the mansion marble. It does appear to be in fairly good condition after seventy years, however (See Figure 4.48).<sup>174</sup>



Figure 4.48: NIST Test Wall entry photo for Sing Sing marble (Courtesy of NIST website).

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<sup>173</sup> Paul E. Stutzman and James R. Clifton, "Stone Exposure Test Wall at NIST," in *Degradation of Natural Building Stone* (Reston, VA: American Society of Civil Engineers: 1997), 20, 21, 24, 31.

<sup>174</sup> *Sing Sing Marble*, in NIST Test Wall Database, [http://stonewall.nist.gov/asp/Z1\\_stonedescription.asp?page=A4\\_stonedescription\\_state.asp?result=Marble&resultnumber=11LB24&stateTrans=New+York](http://stonewall.nist.gov/asp/Z1_stonedescription.asp?page=A4_stonedescription_state.asp?result=Marble&resultnumber=11LB24&stateTrans=New+York) (accessed March 14, 2017).

## Metal (Aluminum)

Suggested considerations when deciding to put metal on the exterior of a building are the atmospheric and climatic environment of the site. A third consideration is the building design itself and trying to foresee any potential complications between the metal or surrounding materials. Corrosion is the major problem associated with metal in terms of deterioration and weathering. If one takes measures to avoid corrosion, metal on the exterior of buildings weathers very well and is quite durable. Corrosion can occur due to changes in the environment, contact with certain materials and changes in composition.<sup>175</sup> Contact of incompatible metals creates the potential for deterioration due to corrosion.

Common metals used for roofing and flashing applications are lead and aluminum. Although these metals should never be used for structural purposes, they have a natural resistance to corrosion. In particular, the pure grades of aluminum tend to have outstanding corrosion resistance. A thin layer of oxide film forms on the aluminum surface, which accounts for its resistance to corrosion. This film also forms quickly when scratches form on the metal or cutting of the material occurs and works by isolating the material and preventing continued attack. Aluminum also resists corrosion that may form due to atmospheric exposure. In most cases, aluminum roofing requires no maintenance because the material performs so well on its own. This means that if one follows suggested applications for an aluminum roof, the result should be a very

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<sup>175</sup> Simpson, Horrobin, *Weathering and Performance of Building Materials*, 186-187.

long service life.<sup>176</sup> According to the Metal Construction Association coated aluminum zinc metal roofs should have a life expectancy of up to 60 years. Additionally, this statement by the Association resulted from research conducted using five different climatic zones in the United States.<sup>177</sup>

### Glass

Glass contains four notable thermal properties that can affect its durability: thermal expansion, specific heat, thermal conductivity and maximum working temperature. The strength of glass is mainly ascribed to the existence of defects on the surface of the material. The defects can be described as focused areas of stress in which eventually a fracture will form when the strength of the material is exceeded. Defects in glass are formed when it comes in contact with materials that are of a higher hardness. Other ways in which flaws can be introduced to glass are through thermal stresses and chemical attack. Thermal stress to glass is generally attributed to the heating up of the material followed by a fast cooling. This will cause thermal shock which will greatly weaken glass.<sup>178</sup> Thermal properties are extremely important to recognize as glass is an inherently brittle material. There are three significant temperature points associated with glass in the ascending order of: softening point, annealing point and point of strain.

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<sup>176</sup> Ibid, 193-194, 196, 200-202.

<sup>177</sup> Metal Construction Association, "Retrofit Roofs Offer Design, Environment, and Financial Benefits in New and Existing Construction," Metal construction Association 2, (August 29, 2016), file:///C:/Users/labuser/Downloads/White%20Paper%20-%20Benefits%20of%20Retrofit%20Roofing%20(1).pdf (accessed February 27, 2017).

<sup>178</sup> James E. Shelby, *Introduction to Glass Science and Technology* (Cambridge: Royal Society of Chemistry, 2005), 191-192.



The strain point is understandably far higher than requirements for use in buildings.<sup>179</sup>

The strength of glass is dependent on varying characteristics and is often considerably different from material to material. This variance can make it somewhat unpredictable and sometimes causes the view of being a drawback in terms of strength.<sup>180</sup> Of this it is said, “although the molecular bonding of glass is very high, the manufactured product, with its unique chemistry and complex (and usually “damaged”) surface makes glass an unreliable material to consider in terms of usual strength parameters.”<sup>181</sup>

Although the strength of glass is questionable, it is a naturally hard material.

In terms of chemical durability, glass rates very high and it is very resistant to chemical attack. Chemical durability typically means that it is resistant to water, acid, and water and sulfur dioxide that can lead to weathering. In general, glass had a somewhat high weathering durability, but can vary from each example depending on the chemical durability and hardness in the specific glass.<sup>182</sup> If water remains standing on glass for a lengthy amount of time it can affect its durability by leading to leaching. Leaching can ultimately lead to corrosion on the glass surface, which does not help its durability. This type of corrosion rarely happens to the glass of windows and is more likely to occur with horizontally placed glass, such as glass found on low pitched roofing applications or skylights.<sup>183</sup>

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<sup>179</sup> Michael Wigginton, *Glass in Architecture* (London: Phaidon Press, 2002), 244.

<sup>180</sup> *Ibid*, 245.

<sup>181</sup> *Ibid*, 246.

<sup>182</sup> *Ibid*, 247.

<sup>183</sup> Christian Schittich, *Glass Construction Manual* (Munich: Birkhäuser Architecture, 2007), 60-61.

## Plastics (Polyurethane)

Weathering of plastics includes plasticizer loss, polymer degradation, fading of pigment and breaking down of the fiber to resin bond.<sup>184</sup> Environmental factors that can lead to a chemical or physical change in a plastic comprise factors such as heat, moisture, light, biological activity and chemical conditions.<sup>185</sup> Light is of particular concern, as most plastics can experience photodegradation and absorb ultraviolet light containing high energy radiation. This will increase reactivity due to activated electrons and eventually will lead to cleavage, oxidation and other forms of degradation. Thermodegradation can also be common in plastics and eventually cause the optical and physical properties of the plastic to change. Thermal degradation typically results in color changes, cracking, chalking, reduction in ductility and embrittlement, as well as reduction in other physical characteristics.<sup>186</sup> A characteristic deemed desirable in plastics is that they are not easily prone to water-absorption and therefore do not usually experience degradation as a result of exposure to water. Chemical change occurring in the material is evident if a yellow discoloration occurs.<sup>187</sup> If used on exterior building applications, most plastics will include an added absorber for ultraviolet light. To determine whether a particular plastic might be successful as an exterior

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<sup>184</sup> J.R. Crowder, "Some Aspects of the Durability of Plastics in Building," *Durability of Building Materials and Components*, STP36111S, ed. P. Sereda and G. Litvan, ASTM International, (West Conshohocken, PA, 1980), <https://doi.org/10.1520/STP36111S> (accessed February 8, 2017), 812.

<sup>185</sup> Aamer Ali Shah, Fariha Hasan, Abdul Hameed and Safia Ahmed, "Biological Degradation of Plastics: A Comprehensive Review," *Biotechnology Advances* 26, no. 3 (May 2008): 248.

<sup>186</sup> *Ibid*, 250.

<sup>187</sup> Simpson, Horrobin, *Weathering and Performance of Building*, 234.

element it is wise to access data sheets on the particular material to find the distortion temperature.

In terms of durability, the presence of high temperatures, ultraviolet light and sometimes moisture, especially if one occurs in combination with another, has the potential to alter the polymer's molecular structure and in turn reduce the strength significantly. In most cases plastics remain durable in the face of micro-organism attack and industrial atmospheres to which they are reasonably resistant. Because most weathering of plastics will occur at the surface level, a common way to increase service life is by applying a coating or film to the surface for protection. Painting is a more traditional solution, as you would do to another material such as wood for protection. The application of a film over the plastic is more common in recent times, often applied to the substrate at the time of manufacture.<sup>188</sup>

Polyurethane is a common plastic used in casting. It can be cast with the varying properties of gel, rubber or hard. Polyurethane resin is employed for both exterior and interior uses and is UV resistant, however support is recommended at every eighteen inches. Likewise, nine inches of overhang at maximum is recommended for polyurethane. A cheaper and less UV resistant, but similar casting material is polyester resin.<sup>189</sup>

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<sup>188</sup> Ibid, 235-236.

<sup>189</sup> Blaine Brownell, *Transmaterial: A Catalog of Materials That Redefine Our Physical Environment*. (New York: Princeton Architectural Press, 2005) 103.

## Wood (Mahogany and Poplar)

Moisture content can be one factor affecting the strength of wood. In general, wood is stronger the drier it is and more durable also. The strength of wood will start to decrease once it reaches the fiber saturation point, which is “the condition where cell walls are fully saturated but cell cavities are free of water.” The amount of time wood is placed under a load can also have an effect on strength and overall durability. When placed under too much of a load over an extended period of time, creep can occur. A type of deformation, creep often results in excessive bending and eventually failure. Additionally, temperature affects the strength of wood. In general, the strength of wood will decrease as the temperature rises, while it will increase with colder temperatures. Excessive heat may result in the loss of strength in wood permanently.<sup>190</sup>

The strength of wood will vary from species to species and therefore its use needs to be taken into consideration. In general, the denser a piece of wood is, the more durable and strong it will be. There are two categories of wood, softwood and hardwood. Despite the connotation from the names of these categories, some species of hardwood are not a higher hardness than some species of softwood. In general however, hardwoods are usually denser than softwoods.<sup>191</sup> Between the two types of wood there are many differences in cellular structure, which will determine characteristics such as: fire resistance, density, strength, hardness, weight, sensitivity to

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<sup>190</sup>. Bruce R. Hoadley., *Understanding Wood: A Craftsman’s Guide to Wood Technology* (Newtown, CT: The Taunton Press, 2000), 95.

<sup>191</sup> Architectural Woodwork Institute, *Guide to Wood Species* (Arlington, VA: Architectural Woodwork Institute, 1977), 1.

moisture and susceptibility to biological attack.<sup>192</sup> A comparative table of wood species lists mahogany as a hardwood, with a hardness of medium. The same chart lists poplar as medium in hardness as well, with the comments of “good utility hardwood, excellent paintability.” Mahogany’s resistance to decay and inherent stability make it a durable choice for both interior and exterior applications.<sup>193</sup> Its moderate price and versatility makes poplar a popular choice for interior applications, but, would most likely not be a durable choice for exterior applications.<sup>194</sup> This recommendation of interior use for poplar is due to its low resistance to decay.<sup>195</sup>

#### Analysis of Durability of Materials

After examining the original and substitute materials used in the projects chosen for examination at Lyndhurst, a clearer understanding of their durability was formed. The various properties and common modes of deterioration help inform the durability characteristics of each material. With this more thorough understanding, a more informed comparison between materials was possible.

The mansion at Lyndhurst contains joints in which portland cement was used to repoint areas where a historic common lime mortar previously was applied. As a material, portland cement has characteristics and properties which make it extremely durable. While durability is normally a desirable characteristic, in this instance it is not

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<sup>192</sup> Watt, *Building Pathology*, 42-43.

<sup>193</sup> Ibid, 21.

<sup>194</sup> Ibid, 21, 32.

<sup>195</sup> Hoadley, *Understanding Wood: A Craftsman’s Guide to Wood Technology*, 44.

suitable for the application in question. That is, the strength and hardness of the material may damage the surrounding materials which are weaker. In the case of historic lime mortar, the material is durable, but not to the degree of portland cement. This makes it an ideal material to serve as the sacrificial layer between the building stones. Although this historic mortar requires more maintenance than portland cement, its flexible durability is a desirable quality and will in the long run save building materials and time. The increased durability of mortar will occur with a proper mixture, quality ingredients and skilled application.

Another replacement of materials occurred on the mansion's porte-cochere where cast concrete replaced cut dolomitic Sing Sing marble. Concrete contains portland cement, the source of much of its durability. Like mortar, durability of concrete will increase with care taken in adding quality ingredients, mixture and skill in making the material. If prepared correctly, concrete can last for many years, as demonstrated by the ancient structures of Rome. As with portland cement, although concrete is durable the extent of its durability may be detrimental rather than beneficial, because it is much harder than the surrounding stone. The durability of marble does not compare to that of concrete, but can still be very durable depending on the environment it is placed and conditions inflicted on the material. As a building material there are many factors that can have an effect on marble's durability. In the case of Lyndhurst, the incorrect cutting of many of the stones is causing considerable

deterioration along the bedding planes which are perpendicular to the load that is being placed on them.

Aluminum corrugated roofing replaced the swimming pool building's glass roof in 1984. The durability of aluminum exceeds that of glass, but they are very different materials. Aluminum will last a very long time given its application and design. It is naturally resistant to many forms of deterioration and is ideal for roofing. Also, highly resistant to corrosion, aluminum is a good choice for the purpose it serves. The installation of the aluminum roof occurred as a measure to stabilize the building until a later date when the option of restoration presented itself. Glass can be brittle and fail when it reaches a high temperature. Additionally, glass can be significantly weakened with the potential to break when merely scratched. While glass is often unpredictable in terms of durability, the desired characteristic of transparency was the reason for its selection.

The next materials, wood and plastic, occurred in two different applications, one in the interior of the bowling alley and one on the exterior of the mansion. In both of these instances, a polyurethane casting replaced wood. In the case of the bowling alley wood was poplar, while on the exterior of the mansion the wood species was mahogany. In general, plastics are very durable material and are not prone to many types of deterioration. Ultraviolet light is one main factor which can lead to problems in plastics. This is usually not an issue if a coating is applied to the plastic. Because the bowling alley castings are interior features of the building, photodegradation is not a

concern. The mansion finials on the exterior of the building however, are in a vulnerable position for this kind of deterioration. The finials show no signs of deterioration at this time, perhaps due to the fact that they are painted.

Wood is a very durable material provided that the introduction of moisture does not occur. Wood can sometimes fail due to excessive loads; however, neither application at Lyndhurst serves a structural function. Mahogany is an appropriate material for both internal and external applications on a building, while poplar should only be used inside. In both instances, the wood was located in an appropriate environment.

In all instances of the five evaluated projects at Lyndhurst, a more durable material replaced the original material. Although this might have been viewed as advantageous when the decision was made, in some instances a more durable material may not have been appropriate.



## **PART FOUR: PRESERVATION PHILOSOPHY ANALYSIS**

One of the factors that shaped decisions about the proper course of repairs applied at Lyndhurst was the preservation philosophy espoused at the site. In order to assess to what extent this factored into repairs done on the property, the examination of paperwork in Lyndhurst archives occurred, as did interviews of past and current staff. While there were some clear indications of their preservation philosophy located in meeting minutes, historic structure reports, development plans and an assessment report provided by a Getty Conservation Institute grant, Lyndhurst's archives provided an incomplete accounting of the full spectrum of philosophy over the years. What was found in the archives seemed inconsistent and unclear over the years, with gaps in the information that could be found. The documents from the 1980s, early 1990s and early 2000s contained the most information on philosophy, although interviews assisted in supplementing some of the information on preservation philosophy for less documented years. In order to better understand all of the various philosophies encountered, it proved helpful to examine these ideals separately and then generally for the entire property.

### General Preservation of Lyndhurst Findings

The first mention of a general preservation philosophy for Lyndhurst found in their archives was in the form of an untitled revision to specific ideas outlined in a

report referred to as the “1979 Waite Plan.” Unfortunately, the original Waite plan’s location was unknown to obtain a better idea of content. The revision however outlines the original ideas of the Waite plan, followed by the subsequent revisions for the years 1981 and 1984. The 1979 Waite report proposed in a general statement that the property should operate at the level of its National Historic Landmark status and its museum potential. Later, the 1981 revision to this statement re-evaluated the purpose, “to preserve the historic and architectural integrity of the estate while recognizing the need to adapt certain elements to meet present and future requirements of public use, in a manner compatible with historic character and consistent with national preservation objectives.” The next revision occurring in 1984 stated the need for no changes to the previous statement, except the addition of the goal of self-sufficiency.<sup>196</sup> In 1983, a document entitled the National Trust for Historic Preservation Five Year Plan expressed philosophical ideals under a heading of “Goals” for property management as part of its contents. Mentioned was that the intention of the National Trust is to use the highest standards in managing its properties taking into consideration methods of maintenance, interpretation, preservation, restoration and if appropriate, rehabilitation. The document further describes that adaptive uses applied appropriately will help support preservation efforts and maintenance by producing income for the properties.

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<sup>196</sup> Revisions to 1979 Waite plan for buildings, 1984, 1-2.

Accurate interpretation and restoration further described the aim of the National Trust to reflect “each property’s historical and architectural integrity.”<sup>197</sup>

A general philosophy next emerged for the property under the heading of “statement of significance and preservation purpose” in the document Summary Recommendations: Lyndhurst Development Plan and targeted the 1980s. The preservation purpose stated the goal of Lyndhurst was to be a model of preservation and that additional uses of the property needed to keep its historic character in mind. The document stated the need to recognize that while every preservation policy needs to address the integrity of Lyndhurst’s buildings, consideration regarding the needs of twentieth century audience of visitors was necessary. Of philosophy, the document stated that, “because of its great significance, the property- buildings, grounds and collections- merits preservation and restoration to reflect its entire period of use (1838-1961) prior to acquisition by the National Trust for Historic Preservation.”<sup>198</sup>

Next, in the early 1990s, a document called Lyndhurst, A Property of the National Trust: Five Year Plan, 1992-1997 presented a series of statements outlining the means for Lyndhurst to achieve its mission. The first listed statement voices an intention as, “preserving and maintaining the buildings, landscape and collections in accordance with accepted museum practices and the policies of the National Trust for Historic Preservation.” Under a section entitled Management, the goal stated was to ensure the preservation of Lyndhurst’s integrity by developing specific policies that enhance its

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<sup>197</sup> National Trust for Historic Preservation Five Year Plan, May 6, 1983, 2.

<sup>198</sup> Summary Recommendations: Lyndhurst Development Plan, 1.

efficient property management. Under a heading of Next Action Steps, a future goal is to setup a computerized cyclical maintenance scheduling system specifically for maintenance on the property.

The next example of a general preservation philosophy for Lyndhurst was in a section of a 2004 report created by the Getty Conservation Institute in response to grant application for an Architectural Conservation Implementation Program. The application is specifically for the investigation into the condition of exterior stone masonry of the mansion at Lyndhurst. The Getty report contained a section about the conservation principles of Lyndhurst, in which it pointed to the Secretary of Interior Standards for the Treatment of Historic Properties and modern building practices as the basis for suggested work on the exterior of the mansion. To achieve these standards, the recommendations presented for work include: least intervention possible, reversibility, maintenance of the original appearance, avoidance of damage and a long-term solution. The conservation philosophy of Lyndhurst listed later in the document states the goal “is to stabilize and preserve for the public, the design of noted architect A.J. Davis and historic features as they existed during the period of the Paulding, Merritt and Gould families.”<sup>199</sup> The reiteration of the idea that treatments cause no harm and be reversible occurs toward the end of the section.<sup>200</sup>

Because the uncovered philosophies included only specific scattered years, the interviewing of current and former employees occurred with the hope of learning more

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<sup>199</sup> Getty Conservation Institute, “Project Work Plan: Summary,” section, 1-2.

<sup>200</sup> Ibid, 3.

information. The first interview conducted was with David Overholt, former Restoration Project Manager of Lyndhurst, who informed the preservation philosophy of the estate during his employment of 1987 to 2003. According to Mr. Overholt, the property could not have been in better hands under an extremely knowledgeable director and competent staff. With a degree from Columbia and a great familiarity with material sciences, the director proved to be a great resource when repairs emerged around the property. Architects of the National Trust also provided oversight when it came to the larger projects at Lyndhurst. Larger projects typically included those in which a contractor became involved. The smaller day to day operations and repairs did not need outside approval, however. The property staff's discretion provided the basis for these decisions. As far as philosophy, Mr. Overholt states that Lyndhurst in general followed the Secretary of Interior's Standards for the Treatment of Historic Properties, as Lyndhurst is a National Historic Landmark. Within this vein of the National Park Service, he expressed that they sought to retain as much of the historic fabric as possible, while trying to make repairs as retreatable or reversible as possible. He noted that they never intentionally set out to use replacement materials, but funds were often "not in the budget" to pay for special testing such as specific analysis of wood species. Other factors driving their decision making were identifying and choosing the materials or methods that would add a better service life to a building component.<sup>201</sup>

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<sup>201</sup> David Overholt, interview by author, January 13, 2017.

According to the current Restoration Project Manager, Thomas Richmond, the property continues to follow the Secretary of Interior's Standards for the Treatment of Historic Properties in terms of a preservation philosophy. He added that if a grant is involved for a repair project, for the most part it is an absolute requirement that the organization follow the Secretary of Interior's Standards. Mr. Richmond contributed information about the preservation philosophy since 2013, the year he joined the staff of Lyndhurst. He also confirmed Mr. Overholt's statement that the Trust largely stays out of the day to day management of the property and its repairs, unless there is a contractor engaged to address a more complex repair. In terms of decisions, Mr. Richmond said that he tries to choose a longer lasting material, such as the use of stainless steel screws for attachment of architectural elements. It is unclear if this is a personal preference or a philosophy component of Lyndhurst. He expressed another factor as being expediency, because often there is not enough time to thoroughly research everything when a solution needs implementation immediately. He further stated that when he has interns, he has more manpower and time; he can assign an intern to research a specific material or method while he is busy handling the day to day needs of the property. If he had more time allotted, he would love to devote more attention to this kind of research.<sup>202</sup>

Last, Krystyn Hastings-Silver, the Associate Director, reflected on her ten years of employment at Lyndhurst. When asked about decision making factors, Ms. Hastings-

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<sup>202</sup> Thomas Richmond, interview by author, January 20, 2017.

Silver expressed the desire to balance what the property can afford to do with the importance of presenting a complete picture to the guest at Lyndhurst. She stated that she believes that choices at Lyndhurst in regards to materials and repairs have not compromised the integrity of the building in addition to following the Secretary of Interior's Standards by replacing in-kind or with a better material that is compatible. She explained that although she came from an academic background where this replacement seems inappropriate, the realities of stewardship over a historic site come into play and choices happen. Ms. Hastings-Silver explains that repairs must be done in a financially responsible way due to the property's limitations in budget. In the case of the cast plastic finials that replaced the wooden ones, she believes that bringing back missing details helps to provide those who visit the property with a more complete experience of Alexander Jackson Davis' vision while doing no harm. The extended service life of the plastic material is an added bonus in her mind, allowing funding to spread further for property needs. In her mind, guests are unaware of these small deviations in materials which allow them the pleasure of seeing the house in its intended completeness.<sup>203</sup>

#### Preservation Philosophy Findings for Specific Buildings

Conducted research also included finding specific information about the buildings where the application of substitute repair methods occurred. The mansion,

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<sup>203</sup> Krystyn Hastings-Silver, interview by author, February 8, 2017.

bowling alley and swimming pool building had a variety of preservation philosophy, with some of the methods identified for a specific building sometimes changing over time. Additionally, some preservation philosophies for specific buildings seemed to be conflicting. Although like general philosophy for property, philosophy information for the individual buildings was few and far in between, what could be found provided useful information for analysis of preservation philosophy.

The first mention of a preservation philosophy for the mansion at Lyndhurst appears in the untitled document outlining revisions to the 1979 “Waite Plan.” This 1970 plan envisions the role of the mansion as operating as a house museum with its use reinforcing the ideal of conserving its collections and historic fabric. Subsequent revisions in 1981 and 1984 retain this intention for the building.<sup>204</sup> Also in 1984, a document entitled Summary Recommendations: Lyndhurst Development Plan contains guidance related to the mansion. The plan recognizes the demands placed on the mansion as the property’s main attraction and acknowledges that while it should function as a house museum only; lines must be drawn when it comes to any use that could affect historic fabric and the intended conservation and preservation of the building.<sup>205</sup> Next the Getty Conservation Institute grant of 2004 mentions philosophy directly related to the mansion during this period. Of past repairs to the mansion, it stated the building, “has had ongoing conservation work on the exterior and interior during the National Trust’s stewardship which has reflected the changing attitudes and

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<sup>204</sup> Revisions to 1979 Waite plan for buildings, 1984, 1-2.

<sup>205</sup> Summary Recommendations: Lyndhurst Development Plan, 3.



technology in the field of material conservation.” Listed under this statement the specific in the past work included the replacement of failing stone with cast concrete and composite repairs of stone.<sup>206</sup> The assertion is later added that, “the conservation methods and technology used were the best and most appropriate of the era,” regarding the work done by the restoration workshop.<sup>207</sup> The Getty report also contained a section about the conservation principles of Lyndhurst, in which it points to the Secretary of Interior Standards for the Treatment of Historic Properties and modern building practices as the basis for suggested work on the exterior of the mansion. To achieve these standards, the recommendations presented for work include: least intervention possible, reversibility, maintenance of the original appearance, avoidance of damage and a long-term solution.<sup>208</sup>

The revisions document to the “Waite Plan” is the first document with information related to the philosophy of the bowling alley occurring in 1979. The document reports that the Waite plan listed the rehabilitation of the recreation building (bowling alley) for use as a facility for catering and rental. The plan stays the same for the 1981 and 1984 revisions for the building.<sup>209</sup> A document simply entitled, “Lyndhurst Bowling Alley” provided further information with no date included, but based on information enclosed was most likely during the 1980s. The document stated the bad condition of the building when acquired by the National Trust. Some stabilization was

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<sup>206</sup> Getty Conservation Institute, “Project Work Plan: History,” section 2, 1.

<sup>207</sup> Ibid, 2.

<sup>208</sup> Getty Conservation Institute, “Project Work Plan: Summary,” section 1, 1-2.

<sup>209</sup> Revisions to 1979 Waite plan for buildings, 1984, 1-2.

necessary as result, in the form of minor structural repairs and a temporary roof. The intention of adaptive reuse was outlined for use as a rental facility for parties, receptions, weddings and small conferences. The rehabilitation of the building would ensure the “preservation of an important element of the Lyndhurst landscape,” according to the document. Other benefits outlined would be the reduction of stress on the mansion and generated income from events to support its maintenance and funding for other preservation efforts at Lyndhurst.<sup>210</sup> Mentioned again is stress and wear alleviation for the mansion by making the bowling alley an event space contained in the 1980s document, Summary Recommendations: Lyndhurst Development Plan. This document outlines that the building will receive the second phase of a highly-prioritized restoration for special property use.<sup>211</sup>

Preservation philosophy for the swimming pool building at Lyndhurst is first mentioned in the untitled document revising the 1979 “Waite Plan” for the years 1981 and 1984. The Waite plan called for the conversion of the building into a visitor orientation center. A change in the intended use for the building occurs in the revisions of 1981 and 1984, which stated the intention to stabilize and mothball the building for use as a pool in 1981 and adaptive reuse in 1984.<sup>212</sup> Expanding on this philosophy for the building, the 1980s Summary Recommendations: Lyndhurst Development Plan, expresses that it is ideal for the restoration of the building to result in its original

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<sup>210</sup> Lyndhurst staff, “Lyndhurst Bowling Alley,” date unknown, 1-3.

<sup>211</sup> Summary Recommendations: Lyndhurst Development Plan, 4.

<sup>212</sup> Revisions to 1979 Waite plan for buildings, 1984, 1-2.

appearance and use.<sup>213</sup> The 1988 historic structures report for the swimming pool building contains a section on preservation philosophy. The section states that the stabilization of the building served to ensure a commitment to “preserve and maintain the building for future use.” In a later paragraph however, it states, “the immediate restoration goal for this building over the next seven years is to continue exterior restoration so that the building will approximate its 1911 appearance from the front façade.” The mention of using an interpretive sign with photos of the interior and French doors in the front allowing views for visitors into the building, implies that the interior of the building will be closed to the public. Later, the document states, that the future of the building could take several forms requiring further thought and research. Presented as a possible use for the space are collections storage and office space. The choice of restoration is presented, but points out that replacement of the original glass roof and possibly some of the steelwork could be very expensive. Use as a visitor center is also presented, but notes that it is at a somewhat awkward location on the property for this use.<sup>214</sup> In 2003, Lyndhurst applied for Historic Sites Fund grant for the stabilization of the swimming pool building, confirming that none of these plans occurred and the structure was again in need of help. Stabilization is requested for the masonry walls however, since the 1984 stabilization entailed the roof of the building. This document again asserts the intention to restore the swimming pool building at a

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<sup>213</sup> Summary Recommendations: Lyndhurst Development Plan, 4.

<sup>214</sup> Barbara M. Hammond, James Diermeier, Anne-Marie Demetz, “Swimming Pool Building,” (historic structures report, 1988), 26-27.

future date. The stabilization, it says, will ensure the safety of the shell of the building while the completion of the bowling alley restoration is continued.<sup>215</sup>

### Preservation Philosophy Analysis

After looking over the various documents and asking questions of current and past staff members, a clearer picture of Lyndhurst's preservation philosophy and the philosophy related to individual buildings emerges. In regards to the general philosophy of the property, there seems to be a number of treatment categories listed with sometimes confusing or conflicting language. Even with the individual buildings documents indicated changes over time and provide confusing accounts of the prescribed philosophy application, sometimes within the same year or document.

Within the larger context of the property, paperwork found in Lyndhurst's archives indicated that language started out fairly vague and gradually got more specific over the years. For example, the earliest piece of information referenced a statement from the Waite plan with the broad intention for the property to operate up to its National Historic Landmark status and then a few years later to be consistent with national preservation objectives while meeting future requirements of public use. By 2004, when the Getty Conservation Institute grant was written for assessment of the mansion, the language is more precise for the property's philosophy using words and phrases such as "reversible", "least intervention possible" and "stabilize and preserve

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<sup>215</sup> Lyndhurst Estate, Historic Site Fund application to National Trust for Historic Preservation, November 12, 2003, 1.

for the public”, but then treatments such as restoration are used. This is not the first document presenting multiple treatments for a single building, however. This language can be quite confusing when looking for a clear philosophy. Perhaps the use of the terms “preserve” and “preservation” are in a general sense in these cases and not for a prescribed treatment or philosophy, which explains the use of other treatments such as restoration and rehabilitation. In any case, clearer language would have been helpful.

Another key component of philosophy that emerged for the property is the insertion of the term “self-sufficiency,” which appeared early in the 1980s. From this point forward it is mentioned periodically, especially when regarding certain buildings such as the bowling alley and swimming pool building, as possible income generating sources in the future. Interviews provided more information, but still do not necessarily point to a definite set of guidelines the property adheres to. Although, the Secretary of Interior’s Standards seems to be a constant set of principles pointed out in both document and by those interviewed, it appears other factors play into what materials and methods are chosen when it comes to repairs. It appears that over the years, it has been consistent that the Trust takes a more active role in repairs when it is a large project or a contractor is involved. Other smaller repairs made around the property are largely left up to the staff. It also seems that based on interviews, the methods and materials chosen over the years are a product their time and were the most appropriate and economically responsible decision to make during that period.

In the case of individual buildings and their philosophy a similar claim can be made when it comes to somewhat frequent changes in treatment ideals. Again, early language starts out somewhat vague and becomes more specific as the years go by. Inconsistencies emerge as seen with the property philosophy, again the word “preserve” is used in the same document as “restore” and “rehabilitation” in reference to the same building such as the swimming pool, which is confusing.

Overall, preservation philosophy seems scattered and unclearly stated over the years at Lyndhurst. Although, different treatments for different buildings is not too surprising for a property with as many buildings as Lyndhurst has, in some cases a single building’s philosophy is confusing. Perhaps this lack of clarity has an effect on decision making when it comes to repairs. In any case, a thorough look into overall philosophy and individual building philosophy should be considered at some point by the staff.

## CHAPTER FIVE

### CONCLUSIONS

#### Project Analysis Conclusions

Clear conclusions can be drawn from the assessment of substitute materials which replaced original materials in repairs at Lyndhurst. Overall, the substitute materials performed better than expected, especially considering the very different characteristics between the original and replacement material. However, performance would be better and more predictable with an in-kind repair. It should be noted that at the time some of these methods and materials were chosen they were often considered an appropriate treatment. In the case of the repairs made with portland cement and cast concrete, the damage we are aware of today was probably less known at the time. In the case of the swimming pool building where corrugated metal roofing replaced the glass roof, the decision was meant to be a temporary solution. This roof remained in place not because it has performed better, but because there is a lack of other options and money.

Of the five projects, three were determined to be 'unsuccessful' based on ratings they received from the four assessment categories created for this thesis. These projects were as follows:

- Historic mortar replaced with portland cement on the mansion exterior
- Sing Sing marble replaced with cast concrete on the mansion's porte-cochère

- Glass replaced with corrugated aluminum metal paneling on the swimming pool building roof

The main factor in rating these projects unsuccessful is the difference in material properties and appearance between the original material and substitute material. Many of the assessment categories required the comparison of the replacement to the original, as having similar material characteristics and aesthetics is desirable. Processes also contributed to the rating of each project's success, which necessitated a comparison of factors such as how labor intensive the process was and the level of skill required. In the case of the swimming pool roof replacement, inaccessibility to many areas of the roof and absence of the original material for comparison disqualified ratings of some categories or subcategories created to inform success.

Two of the five projects received the final assessment of 'successful' based on ratings they received. These projects were:

- Wooden mahogany finials replaced with cast polyurethane finials on the mansion's roof
- Wooden poplar decorative brackets replaced with cast polyurethane brackets inside the bowling alley

The main factors giving these projects favorable ratings in many categories is the ability of the casting material to replicate dimensions and details of the original objects almost exactly. Another factor contributing to its success is the ability to remove the cast replicas later with a certain amount of ease and little destruction to the surrounding materials. It should also be noted that since these projects are the most



recently completed, they may not have exhibited any signs of failure, but it is a possibility in the future. At this time however, they seem to be performing well.

### Decision Making Conclusions

After analyzing the decision making aspects of the choices to use substitute materials instead of in-kind for the five projects, clearer conclusions form. The three decision making categories analyzed for contribution to choices were cost, durability and philosophy. Archival research examined and interviews conducted with past and present employees provided information to form conclusions about each category and its influence on the decision making.

The first decision making category analyzed was cost. A known determinant, the extent to which cost informed decisions was unknown. Cost was a factor from the beginning of the property's management by the National Trust for Historic Preservation. The condition of many of the buildings on the estate was poor when the National Trust received the property. Some of the buildings were already in declining condition and in need of considerable work. This left the National Trust and staff at Lyndhurst at a disadvantage from the start. Over the years, Lyndhurst continuously operated at a deficit. When outside sources of income started to dwindle, it became almost impossible to catch up financially. According to staff at the site today, these financial constraints result in the need to set priorities for repairs around the property and look for other solutions to make money go further.

The second category analyzed for impact on repair decision making was durability of materials. Research into the properties of the specific materials used in the five projects aided in the analysis of durability factors contributing to the decision making. Upon researching the different materials and their durability, it became clear that all of the substitute materials used in these repairs are more durable than the original materials. Although not documented as the reasoning behind all of the decisions, this was likely a great contributor when choosing these substitute materials. First, the durability of portland cement is so pronounced that its high strength and service life is detrimental to the materials around it. A material that has similar characteristics is cement, which contains portland cement. Although these materials are extremely successful in the correct applications, when installed around materials that are very different they can do damage. In the case of the aluminum roofing replacing the glass of the swimming pool building roof, the substitute material was a very good choice given its high durability and resistance to corrosion. Although the material was not comparable to the glass it replaced, it was a great choice for the intended stabilization and protection of the building until a more permanent repair occurred. The polyurethane that replaced the wooden finials on the mansion roof and brackets inside the bowling alley is another durable material. The biggest threat of degradation for this material is extended exposure to ultraviolet light. This threat is greatly reduced if the object is coated however, which is the case in both replacement projects.

The last category related to decision making leading to the substitute materials used in these projects is philosophy. Information on the philosophy of Lyndhurst over the years proved difficult to find for the full range of time owned by the National Trust, however interviews conducted were able to fill in the gaps slightly. In general, research and interviews have pointed to the Secretary of Interior's Standards as the preservation philosophy of Lyndhurst at least since the mid 1980s. Information on philosophy before this time seems to be more general statements about what function the buildings should serve rather than a definite philosophy. For example, the bowling alley and swimming pool buildings often discussed in meetings as spaces for events, demonstrated a shift in philosophy for these buildings between rehabilitation and restoration. Perhaps there was never a definite philosophy statement that Lyndhurst created to speak for the property as a whole. Interviews provided a more specific look at property philosophies. In general, the National Trust had and continues to have a fairly hands off approach to repairs around the property unless it is a larger project requiring contract work. The staff at Lyndhurst makes the decisions for smaller day-to-day repairs. It is important to display the mansion in its intended and completed form according to Lyndhurst's current Associate Manager. She feels this philosophy justifies the use of substitute materials if they save already scarce funds and do not harm the historic fabric. Perhaps this approach is more in line with the philosophy of Lyndhurst today.

Based on all of the information gathered in these three categories, it appears that there is often a combination of factors contributing to decision making when it comes to repairs. It seems different factors are considered in most cases, rather than just one guiding principle or haphazardly choosing something. Also pointed out in an interview with Thomas Richmond, is the factor of expediency which arises from time to time. If a repair needs to be addressed quickly, that is often also a factor on what staff decides to do for a repair. Although a combination of considerations contributes to the decision making, it appears that cost is the deciding factor more often than not after other factors are considered. This hardly seems surprising given the amount of buildings and therefore the required maintenance on the property as well as income constraints over the years.

## CHAPTER SIX

### RECOMMENDATIONS

#### Substitute Repair Project Recommendations

Based on the conclusions of both the analysis on the project assessments and the analysis of decision making contributors, some aspects of each are going well and some could use some work. After examining all components, the need for recommendations emerges to provide ideas for monitoring the substitute projects already completed. Likewise, recommendations of responsible decision making for future considerations of substitute materials for repairs and other related areas will hopefully assist in any remaining or future building repairs.

The projects examined for the purposes of this thesis contain both substitute materials that are removable at a later time and those that would be very difficult to remove without causing damage. Although some materials can be easily removed while others cannot, it is important that all repair projects are regularly examined with both substitute materials and surrounding historic fabric being monitored. Similarly, while some of the repair projects received ratings culminating in a score of 'unsuccessful' many of the substitute materials are performing better than expected at this time despite material properties thought to be incompatible with surrounding materials. The repair projects receiving the ratings leading to the final assessment of 'successful' contain substitute materials added within the last five years and therefore may not be

showing any signs of incompatibility at this time. Because of this possibility, a project based recommendation is the examination of these repairs annually for assurance that they are performing adequately and to inspect for any maintenance needs. This measure will ensure that these repairs are stable going forward and assist in the early identification of any problems associated with substitute materials, so that appropriate measures can be taken to remedy issues.

### Decision Making Recommendations

#### *Financial*

The decision making conclusions show that while there is effort made to examine multiple options for repairs, there is room for other considerations to make a more informed decision. Within the financial component of decision making for these endeavors, a recommendation identified that might help the staff at Lyndhurst is trying a more systematic or specialized approach for choosing between different materials. One option that may prove helpful for this process is a life-cycle cost analysis (LCCA). This process is helpful when comparing several alternatives related to buildings or in this case materials. The analysis is designed to measure the long-term performance of given options and takes into consideration all costs associated with a material over its service life rather than just the initial cost. In the instance that this is seen as too time consuming, software can be obtained to quickly find the results.

### *Durability of Materials*

While life-cycle costing can also aid informing the durability aspect of decision making for repairs, further recommendations for information on this influential factor are advised. The first recommendation is for a thorough research on materials before choosing a method for replacement. A clear understanding of options, their properties and potential to react adversely to surrounding materials will ensure a more successful repair and a longer service life. The second recommendation is testing of materials that are not as established or with little performance information available. While performance testing occurred to some extent with the roof finial replacements on the mansion, it would be ideal to perform these kinds of tests before installation on historic fabric. Testing of this kind could predict future failures and prevent unforeseen tragic effects to historic building components.

### *Preservation Philosophy*

Regarding the decision making factor of philosophy, there are a few recommendations that might help further clarifying the preservation philosophy at Lyndhurst. Although the Secretary of Interior's Standards are a good source for guiding preservation philosophy and practice, it seems other factors come into play at Lyndhurst depending on the situation. While the circumstances surrounding every repair will be different and must be handled on a case by case basis, it might help to have a more focused philosophy for the staff to reference. This prompts the first recommendation

that Lyndhurst staff take a look at what their values and goals are regarding the property and establish a clear philosophy statement. This philosophy statement would be an excellent addition to the website and would inform visitors of the ideals that go into caring for a property like Lyndhurst.

Additionally, another recommendation is that Lyndhurst apply clear site specific preservation philosophies to each building. Although philosophy associated with each building is somewhat apparent to staff at this time, clarification and official guiding principles are necessary. This would be helpful going forward for use by staff when making decisions related to a specific building. The Secretary of Interior's Standards for the Treatment of Historic Properties can be a helpful source in deciding which treatment best applies based on the considerations of: relative importance in history; physical condition; proposed use; and mandated code requirements.<sup>216</sup> Based on these considerations related to the standards, recommendations can be made for the three buildings examined in this thesis: the mansion, bowling alley and swimming pool building. Additionally, it should be noted the estate of Lyndhurst is designated as a National Historic Landmark.

First, because the mansion at Lyndhurst is associated with a master of architecture and with a distinctive type of architecture, it is the most significant structure on the property. The mansion is also considered the main attraction for those who visit the property. The Secretary of Interior suggests that, "National Historic

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<sup>216</sup> National Park Service, "Technical Preservation Services: The Treatment of Historic Properties," National Park Service, <https://www.nps.gov/tps/standards.htm> (accessed March 22, 2017).



Landmarks, designated for their, 'exceptional significance in American history,' or many buildings listed on the National Register often warrant Preservation or Restoration."<sup>217</sup> Because, the building has been restored to a period of significance it is recommended that the philosophy of the building be specifically classified as a restoration in treatment.

Second, the bowling alley at Lyndhurst although identified with the intention of both restoration and rehabilitation over time based on found documents, should be classified as a restoration based on the treatments already applied to the building. Although it may be given a new use as an event space going forward, it will still retain the characteristics of a specific period and will still have a usable bowling alley which was its original use.

Third, the swimming pool building which has also been identified over the years in documents with the intended purpose of both restoration and rehabilitation, should pursue the classification of rehabilitation once money is secured for treatment to the building. This treatment is fitting for the building due to its fragile condition and the loss of much of the original fabric. Current conditions would require much of the material found in the building to be replaced. It is also apparent that due to current health and building codes, it is likely the building could not go back to use as a pool according to current Restoration Project Manager, Thomas Richmond. An adaptive reuse to serve another function would be the most appropriate treatment going forward in this case.

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<sup>217</sup> National Park Service, "Technical Preservation Services: The Treatment of Historic Properties," National Park Service, <https://www.nps.gov/tps/standards.htm> (accessed March 22, 2017), 1.

## General Recommendations

Lastly, there are general recommendations related to repairs that are advised to provide assistance and inform future caretakers and interested parties of the property. The first recommendation is that the priority be made for documentation take place during repairs in the future. Extensive photographs during the process and a written report would provide a record of the replaced materials, processes and other factors that staff and others would find helpful in the future. This procedure is advised to occur during or shortly after the repair has been done to insure its creation. Although Lyndhurst staff has completed documentation for many projects to some degree for repairs and have had good intentions in documenting others, ultimately important parts of a repair are likely forgotten if enough time goes by. Documentation will serve as an invaluable source of information on changes the buildings have seen over time and why. Additionally, photographs can sometimes provide information that is difficult to convey in a written report and vice versa, this is why both forms of documentation are necessary.

A second general recommendation is to take time to better organize paperwork and other materials in the archives at Lyndhurst to ensure their safe keeping and accessibility. It may also be beneficial to digitize much of the paperwork and photos. Although this has been done for part of the collection in the form of filing, many sources are not easily found or accessible. This should include paperwork and other materials

found in basement and first floor of the laundry building as well as the office of the maintenance building.

Lastly, it should be noted that some of these recommendations were not previously implemented due to understaffing or the general demands of a busy property. This is understandable as the staff is hard working and constantly busy. Because of this, a third recommendation is that Lyndhurst seek out volunteers or more interns interested in preservation to take on some of these roles and tasks. Extending intern employment to all parts of the year instead of just the summertime might help with this need.

## APPENDICES

Appendix A

Project Repair Assessment Forms

<b>Project title:</b> Historic Mortar Mixture vs. Portland Cement <b>Location:</b> Lyndhurst Estate, Tarrytown, NY <b>Building:</b> Mansion <b>Location on/in Building:</b> Scattered on exterior		<b>Name:</b> Kirsten Freeman <b>Date:</b> December 6, 2016	
<b>CRAFTSMANSHIP</b>			
<b>1. Is it aesthetically pleasing?</b>  <b>Notes:</b> Color is off and applied somewhat sloppy.	Good	Fair	<b>Poor</b>
<b>2. Was the process of producing labor intensive?</b>  <b>Notes:</b> Probably comparable to the original.	<b>Good</b>	Fair	Poor
<b>3. Was skill required to make it?</b>  <b>Notes:</b> Some skill required to make it, however it should have been apparent it was not a match for the original.	Good	<b>Fair</b>	Poor
<b>4. Are the basic dimensions the same as the original?</b>  <b>Notes:</b> Some of the repointing is comparable to the original, but some is not.	Good	<b>Fair</b>	Poor
<b>5. Were similar construction techniques used?</b>  <b>Notes:</b> Same techniques used in applying both mixtures.	<b>Good</b>	Fair	Poor
<b>6. Are the details of the original present in the replacement?</b>  <b>Notes:</b> They look very different	Good	Fair	<b>Poor</b>
<b>REPLACEABILITY</b>			
<b>Was it installed with the option of later removal?</b>			
<b>1. Research based conclusions: N/A</b>  <b>Notes:</b> Could not find information about this.	Good	Fair	Poor
<b>2. Physical examination based conclusions:</b>  <b>Notes:</b> Portland cement is notoriously hard to remove. It can be done, but will likely cause at least some damage.	Good	Fair	<b>Poor</b>

Figure A-1: Replacement of historic mortar with portland cement, side one

<u>IMPACT ON SURROUNDING MATERIALS</u>			
<b>Deterioration or wear present:</b>			
1. <b>BIOLOGICAL:</b> Mold and algae	Good	Fair	Poor
<b>Notes:</b> There are some forms of biological growth seen on the portland cement and surrounding materials in certain areas. This could be a result of location, rather than materials.			
2. <b>CHEMICAL:</b> N/A	Good	Fair	Poor
<b>Notes:</b> Nothing at this time.			
3. <b>MECHANICAL:</b> Cracking	Good	Fair	Poor
<b>Notes:</b> Cracking is present in some areas due to the thermal/moisture expansion and contraction most likely.			
4. <b>ANTHROPOGENIC:</b> Choice of mortar mixture	Good	Fair	Poor
<b>Notes:</b> Because this mixture was chosen instead of something closer to the original or something softer, it points to a negative impact inflicted by humans.			
<u>WEATHERING</u>			
1. <b>COLORING:</b> Original: Lighter gray Sustitute (As compared to original): Darker gray	Good	Fair	Poor
<b>Notes:</b> Portland cement is much darker than the orginal			
2. <b>SURFACE TEXTURE:</b> Original: Finely grained and soft Sustitute (As compared to original): Finely grained	Good	Fair	Poor
<b>Notes:</b> Texture is similar, but the portland cement is much harder.			
3. <b>BIOLOGICAL GROWTH:</b> Original: Brown and green mold or algae Sustitute (As compared to original): Similar mold or algae	Good	Fair	Poor
<b>Notes:</b> Can be found on both types of mortar in certain areas.			
4. <b>WATER PENETRATION: RILEM TUBE TEST RESULTS *(Mortar &amp; Stone only)</b> N/A Original: Sustitute (As compared to original):	Good	Fair	Poor
<b>Notes:</b> Could not form tight enough bond of RILEM tube to either mortar type. Water continuously leaked out the sides making the experient ineffective.			

Figure A-2: Replacement of historic mortar with portland cement, side two

<b>Project title:</b> Porte-Cochere- Marble vs. Cast Concrete <b>Location:</b> Lyndhurst Estate, Tarrytown, NY <b>Building:</b> Mansion <b>Location on/in Building:</b> Porte-Cochere, west elevation		<b>Name:</b> Kirsten Freeman <b>Date:</b> December 6, 2016	
<b>CRAFTSMANSHIP</b>			
1. Is it aesthetically pleasing?	Good	Fair	Poor
<b>Notes:</b> Material difference less noticable from a distance.			
2. Was the process of producing labor intensive?	Good	Fair	Poor
<b>Notes:</b> Somewhat.			
3. Was skill required to make it?	Good	Fair	Poor
<b>Notes:</b> Yes, a ceratain amount of skill is required for cast concrete			
4. Are the basic dimensions the same as the original?	Good	Fair	Poor
<b>Notes:</b> Same dimensions.			
5. Were similar construction techniques used?	Good	Fair	Poor
<b>Notes:</b> Totally different techniques.			
6. Are the details of the original present in the replacement?	Good	Fair	Poor
<b>Notes:</b> Texture, luster and coloring are very different.			
<b>REPLACEABILITY</b>			
Was it installed with the option of later removal?			
1. Research based conclusions:	Good	Fair	Poor
<b>Notes:</b> No evidence to point to the intention of later removal. Meant to be permanent.			
2. Physical examination based conclusions:	Good	Fair	Poor
<b>Notes:</b> Nothing to indicate later removal as an option.			

Figure A-3: Replacement of Sing Sing marble with cast concrete, side one

<u>IMPACT ON SURROUNDING MATERIALS</u>			
<b>Deterioration or wear present:</b>			
1. <b>BIOLOGICAL:</b> Very little to none	Good	Fair	Poor
<b>Notes:</b> Few signs that the cast concrete is causing any biological growth, etc. on surrounding materials.			
2. <b>CHEMICAL:</b> N/A	Good	Fair	Poor
<b>Notes:</b> Nothing at this time.			
3. <b>MECHANICAL:</b> Loss of stone	Good	Fair	Poor
<b>Notes:</b> Seem to be areas of stone loss around many of the cast concrete units. Where this has occurred parging is present over some of the areas of stone loss.			
4. <b>ANTHROPOGENIC:</b> Improper choices/repair	Good	Fair	Poor
<b>Notes:</b> Cast concrete was probably not the best choice for the surrounding stone. May be causing cracking and further loss of material.			
<u>WEATHERING</u>			
1. <b>COLORING:</b> <b>Original:</b> Variations of same stone- white to light gray <b>Sustitute (As compared to original):</b> Same shade of gray <b>Notes:</b> Does not not have the color variation that the marble has and does not have its luster.	Good	Fair	Poor
2. <b>SURFACE TEXTURE:</b> <b>Original:</b> Slightly rough/unpolished texture <b>Sustitute (As compared to original):</b> Smooth <b>Notes:</b> Cast concrete is more smooth and contains texture of small holes.	Good	Fair	Poor
3. <b>BIOLOGICAL GROWTH:</b> <b>Original:</b> Small amounts of moss or algae <b>Sustitute (As compared to original):</b> None <b>Notes:</b> No biogrowth on concrete, unlike marble.	Good	Fair	Poor
4. <b>WATER PENETRATION: RILEM TUBE TEST RESULTS *(Mortar &amp; Stone only)</b> <b>Original:</b> After 30 min. measured at 5 1/2 on tube <b>Sustitute (As compared to original):</b> Below 0 at 30 min. <b>Notes:</b> The marble absorbed water at a much faster rate than the cast concrete.	Good	Fair	Poor

Figure A-4: Replacement of Sing Sing marble with cast concrete, side two



<b>Project title:</b> Roof- Glass vs. Corrugated Metal Paneling <b>Location:</b> Lyndhurst Estate, Tarrytown, NY <b>Building:</b> Swimming Pool Building <b>Location on/in Building:</b> Roof		<b>Name:</b> Kirsten Freeman  <b>Date:</b> December 6, 2016	
<b>CRAFTSMANSHIP</b>			
1. Is it aesthetically pleasing?	Good	Fair	<b>Poor</b>
2. Was the process of producing labor intensive?	Good	<b>Fair</b>	Poor
<b>Notes:</b> Only installation can be considered labor intensive.			
3. Was skill required to make it?	Good	Fair	<b>Poor</b>
<b>Notes:</b> Requires little skill and is machine made.			
4. Are the basic dimensions the same as the original?	<b>Good</b>	Fair	Poor
<b>Notes:</b> Although I do not have access to measure or take a close look, the conclusion that the dimensions are the same can be made.			
5. Were similar construction techniques used?	Good	Fair	<b>Poor</b>
<b>Notes:</b> Very different techniques.			
6. Are the details of the original present in the replacement?	Good	Fair	<b>Poor</b>
<b>Notes:</b> Two totally different materials.			
<b>REPLACEABILITY</b>			
<b>Was it installed with the option of later removal?</b>			
1. Research based conclusions:	<b>Good</b>	Fair	Poor
<b>Notes:</b> Because this was put up in an effort to stabilize the building, later removal was always an option when the opportunity came.			
2. Physical examination based conclusions:	<b>Good</b>	Fair	Poor
<b>Notes:</b> Although the roof could not be examined close up there was enough evidence that could be seen from pointing to the possibility of later removal.			

Figure A-5: Replacement of glass with corrugated aluminum, side one

<u>IMPACT ON SURROUNDING MATERIALS</u>			
<b>Deterioration or wear present:</b>			
1. <b>BIOLOGICAL:</b> Plants, possible animals	Good	Fair	Poor
<b>Notes:</b> The corrugated metal roof provides basic protection, however openings present opportunities vines to enter as well as animals such as birds.			
2. <b>CHEMICAL:</b> Corrosion	Good	Fair	Poor
<b>Notes:</b> Present on the metal trusses supporting the roof, but it is unclear if this was present before the metal roof was installed.			
3. <b>MECHANICAL:</b> N/A	Good	Fair	Poor
<b>Notes:</b> Cannot access for a closer look.			
4. <b>ANTHROPOGENIC:</b> Maintenance Issues	Good	Fair	Poor
<b>Notes:</b> Regular cleaning of debris and maintenance is needed.			
<u>WEATHERING</u>			
*** NO EXAMPLES OF ORIGINAL GLASS AVAILABLE FOR COMPARISON			
1. <b>COLORING:</b>			
Original:			
Sustitute (As compared to original):	Good	Fair	Poor
Notes:			
2. <b>SURFACE TEXTURE:</b>			
Original:			
Sustitute (As compared to original):	Good	Fair	Poor
Notes:			
3. <b>BIOLOGICAL GROWTH:</b>			
Original:			
Sustitute (As compared to original):	Good	Fair	Poor
Notes:			
4. <b>WATER PENETRATION: RILEM TUBE TEST RESULTS *(Mortar &amp; Stone only)</b>			
Original:			
Sustitute (As compared to original):	Good	Fair	Poor
Notes:			

Figure A-6: Replacement of glass with corrugated aluminum, side two

<b>Project title:</b> Roof Finials- 2nd generation Wood vs. Plastic <b>Location:</b> Lyndhurst Estate, Tarrytown, NY <b>Building:</b> Mansion <b>Location on/in Building:</b> South and west side of bldg.	<b>Name:</b> Kirsten Freeman  <b>Date:</b> December 26, 2016
<b>CRAFTSMANSHIP</b>	
1. Is it aesthetically pleasing?	<input type="radio"/> Good <input type="radio"/> Fair <input type="radio"/> Poor
2. Was the process of producing labor intensive?  <b>Notes:</b> Compared to original, not as labor intensive.	<input type="radio"/> Good <input type="radio"/> Fair <input checked="" type="radio"/> Poor
3. Was skill required to make it?  <b>Notes:</b> Yes, casting can take a while to master. It is a different and less demanding skill than woodworking however.	<input type="radio"/> Good <input checked="" type="radio"/> Fair <input type="radio"/> Poor
4. Are the basic dimensions the same as the original?  <b>Notes:</b> Dimensions are the same.	<input checked="" type="radio"/> Good <input type="radio"/> Fair <input type="radio"/> Poor
5. Were similar construction techniques used?  <b>Notes:</b> Very different construction techniques.	<input type="radio"/> Good <input type="radio"/> Fair <input checked="" type="radio"/> Poor
6. Are the details of the original present in the replacement?  <b>Notes:</b> Almost exact copies, in minor cases there are dips and depressions present. These are mostly unnoticeable, however.	<input checked="" type="radio"/> Good <input type="radio"/> Fair <input type="radio"/> Poor
<b>REPLACEABILITY</b>	
Was it installed with the option of later removal?	
1. Research based conclusions:  <b>Notes:</b> Later removal is an option, however this is likely the permanent solution	<input type="radio"/> Good <input checked="" type="radio"/> Fair <input type="radio"/> Poor
2. Physical examination based conclusions:  <b>Notes:</b> Seem attached fairly well with fasteners, but should be able to be removed easily.	<input checked="" type="radio"/> Good <input type="radio"/> Fair <input type="radio"/> Poor

Figure A-7: Replacement of mahogany with polyurethane, side one

IMPACT ON SURROUNDING MATERIALS			
<b>Deterioration or wear present:</b>			
1. <b>BIOLOGICAL:</b> Small amount of mold or algae.	Good	Fair	Poor
<b>Notes:</b> Minor amounts in shaded areas and depressions.			
2. <b>CHEMICAL:</b> N/A	Good	Fair	Poor
<b>Notes:</b> Nothing at this time.			
3. <b>Mechanical:</b> N/A	Good	Fair	Poor
<b>Notes:</b> Same methods and fasteners used as wooden finials, therefore no change.			
4. <b>ANTHROPOGENIC:</b> N/A	Good	Fair	Poor
<b>Notes:</b> Nothing at this time.			
WEATHERING			
<b>1. COLORING:</b>			
<b>Original:</b> Paint is slightly dulled.			
<b>Sustitute (As compared to original):</b> Looks freshly painted.	Good	Fair	Poor
<b>Notes:</b> Color is brighter and new looking compared to the the second generation.			
<b>2. SURFACE TEXTURE:</b>			
<b>Original:</b> Paint is more distressed and cracked.			
<b>Sustitute (As compared to original):</b> Looks freshly painted.	Good	Fair	Poor
<b>Notes:</b> The substitute still looks pristine.			
<b>3. BIOLOGICAL GROWTH:</b>			
<b>Original:</b> Little to no signs.			
<b>Sustitute (As compared to original):</b> Some mold or algae.	Good	Fair	Poor
<b>Notes:</b> A few have biogrowth in cracks and recessed areas where little sunlight reaches and moisture collects.			
<b>4. WATER PENETRATION: RILEM TUBE TEST RESULTS *(Mortar &amp; Stone only)</b>			
<b>Original:</b>			
<b>Sustitute (As compared to original):</b>	Good	Fair	Poor
<b>Notes:</b>			

Figure A-8: Replacement of mahogany with polyurethane, side two

<b>Project title:</b> Decorative Brackets- Wood vs. Plastic <b>Location:</b> Lyndhurst Estate, Tarrytown, NY <b>Building:</b> Bowling Alley <b>Location on/in Building:</b> Interior		<b>Name:</b> Kirsten Freeman  <b>Date:</b> December 7, 2016	
<b>CRAFTSMANSHIP</b>			
1. Is it aesthetically pleasing?	<input checked="" type="radio"/> Good	<input type="radio"/> Fair	<input type="radio"/> Poor
2. Was the process of producing labor intensive?	<input type="radio"/> Good	<input type="radio"/> Fair	<input checked="" type="radio"/> Poor
Notes: Compared to original, not as labor intensive.			
3. Was skill required to make it?	<input type="radio"/> Good	<input checked="" type="radio"/> Fair	<input type="radio"/> Poor
Notes: Yes, casting can take a while to master. It is a different and less demanding skill than woodworking, however.			
4. Are the basic dimensions the same as the original?	<input checked="" type="radio"/> Good	<input type="radio"/> Fair	<input type="radio"/> Poor
Notes: Dimensions are the same.			
5. Were similar construction techniques used?	<input type="radio"/> Good	<input type="radio"/> Fair	<input checked="" type="radio"/> Poor
Notes: Very different construction techniques.			
6. Are the details of the original present in the replacement?	<input checked="" type="radio"/> Good	<input type="radio"/> Fair	<input type="radio"/> Poor
Notes: Almost exact copies.			
<b>REPLACEABILITY</b>			
Was it installed with the option of later removal?			
1. Research based conclusions:	<input type="radio"/> Good	<input checked="" type="radio"/> Fair	<input type="radio"/> Poor
Notes: Later removal is possible, but most likely will not occur due to cost.			
2. Physical examination based conclusions:	<input checked="" type="radio"/> Good	<input type="radio"/> Fair	<input type="radio"/> Poor
Notes: Brackets can simply be unscrewed to be uninstalled.			

Figure A-9: Replacement of poplar with polyurethane, side one

<u>IMPACT ON SURROUNDING MATERIALS</u>			
Deterioration or wear present:			
1. BIOLOGICAL:	Good	Fair	Poor
Notes: Location on interior of building reduces the threat of biological attack. Currently, there are no signs that this has occurred, but it is possible later.			
2. CHEMICAL: N/A at this time	Good	Fair	Poor
Notes:			
3. Mechanical: Penetration from screws.	Good	Fair	Poor
Notes: Screws used to install brackets to columns.			
4. ANTHROPOGENIC: N/A at this time	Good	Fair	Poor
Notes:			
<u>WEATHERING</u>			
1. COLORING:			
Original: Naturally faded over time.			
Sustitute (As compared to original): Looks new.	Good	Fair	Poor
Notes: Staining on substitute brackets does not match existing brackets.			
2. SURFACE TEXTURE:			
Original: Smooth, but grain can be seen/felt			
Sustitute (As compared to original): Especially smooth.	Good	Fair	Poor
Notes: Very smooth, staining helps this to be less evident however.			
3. BIOLOGICAL GROWTH: N/A			
Original:			
Sustitute (As compared to original):	Good	Fair	Poor
Notes:			
4. WATER PENETRATION: RILEM TUBE TEST RESULTS *(Mortar & Stone only)			
Original:			
Sustitute (As compared to original):	Good	Fair	Poor
Notes:			

Figure A-10: Replacement of poplar with polyurethane, side two

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