2019

A Conservation Assessment of the Architectural Wood of the Original Dining Room at Taliesin West

Mia Maloney

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A Conservation Assessment of the Architectural Wood of the Original Dining Room at Taliesin West

Abstract
Taliesin West, located in Scottsdale, Arizona, was Frank Lloyd Wright’s winter home and studio from 1938 until his death in 1959. Through the Taliesin Fellowship, Wright trained hundreds of apprentices who helped him build and continually alter the site. Taliesin West has continued to evolve since 1959 and currently operates as both a school and museum. This thesis focuses on the conservation of the architectural wood in the Original Dining Room, presently referred to as the Board Room. The Original Dining Room was one of the first structures built at the site and functioned as the Taliesin Fellowship’s dining space until its conversion into Wright’s private dining room c. 1951. Initial investigation began with archival research and building archaeology with the goal of better understanding how the structure was built and to establish a chronology of Wright’s many modifications to the space. This was accompanied by an assessment of the wooden elements, wood species identification, finishes analysis, monitoring, and the gathering of environmental data to determine the condition of the structure and the mechanisms of deterioration. This data informed recommendations for an anticipated restoration project and future preventive conservation of the Original Dining Room, with potential application to Taliesin West as a whole.

Keywords
Frank Lloyd Wright, building chronology, condition assessment, modeling, Arizona

Disciplines
Historic Preservation and Conservation

Comments
Suggested Citation:
A CONSERVATION ASSESSMENT OF THE ARCHITECTURAL WOOD OF THE ORIGINAL DINING ROOM AT TALIESIN WEST

Mia Elizabeth Maloney

A THESIS

in

Historic Preservation

Presented to the Faculties of the University of Pennsylvania in Partial Fulfillment of the Requirements of the Degree of

MASTER OF SCIENCE IN HISTORIC PRESERVATION

2019

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ACKNOWLEDGMENTS

Thank you to my advisor, Andrew Fearon, for his knowledge, guidance, invaluable advice, and for pushing me to challenge myself and expand my goals.

Thank you to Frank G. Matero, Professor and Chair of the Historic Preservation Department, for making this thesis a reality and for his support throughout the process.

Thank you to Fred Pozzillo, Emily Butler, and all others associated with the Frank Lloyd Wright Foundation and Taliesin West who made this thesis possible. I am gracious for the opportunity to work so intimately with a Frank Lloyd Wright building.

Thank you to Gunny Harboe for his conversation and for the Preservation Master Plan which served as a springboard for this research.

Thank you to the faculty and staff of the Historic Preservation Department of the University of Pennsylvania, each of whom played a critical role in providing me with the skill set and tools needed to approach this thesis.

Thank you to the Jack Kent Cooke Foundation for giving me the opportunity and resources to pursue my passions.

Thank you to my peers for their friendship and encouragement.

Thank you to my parents, Mark Maloney, Lynn Deardorff, and Kevin Deardorff, and to my grandparents for their unending support. Thank you for your countless influences that helped me develop my interests in history, building, art, architecture and science, all of which led me to the field of Historic Preservation.

Finally, a special thank you to Joseph Owens for his relentless patience, unconditional support, and bringing joy to my life every day.
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1.0 INTRODUCTION

Taliesin West, Frank Lloyd Wright's former winter home and studio, is located in Scottsdale, Arizona. Founded as a winter camp for the Taliesin Fellowship in 1937, the site grew into a permanent winter home at which Wright lived and worked until his death in 1959. The focus of this thesis, the Original Dining Room, was one of the first structures built on the site, completed in its first from in the winter of 1938-39. The space functioned as the dining area for the Fellowship from its construction until its conversion into a private dining room for the Wrights in the early 1950s. The Original Dining Room evolved under Wright's direction for twenty-two years, with modifications carried out by the apprentices. Wright, his family, and the Fellowship returned to Arizona nearly every winter, redesigning, reconstructing, and adding to the site each time. After Wright's passing, the site continued to evolve under the direction of Wright's widow, Olgivanna, until her death in 1985. Today, Taliesin West serves as both a school and a museum. The Original Dining Room, now known as the Board Room, primarily functions as a classroom.

Preservation efforts have been underway at the site over the last several decades. Taliesin West was added to the National Register of Historic Places in 1974 and was designated a National Historic Landmark in 1982. More recently, in 2015 Harboe Architects developed a Preservation Master Plan for the site. The plan established Taliesin West's period of significance as 1938-1959, the era associated with Wright. Four preservation zones were developed for the site, with Zone 1 (Primary Significance) and Zone 2 (Secondary Significance) containing spaces and structures within the historic core that

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contain elements dating to Wright’s time at Taliesin. Zone 3 (Tertiary Significance) is composed of spaces outside of the historic core that have been largely altered following Wright’s death, and Zone 4 (Minor Significance) includes spaces constructed following Wright’s death. The majority of the recommended scope provided in the Preservation Master Plan involves Zones 1 and 2, as the plan mostly refers to rehabilitating, preserving, and restoring the buildings, elements, and sites associated with the period of significance, with a goal of restoring to 1959.²

The Original Dining Room was one of the Zone 1 structures featured in the Preservation Master Plan. A condition assessment revealed that the exterior roof beams, trim, and decking contained significant ultraviolet damage and rot. On the interior, the plywood ceiling panels featured water staining and scratches, but were in fair to good condition. Doors were also noted to be in fair to good condition. Recommendations outlined in the plan include preserving the roof’s wood framing where possible, with the understanding that supplementary new wood may be necessary, and the installation of a wooden skylight to match the one that was present in 1959. Interior millwork should be preserved with missing or damaged pieces replaced in kind. Decorative wooden elements, referred to as “icicles,” should be recreated. Wood identification and finish analysis should be conducted in conjunction with the preservation and restoration work.³

Growing out of the Preservation Master Plan, a project has been under development for the Original Dining Room and is scheduled to begin in Spring of 2019. The project will include repainting and repairs of exterior elements, stabilization of the exterior wood, and repairs to the structural failures in the exterior beams. While the Preservation Master Plan laid the groundwork for the project and provided a great overview of Taliesin West’s

³ Ibid., 380-381.
preservation needs, the large, site-wide scope meant that an in-depth analysis of each space could not be included. Because the Original Dining Room has a high level of significance and integrity, with a much of the present wood dating to Wright's period, additional information and recommendations for the space have been requested. It is the intention of this thesis to answer some of the remaining questions about the wooden architectural elements of the space, including its construction chronology and current conditions, and to provide recommendations for its conservation in the regards to both the upcoming project and its long-term maintenance.

1.1 Overview

The primary goal of this thesis is to provide recommendations for the upcoming project and for the long-term conservation of wooden elements of the Original Dining Room. To meet this objective, the current conditions and associated pathologies were documented and described following an on-site investigation and analysis of the environment. Appropriate interventions were then identified, informed by the Frank Lloyd Wright Foundation’s preservation philosophy, the integrity of the wooden features, and the intended use of the space. An integral part of this process was understanding the context in which the structure developed and the creation of a building chronology, derived from archival research and building archeology.

While the findings and recommendations may be applicable to multiple structures at Taliesin West, the scope of this thesis is limited to the Original Dining Room with a focus on the wooden architectural elements. The building chronology encompasses all materials found in the space, but only the wooden elements have been included in the condition survey. Because the conservation of the wooden architectural elements is dependent on the function of the structure as a system, non-wooden are included in the recommendations.
1.2 Description of the Original Dining Room

Located on the southwestern edge of Taliesin West, The Original Dining Room [Figure 1] is visible when approaching the complex from the main drive. As one of the first permanent structures erected, the Original Dining Room contributes to the historic core and is physically connected to several other early spaces including the Kitchen and Drafting Room. The one-story structure is primarily constructed of masonry, wood, and glass.

The Original Dining Room is bound by the Dishwashing Area to the north, which was constructed along with the Original Dining Room and shares two masonry walls. The two spaces are divided by a frame wall with a masonry fireplace in the center. The north wall features a geometric mural painted on plywood over built-in coves on the west side of the fireplace. The east side of the fireplace contains built-in shelving, a heater, and a doorway to the Dishwashing Area [Figure 2]. A Conference Room, which originally functioned as bedrooms for Wes and Svetlana Peters and Gene Masselink, boarders the Original Dining Room to the east. The south wall of the Original Dining Room features double glass doors in its center. Three steps on the exterior side of the door lead to a small landing, with two additional sets of steps down to the lawn on both the east and west side of the landing. A short desert masonry wall separates the steps from the lawn. A decorative Chinese ceramic frieze is embedded in the center of the wall. On the western side of the Original Dining Room, a platform of thirteen steps rise along the masonry wall and lead to the Drafting Room [Figure 3]. A shallow triangular pool resides at the base of the steps, beginning near the southwest corner of the Original Dining Room.

The Original Dining Room is constructed primarily of battered desert masonry walls with a slope between 75 and 80°. The walls rise approximately 8.5 feet from ground level on the exterior, and nearly 5 feet from floor level on the interior. The walls range in thickness
Figure 1: View of the Original Dining Room from the south.

Figure 2: The interior of the Original Dining Room, facing north (Fearon).
from 4 feet and 4 inches wide at the base to approximately 1 foot and 3 inches at the top. At floor level, the interior of the Original Dining Room is approximately 21.5 feet long at its deepest point, and 21 feet at its widest. The desert masonry walls are left uncovered and unfinished on both the interior and the exterior. The walls have horizontal indented grooves at 2 and 4 feet from the ground on the exterior and at 1 foot from the floor on the interior. The interior walls also feature a low chair-rail type element 2 feet from the floor on the west, south, and east walls.

Clerestory windows are situated directly on top of the desert masonry walls and run the length of west wall. Two rows of alternating fixed wooden panels and operable wooden shutters with piano hinges cover all but the first 3 feet of clerestory windows on the southern end of the west wall. Wooden roof support elements are located between the shuttered and non-shuttered clerestory windows on the west wall and where the west wall meets the north wall. On the south wall, clerestory windows without shutters span both sides of the doorway. Roof supports which are larger and more decorative than those on the west wall separate the clerestory windows from the doorway [Figure 4]. On the southern side of the east wall, the clerestory window continues for 3 feet. This is followed by a roof support element similar to those on the west wall, after which wooden panels and mirrors covered by wooden shutters take the place of the clerestory window and continue for 11.5 feet. The rest of the east wall is masonry.

Four beams spaced approximately 8 feet apart serve as the primary support system of the roof. Each consist of one continuous 2-by-12-inch board which runs from north to south the entire depth of the Original Dining Room and extends 8 feet out from the clerestory windows on the south wall. These continuous boards are lapped on both sides with one, two, or three layers of shorter boards. One of these beams is centered over the
Figure 3: View of the Original Dining Room from the Southwest.

Figure 4: A decorative wooden roof support elements on each side of the south doorway hold the center beams.
west wall and sits directly above the clerestory window, resting on the two roof support elements. A second beam is centered over the east wall above the clerestory window and rests on the wooden roof support element and masonry wall. The remaining two beams begin at the sides of the fireplace on the north wall and span southward, resting on the two roof support elements on either side of the south doorway. Two desert masonry columns situated approximately 3.5 feet from the door serve as additional supports for the two center beams.

Wide boards run beneath the two center beams. Cove lighting is located between these boards and the ceiling on the west side of the westernmost center beam and on the east side of the easternmost center beam. Cove lighting is also present on the other side of these beams and is accompanied by 2 inch wide dentils [Figure 5]. Above this, the two center beams form the frame of a 7.5 foot wide skylight composed of ten fiberglass panels, beginning at the fireplace and spanning for 17.5 feet towards the southern door. A laylight consisting of twenty triangular panels (tri-panels) connected to thin diagonal wooden members hangs beneath the skylight [Figure 6]. Small decorative wooden pyramids adorn the skylight frame below the laylight, above the dentils and lighting.

The ceiling between the westernmost two beams and between the easternmost two beams consists of plywood with recessed lighting. The part of the ceiling between the skylight and the southern door consists of canvas-covered boards. The boards, without the canvas, continue several feet past the southern doorway to the exterior. The roof runs above this, flush with the top of the beams, extending the full 8 feet to the southern end of the center beams. The roof extends 4 feet past the south wall between the two westernmost beams and between the two eastern most beams. The first 4 feet of the south end of the westernmost and easternmost beams are uncovered.
Figure 5: Cove lighting, dentils, and decorative pyramids below the skylight.

Figure 6: View of the skylight facing south.
On the exterior, two decorative wooden icicles hang from the center of the overhanging part of the center two beams [Figure 7]. Triangular in form, they are over 7 feet tall and approximately 8 inches wide at the top. In addition to the icicles, dentils like those near the skylight serve as decorative elements throughout the space. They run along the southern edge of the roof between all four beams, and on the exterior elevations of the west and east walls above the clerestory windows. Dentils can also exist below the roof near the southern clerestory windows on both the exterior and the interior.

Most of the wooden elements of the Original Dining Room are painted Taliesin Red, though details such as shutters, the tri-panels, and doorways are a brighter Mandarin Red. The concrete floor is the darkest color, Maricopa Red. White can be found on the bottom of the overhanging roof between the center beams on the exterior as well as on details of the icicles.

*Figure 7: View facing east of the two decorative icicles hand form the center beams.*
2.0 HISTORY AND CONTEXT

2.1 Wright’s Ideals

Architect, writer, and Fellowship leader Frank Lloyd Wright’s career as a designer spanned over seven decades. Though he is best known for his Prairie style houses and iconic works such as the Guggenheim Museum (1959) and Fallingwater (1935), Wright designed over 1,000 structures in his lifetime, 532 of which were built, with the majority still standing today. Pulling from an array of influences, including his experiences living throughout the United States and abroad and years of study under Lois Sullivan, Wright developed numerous philosophies which are embodied in his iconic style.

2.1.1 Organic Architecture

Wright believed forms should have a purpose and materials should be used in sympathy with their nature, a concept he referred to as “organic” architecture. Rather than designing using traditional styles or in response to taste, all elements should be in harmony and serve a central purpose. The materials and the tools used to build an architectural work should be chosen to ensure that the design has integrity in regard to its structure, location, and time. A structure should be unified with and complimentary to the environment around it.

Tied to Wright’s desire for organic design was his appreciation for the art and architecture of Japan. Wright had seen Japanese architecture in person as early as 1893. At the age of twenty-five he attended the World’s Columbian Exhibition in Chicago and saw the Ho-o-den, the Japanese pavilion, which would go on to have influence that plan of his Prairie

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Houses. Wright would remain acquainted with Japanese culture in the years to follow, collecting woodblock prints and eventually traveling to Japan in 1905. Wright acknowledges the impact woodblock prints had on his drawings, influencing his sense of composition. However, though direct comparisons may be drawn between Wright’s work and elements of Japanese architecture, Wright denied that it was a formal influence on his designs. Rather, Wright saw the Japanese art and architecture he experienced in Japan as being in line with his own work and positions. He did not take their forms, but they did share ideals including connections to nature and the appropriate treatment of materials. He was especially fond of the use of wood by the Japanese, believing “no Western people ever used wood with such understanding as the Japanese used it in their construction, where wood always came up and came out as nobly beautiful.”

2.1.2 Wood as a Material

In a 1928 essay from The Architectural Record, Wright wrote that wood “is universally beautiful to man. It is the most humanly intimate of all materials.” Wood’s natural form, he believed, is best shown in simple, rectangular shapes, like those created by a machine. Wood from the mill is not only utilitarian and economical, but it best expresses wood’s grainy quality. Any further tooling and processing is not ideal, as it puts taste over wood’s true nature, obscuring it’s beauty. The linearity of machined wood allowed Wright to design in a way which expressed both horizontally as well as individual units. By concealing the joints when butting pieces together, sometimes achieved by designing around standard

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7 Ibid., 3-4.
8 Ibid., 2.
9 Ibid., 7.
11 Ibid.
lengths in order to eliminate the need for cutting in the field, wood could take on the form of a single running unit, building off of the movement of the grain. Alternatively, board and batten or lapped construction could allow the individual pieces to stand out, emphasizing their widths.\textsuperscript{12} Embracing the nature of materials and their natural beauty meant refraining from painting or covering.\textsuperscript{13} Wright wanted neither for wood to weather, which he believed reduced its beauty, nor did he wish to use any coatings that may reduce weathering but would change the wood's appearance.\textsuperscript{14}

However, Wright sometimes acted in seeming contradiction to his desire for honesty, such as his desire to use wood in harsh exterior environments which is not suited to withstand. In some of his designs, steel bracing was concealed within wooden framing, falsely representing the wood as structural.\textsuperscript{15} Wright also endorsed wooden veneers although one may consider them deceitful of what's below the surface.\textsuperscript{16}

\textbf{2.1.3 Usonian Houses}

With the onset of the Great Depression, Wright became aware that the United States needed a practical approach to homebuilding. Though earlier designs had been made with economy in mind, it was not until he was approached by Herbert Jacobs in 1936, one year before the founding of Taliesin West, that Wright had the opportunity to build the first "Usonian" house. The design for Jacobs was intended to be both affordable and suitable for a simplified lifestyle. Only the essentials were to be included, with the garage replaced by a carport, complicated roofs reduced to flat ones, and the basement nearly eliminated.\textsuperscript{17}

\textsuperscript{12} Patterson, \textit{Frank Lloyd Wright and the Meaning of Materials}, 19-20.
\textsuperscript{14} Patterson, \textit{Frank Lloyd Wright and the Meaning of Materials}, 48.
\textsuperscript{15} Ibid., 240.
\textsuperscript{16} Ibid., 12-15.
\textsuperscript{17} Bruce Brooks Pfeiffer, \textit{Frank Lloyd Wright Usonian Houses} (Global Architecture Traveler Tokyo: A.D.A. Edita Tokyo, 2002).
Wright’s Usonian houses were not a style; they were a system of building. Field labor was kept to a minimum to reduce the cost when constructing Usonian Houses. Interior and exterior materials were one in the same, with no painting or plastering for interior finishes. Lumber was incorporated into the design in the dimensions in which it was milled, forming horizontal and vertical units to form board and batten or lapped walls with a plywood base. At times these entire walls were fabricated off-site. Building furniture into the walls reduced the amount of material needed to make the walls sturdy and eliminated the need to pay for a cabinet maker. Movable furniture was designed so that it could be built out of plywood by a carpenter.\textsuperscript{18}

Wright was not just concerned with building affordably. He was also concerned about how his clients lived in the houses. The Jacobs House and later Usonian projects included “gravity heat,” a system which involved hot water, iron pipes and crushed rocks and was more affordable to run than heating with oil. Centralizing plumbing to one area of the house by placing the kitchen, bathroom, and heating pipes adjacent to each other not only reduced construction costs, but also allowed for the a more open plan, allowing for housewives to not be shut off from the rest of the home while in their “workspace.”\textsuperscript{19}

2.2 The Path to Arizona and Founding of Taliesin West

Wright made his first venture to Arizona in 1927. Commissioned to design the Biltmore Hotel, he rented a house in Phoenix through 1928 with his wife, Olgivanna, and daughters, Svetlana and Iovanna. During this time Wright was asked to design a second hotel in the area. He returned in January of 1929 for the building of San-Marcos-in-the-Desert, this time choosing to set up camp in the desert outside of Chandler with his family

\textsuperscript{18} Ibid.
\textsuperscript{19} Ibid.
and team of draftsmen. The camp, which received the name Ocotilla after a local desert
cactus, took six weeks to build. It featured self-supporting "box-board cabins" with white
canvas roofs. Doors and windows had no glazing, covered instead by operable canvas-
covered frames. Each cabin was united by a band of boards painted a "dry-rose" color
inspired by the desert's light.20

Wright completed the drawings by May and took his family and staff back to their
home state of Wisconsin. A caretaker was left in charge of the site, as Wright intended to
return to Ocotilla in the fall when the weather became cooler and construction of San-
Marcos-in-the-Desert was set to begin. Wright never returned to the camp. The hotel
project, along with Wright's other commissions, were brought to a halt following the Stock
Market Crash of 1929, and Ocotilla was subsequently destroyed by fire and looters.21

The Crash left little work for architects. Wright took up teaching and writing for
income, publishing his autobiography in 1932. He opened an apprentice training program,
the Taliesin Fellowship, at his Spring Green, Wisconsin home the same year.22 Twenty-three
men and women enrolled that October. Apprentices learned by taking part in Wright's work,
though he had little at the time, as well as through the construction and maintenance of the
Wisconsin property, Taliesin. Kitchen and garden work was also shared.23

In 1947, five years after founding the Fellowship, Wright once again wished to
return to Arizona. Wisconsin was too cold during the winter months, forcing the Fellowship
to spend less time building outdoors and more time keeping warm. With the rate of
architectural commissions improving and his income beginning to grow again, Wright had

20 Bruce Brooks Pfeiffer, Frank Lloyd Wright Taliesin West, ed. Yukio Futagawa (Tokyo: A.D.A. Edita Tokyo, 2002),
6-44.
21 Pfeiffer, Frank Lloyd Wright Taliesin West, 10-44.; Pfeiffer, Frank Lloyd Wright Usonian Houses.
22 Pfeiffer, Frank Lloyd Wright Usonian Houses.
23 Lois Davidson Gottlieb, A Way of Life: An Apprenticeship with Frank Lloyd Wright (Mulgrave, Vic.: Images
Publishing Group, 2001), 10.
the means to return to Arizona with his family and the Taliesin Fellowship in search of a location for a new desert camp. He chose a site below the McDowell Mountain, 26 miles northeast of Phoenix and named it Taliesin West. The site was laid out at an orientation derived from the position of the mountain, with no structures directly aligning to the north-south axis in order to prevent one side from being permanently hot or cold. The angling also took advantage of the breezes and views.

Like Ocotilla, the first structures at Taliesin West were tent-like in form. All the buildings were constructed by the Taliesin Fellowship. Cement, redwood, and canvas were brought in by car, and stone was sourced from the land. The first structures to take form included the Vault to house drawings, the Kitchen, a Serving Room, and the Drafting Room, which served as a space for dining and social events in addition to working. There were few partisans between the spaces and the exterior walkways. Apprentices slept in 9-by-9 foot “sheep herder” tents or on the Drafting Room floor while the Wright’s stayed in a small board and canvas structured called the Suntrap. Luxuries were at a minimum, with few bathrooms, no heating or air conditioning, and a limited amount of electricity from a diesel generator.

2.3 Chronology of the Original Dining Room

The Original Dining Room was constructed between 1938 and 1939. Battered desert masonry walls, several feet thick at their base, formed the south, east, and west boundaries...

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25 Harboe Architects, PC. Taliesin West Preservation Master Plan, 123.
27 Pfeiffer, Frank Lloyd Wright Taliesin West, 14.
29 Pfeiffer, Frank Lloyd Wright Taliesin West, 32.
of the room. The north wall consisted of a frame partition which spanned from the west wall to two thirds of the way towards the east wall, where it terminated at a passage into the Dishwashing Area. This was the sole point of entry into the space. A clerestory opening ran the span of the west, south, and southern half of the east wall between the desert masonry walls and the roof. Four redwood beams formed of dimensional lumber, which are still present today, ran from north to south equidistantly spaced across the room, extending over the wall on the southern side and terminating with an angled cut. As they are today, the beams were held up by wooden supports on the south, east, and west walls. An additional board lapped the easternmost beam on its east side beginning at the southern wall and running north the length of the room. The westernmost beam was similarly lapped with an additional board on its west side. Joists, which alternated running north to south and east to west, ran between the beams, supporting a canvas roof. Five decorative boards hung from the overhanding of the four beams in an inverted pyramidal form on the exterior of the structure [Figure 8]. The structure was unpainted, and interior finishes such as plaster were omitted from the design.

Alterations to the Original Dining Room began only a year after it was constructed (see Appendix A). Taliesin West was Wright’s own home and he could afford to alter the site to his pleasing. Some changes were made for the sake of design, while others were

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31 Projecting ceiling beams to exterior featured in other houses of time, but not left open-ended (i.e. Lloyd Lewis House (1939), Pope House (1939), Sturges House (1939), Pew House (1939), Affleck House (1940), Baird House (1940).

repairs made as a result of experiments in construction combined with the limited skill set of apprentices who were still learning. The Wrights and the Fellowship experienced several weeks of rain during the winter of 1940-41, resulting in extensive leakage and the need to rework the canvas roofs. The Office, Living Room, and Drafting Room all received “a band of lapped, one-by-twelve, redwood boards between the trusses.”

Photographs show lapped boards were also added to the ceiling of the Original Dining Room between the two easternmost beams and the two westernmost beams. The choice to use lapped boards at Taliesin West appears to be more than just a practical solution, as contemporaneous Usonian houses designed by Wright including the Pew House (1938), L. Lewis House (1940), and Gregor Affleck House (1940) featured them as well. A skylight was added in the space between the center two beams, rising higher above the roofline on the southern side than on the northern side of the structure and spanning the entire space between the two center beams. The skylight was likely added to allow light into the space following the replacement of the translucent canvas with opaque lapped boards.

The center two beams each received two boards mounted flush onto both of their sides, and two boards were added to the west side of the easternmost beam and the east side of the westernmost beam in the same manor. These may have been added to help to attach the lapped boards added on the ceiling, to support their weight, and for aesthetic appeal. One board was added below the lapped boards of each beam, mitered to meet

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33 Besinger, *Working with Mr. Wright: What it Was Like*, 104.
35 Patterson, *Frank Lloyd Wright and the Meaning of Materials*, 25; Pfeiffer, *Frank Lloyd Wright Usonian Houses*. 
an additional board which capped each beam's end. Fascia boards were installed along the roofline's south, east, and west edges. A single row of vertically lapped shingles, each approximately 1 foot tall and 1 foot wide, were nailed onto of the fascia board along the southern facade between the beams. The five boards that had previously hung from the overhanging beams were replace with two smaller but more elaborate icicles.37

It's likely no major alterations were made to the Original Dining Room over the next several seasons, and no changes occurred over the winter of 1942-44 as the Fellowship remained in Wisconsin that Winter. The next campaign of changes appears to have begun in 1946 following the end of WWII. After the accidental death of Svetlana Peters and her young son in September of 1946, the Fellowship migrated to Arizona earlier than they had in previous years, arriving before Thanksgiving. During this time, Wright wanted to make “up for the lack of materials and labor during the war” and began to “refurbish the camp.”38 This included creating an opening in the center of the masonry of the southern wall of the Original Dining Room to create a doorway, terminating approximately 1 foot above the grade of the floor. Canvas panels were installed as pivot doors. The lapped ceiling boards from 1940 had disappeared, replaced with canvas. The skylight in the center portion of the roof, which extended to the southern doorway, featured canvas spanning between the two center beams over a series of joists. Three boards, decorated with a row of dentils, were added two the clerestory opening on the southern wall, each spanning between two beams.39 Wright had begun introducing glass into the site in February 1945, and by 1947 the glass was inserted into the clerestory openings. The roof was extended outward above the southern

37 Ibid.
38 Besinger, Working with Mr. Wright: What it Was Like, 142-162.
entrance between the two center beams and dentils were added to the fascia boards.\textsuperscript{40}

When Wright and the Fellowship returned to Arizona for the winter of 1948-49, the camp was in better condition than usual. A group of apprentices had stayed behind over the summer to prepare a suite for Iovanna, caring for the camp in the process. Less repairs and maintenance work needed to be done so larger construction projects could commence immediately upon the full Fellowship’s return. With the ending of World War II, enrollment in the Fellowship began to grow, eventually reaching a maximum of 65 apprentices, double the thirty apprentices enrolled in the Fellowship in 1938.\textsuperscript{41} In 1948 a new theatre was constructed to accommodate the Fellowship’s growth. Around the same period as the theatre project, the Loggia, located east of the Kitchen, was enclosed to form a larger dining space for the apprentices, and the Original Dining Room was converted into a private dining space for the Wrights.\textsuperscript{42}

The conversion from public space to private space was accompanied by another campaign of alterations [Figures 9-11]. The fireplace in the northern wall was added by 1949.\textsuperscript{43} Rafters were added over the joists to change the skylight’s roof from flat to gabled, and glass replaced the canvas by 1950. The tops of the rafters were supported by an added hanging beam, notched to fit over the joists. Two boards, decorated with dentils, were mounted at the base of the skylight, protruding at a right angle from the center beams.

\textsuperscript{40} Besinger, \textit{Working with Mr. Wright: What it Was Like}, 162.; [Untitled image of the southwest exterior corner of the Original Dining Room,] ca. 1947, photograph, The Frank Wright Foundation Archives, Museum of Modern Art, Avery Architectural and Fine Arts Library, Columbia University, New York, in \textit{Taliesin West Preservation Master Plan} by Harboe Architects (Frank Lloyd Wright Foundation, 2015.)

\textsuperscript{41} Gottlieb, \textit{A Way of Life: An Apprenticeship with Frank Lloyd Wright}, 10.

\textsuperscript{42} Pfeiffer, \textit{Frank Lloyd Wright Taliesin West}, 28.

\textsuperscript{43} [Untitled aerial image of Taliesin West taken from the southeast,] ca. 1949, photograph, Dorothy & Herb McLaughlin Collection, Arizona State University Archives, Arizona, in \textit{Taliesin West Preservation Master Plan}, Harboe Architects, Frank Lloyd Wright Foundation, 2015.
Figure 8: The Original Dining Room c. 1938 (Frank Lloyd Wright drawings are Copyright ©2019 Frank Lloyd Wright Foundation. Used with permission. Photographs are Courtesy Frank Lloyd Wright Foundation.)

Figure 9: Image of the interior of the Original Dining Room, facing northwest. Dated 1940s, likely c. 1949. (Maynard L. Parker, photographer. Courtesy of The Huntington Library, San Marino, California.)
Figure 10: Undated image of the interior of the Original Dining Room, facing southwest, likely c. 1949. (Maynard L. Parker, photographer. Courtesy of The Huntington Library, San Marino, California.)

Figure 11: Undated image of the exterior of the Original Dining Room, facing northeast, likely c. 1949. (Maynard L. Parker, photographer. Courtesy of The Huntington Library, San Marino, California.)
several inches above where similar boards can be found today. The early 1950s also saw the addition of two desert masonry columns inserted near the southern door under the center two beams.Leaks continued to be an issue at the site, with the 1951-52 being another exceptionally rainy and cold season. A product called “Stormy Weather” was brushed was tested on some of Taliesin West’s canvas roofs during the 1952-53 season, which helped to combat the moisture problem.

By 1955, the door opening in the south wall was lowered to the grade of the interior floor. This change meant that Wright’s guests could enter the space from the exterior more easily, eliminating the need to travel through the Kitchen and Dishwashing Area when entering the room. The desert masonry steps and landing and its embedded Chinese porcelain frieze were added to the south of the Original Dining Room. Shutters were added to the clerestory windows on the east and west walls, increasing the space’s privacy and sense of enclosure. The plywood panel with the mural painted by Gene Masselink on the west side of the fireplace was present by this time, though it may have been added earlier to close off the space from the Dishwashing Area when the room was converted into a private dining space. The projecting boards with dentils on the interior of the skylight were lowered to their present location at the base of the beam. They were likely trimmed from their original length which spanned from between the fireplace and doorway, with the member running from east to west inserted between them, as evidence by the lack of paint.


on the top of the east to west member in comparison to the north to south members. The boards lapped onto the center two beams above this, and the pyramidal shapes mounted along it below the trusses were also put in place. The triangular laylight was installed above this between the trusses. Small changes continued throughout the late 1950s, including the addition of the cove lighting, installed by Arnold Roy, and the painting of the floor.48 Both the interior and exterior wooden elements were painted by 1958.49 The first paints used were hand-mixed linseed oil paints. The painting of the Original Dining Room roughly coincides with Wright’s selection of thirty-six colors for the Taliesin Pallet produced by Martin-Senour in 1955. The pallet included a range of hues, including several reds.50

Wright died in April 1959, but changes continued to be made to the Original Dining Room in the years to follow. The glass of the skylight was replaced with fiberglass during the 1960s. The terrace to the east of the space was enclosed in 1971, resulting in the replacement of the class in the shuttered portion of the clerestory window on the east wall being replaced with mirrors.51 Alterations have also been made to suite the room’s current configuration as a board room and classroom. This includes the addition of shelving and a heating unit between the northern doorway and fireplace, and the addition of a series of bulletin boards on top of the chair rail along the eastern interior wall. Below the mural, two cubbies are the only remaining elements of the built-in buffet that was present in 1958.52 Additional wiring has been added for internet and electrical updates.

48 Harboe Architects, PC. Taliesin West Preservation Master Plan, 56.
51 Harboe Architects, PC. Taliesin West Preservation Master Plan.
52 [Untitled Image of the northwest interior corner of the Original Dining Room.]
3.0 METHODOLOGY

3.1 Documentation

Measured drawings of the structure were provided in the form of CAD files. They were created by the students at the University of Texas at San Antonio for the Historic American Buildings Survey (Survey No. AZ-218) and included a site plan, three exterior elevations, a reflected ceiling plan, and four sections. These drawings served as a base for documenting conditions, readings of light and temperature, the chronology of the space, and general notes and observations during the site-visit. Where missing, details were added to the provided drawings, including information on where butting boards terminate. Because the drawings did not include the entirety of the Original Dining Room, the provided drawings were modified as needed and additional drawings were created post-site-visit. The measurements for the additional drawings were derived from the provided drawings. An alphanumeric naming system was derived to label the majority of the visible wooden elements to aid in clarity when referring to parts of the Original Dining Room, particularly for the elements which repeat throughout the space. Each number consists of two letters which roughly refer to an area of the structure, followed by three digits unique to each element in that area. The areas defined include Exterior Beam Elements (BX), Interior Ceiling Elements (CX), Exterior Ceiling Elements (CX), Interior Dentil (DI), Exterior Dentil (DX), Roof Support Elements (RS), and Skylight Elements (SK).

In addition to the drawings, a three-dimensional model of the Original Dining Room was created post-site-visit using Rhino with all measurements extrapolated from the provided HABS drawings or approximated from photographs taken during the site-visit.

Each wooden member was individually formed in the model, with the goal of representing how each piece fits together rather than only representing their combined massing. The internal structure was determined by studying how the elements visible on the surface interact, and through looking at photos of earlier phases of the space in which now-hidden elements had been exposed. As a result, the measurements in the model are not exact and may not always accurately reflect the internal structural. If the structure could not be determined, such as the area between the roof and ceiling panels, no details were included.

To illustrate the complex building chronology, each element in the model has been color-coded to the period in which it first appeared. The coloring of an element means the specific feature first appeared in that location at that time, but it does not mean that the present fabric of that element dates to that time period. A board may be color-coded to a year even though the element was recycled from an earlier period or replaced later date.

### 3.2 On-Site Investigation

On-site investigation occurred between January 7-12, 2019. During this time, a wide range of diagnostic tools were implemented to confirm the archival information for the chronology, as well as to assess the condition and integrity of the space. Wood and finish samples were taken, and preliminary wood identification and finishes analysis occurred. Glue traps and dataloggers were placed to continue to provide information post-visit. Surface temperature, UV levels, IR thermography, and moisture content readings were used to gain a better understanding of the environment the wooden elements are exposed to. Probing was done to understand the extent of decay. Disassembly helped to inform the construction of the space, its chronology, and deterioration below the surface.
3.2.1 Light Levels

UV and visible light level readings were taken in eight areas of the Original Dining Room using an ELSEC 765C UV+ Logger between 2:28 and 2:35 P.M. on January 10, 2019 (Table 1). Measurements were recorded for UV light by proportion, measured in microwatts of UV radiation per lumen of visible light. Visible light was recorded in Lux. Both visible light and ultraviolet radiation can result in wood degradation. The recommended standards for UV exposure in museum settings is below 75 µW/Lm. The appropriate level of visible light is dependent on whether the space is to be used for work, exhibition, or storage. Finished wooden objects should typically not be exposed to light levels over 200 Lux.

<table>
<thead>
<tr>
<th>Location Measured</th>
<th>Visible Light (Lux)</th>
<th>UV (µW/Lm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior, south corner, near west clerestory window, 5ft above floor</td>
<td>4350</td>
<td>600</td>
</tr>
<tr>
<td>Interior, south wall, doorway, 5ft above floor</td>
<td>1850</td>
<td>420</td>
</tr>
<tr>
<td>Interior, mural, 1ft from clerestory window, 5ft above floor</td>
<td>800</td>
<td>550</td>
</tr>
<tr>
<td>Interior, mural, 1ft from fireplace, 5ft above floor</td>
<td>95</td>
<td>286</td>
</tr>
<tr>
<td>Interior, skylight, north side of tri-panel SK009</td>
<td>2250</td>
<td>0</td>
</tr>
<tr>
<td>Interior, skylight, north side of tri-panel SK017</td>
<td>3175</td>
<td>3</td>
</tr>
<tr>
<td>Interior, skylight, between tri-panels SK018 and SK020</td>
<td>1290</td>
<td>0</td>
</tr>
<tr>
<td>Exterior, south elevation, between west clerestory window and door</td>
<td>1290</td>
<td>449</td>
</tr>
</tbody>
</table>

Visible light readings were high in the skylight, ranging from 1290 to 3175 Lux. However, the highest UV reading in this area was 3 µW/Lm, showing that the skylight’s fiberglass is blocking nearly all UV radiation. This indicates that the UV radiation measured in other areas of the Original Dining Room is originating almost exclusively from the

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54 Instrument Range: 0-10,000 µW/Lm; 0.1-200,000 Lux. Accuracy: Visible light = 5% ±1 displayed digit; UV = 15% ±1 displayed digit.
southern doorway and clerestory windows. The highest levels of both UV and visible light in the Original Dining Room were recorded in the southwestern corner near the clerestory window, with a maximum reading of 4350 Lux and 600 µW/Lm. UV and visible light are of special concern in the northwest corner of the space, as the paints of the mural between the clerestory window and fireplace are susceptible to photodegradation in addition to the plywood substrate. Readings in this area ranged from 95-800 Lux and 286-550 µW/Lm. Except for the UV readings in the skylight, all areas measured within the original dining room had readings outside of the recommended ranges of UV and visible light.

3.2.2 Moisture Content Readings

The presence of moisture is an enabling factor to many of the decay mechanisms of wood. Exterior wood is considered dry when its moisture content is below 15%. Exterior with a moisture content of 15% or higher is considered wet. The moisture content of a piece of wood can be determined using the equation below, where $m_{\text{wet}}$ is the mass of the piece of wood at a given moisture content and $m_{\text{dry}}$ is the mass of the wood when dried in an oven.\(^{57}\)

$$MC = \frac{m_{\text{wet}} - m_{\text{dry}}}{m_{\text{dry}}} \times 100\%$$

While it is often destructive or impractical to determine moisture content using the oven drying method, moisture content can be indirectly measured in situ using a moisture meter. Between 2:00 and 3:00 PM on Wednesday, January 9, 2019, moisture content readings were taken along the roofline of the east and south elevation and on four of the eight exterior eastern and western faces of the beams using a pinless Wagner MMC 210 moisture meter (see Appendix F). The temperature during this period increased.

from 67.2 increased from 67.7°F, and the relative humidity decreased from 30.8 to 30.4%. No rain events were observed on site within 48 hours prior to obtaining the readings.

The meter used has a range of measurement between 4% and 32%, though this can increase or decrease slightly depending on the specific gravity of the species of wood being measured. The meter is capable of measuring species with a specific gravity between 0.30 to 0.70 SG. The scanning depth is 0.75 inches. The accuracy or range of error for the instrument is not provided by the manufacturer. Following the identification of the elements of interest at Taliesin West as redwood, the specific gravity of old growth redwood (0.40 SG) was programed into the meter. Knots and large defects in the wood were avoided when taking measurements.

Readings were taken along the east exterior elevation of boards BX101 and BX104. BX101, which is original to the 1938-39 construction, had the highest moisture content at its south end, with readings up to 31.0%. This puts the member at a significant risk of decay and insect infestation. Though it is not unusual for a boards moisture content to be higher near the end grain where moisture in most easily, the increased moisture retention in this portion of BX101 may also be caused by the abutting BX100 trapping moisture and restricting evaporation. Readings decreased to 10.8% where BX104 begins. Like BX101, the moisture content was concerningly high towards the southern end of BX104, with measurements of 23.0% at its end grain. The remainder of the measurable area of the board was dry, having a moisture content between 5.7% and 4.0%, except for where BX104 comes into contact with the roof support element approximately 6’ 8” from its southern end. Here, the moisture readings increased to 20.0%, nearly as high as the readings at the end grain.

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58 Sensorpush data logger SP-2 (Exterior Beam)
60 Forest Products Laboratory (U.S.), *Wood Finishing: Weathering of Wood*, (Madison, Wis., 1966), 143.
Additional readings were taken of the three easternmost beams, including boards BX105, BX205, and BX307. The moisture content of these members ranged between 12.4% and 32.0% with no consistent pattern. Each of these boards were wet found to be wet, with nearly all of the readings taken of these boards in being over 15.0%.

Measurements were taken on the fascia boards along the south elevation. The moisture content of BX507 ranged from 7.7% to 12.0% at its eastern end. Readings for BX508 were slightly higher with a minimum of 7.0% and a maximum of 12.8%. BX509 had a lower moisture content at its western end at 8.3%, increasing to 19.0% at its eastern end. Except for the westernmost reading of BX508, all readings for the southern fascia boards were below 15%.

3.2.3 Infrared Thermography

Using a FLIR C2 camera, infrared thermography was used to map temperature and moisture patterns of wooden members of the Original Dining Room (see Appendix G). Interior images were taken in the afternoon on January 8, 2019. Exterior images were taken in the morning on January 10, 2019. An infrared camera detects infrared radiation emitted from objects in the form of heat and maps it two-dimensionally according to the intensity of the radiation across the emitting surface. This creates an image, sometimes overlaid with a photograph, showing the distribution of heat.\(^{61}\) Because evaporation is a cooling process and areas with a higher moisture content in wood have higher thermal conductivity, infrared cameras can be used to detect areas of high moisture near the surface of wood. However, infrared thermography for the detection of moisture can only provide qualitative results. The presence of moisture may or may not correspond with active deterioration as a result

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of moisture, and deterioration may exist without moisture being present at the time of measurement. Moisture may also exist within the structure without being detectable on the surface.\textsuperscript{62}

IR thermography was especially helpful in investigating the inner members of the beams where decay was present by measurements could not be taken with a moisture meter due to size restraints. Thermographic images of the tops of Beams 1 and 4 showed that the areas of severe decay had temperatures as far as 15°F below that of surrounding wood, confirming that moisture is still a severe issue in the inner members of the beams.

Infrared thermography was also used to document decayed members of the roof overhang directly below an area of high decay of inner members of Beam 3. Though there was only a 2°F temperature difference between the area of decay and surrounding wood, it is clear that moisture penetration is still an ongoing process and that there is likely additional decay below the surface in the areas surrounding the visible damage. The less drastic temperature difference in this area than on the top of the beams is likely partially a result of the ceiling not having direct sun exposure which would increase the temperature in surrounding wood.

On the interior, thermographic images were taken on the skylight’s northeast corner where signs of termite activity and fungi decay were present. Here, the surface temperature of areas of high decay were up to 10°F below the temperature of surrounding wood. This confirmed that moisture is still entering the structure in this area, meaning that the visible deterioration may still be ongoing.

3.3. Off-Site Investigation

3.3.1 Wood Identification

Six wood samples were taken from the Original Dining Room and analyzed by Andrew Fearon, including two exterior samples and four interior samples (see Appendix C). A sample was taken of the exterior of Beam 1 on member BX0104 (Figure 12) from beneath plywood which was removed during the investigation (Figure 22). From Beam 2, a sample was taken of BX203, the member directly east of the center, main member of the Beam. Samples on the interior were concentrated around the skylight. One sample was taken from a dentil, DI080, and one from a tri-panel, SK017. Pyramid SK044 was sampled, as well as the framing member of the skylight to which it was mounted, SK060. Samples were prepared for analysis by wetting followed by slicing with a platinum coated double-edge razor.

Both macroscopic and microscopic features can be used to identify wood species. After establishing if a wood is a softwood or hardwood, determined primarily by the presence of vessels in hardwoods, several characterizes can be used to additionally narrow down the possible species. Microscopically, the first step for identify the species of a softwood is to determine how resin canals are distributed, if they are present, placing the sample into one of three groups. The species of the sample can then be further narrowed down by observing characteristics such as the transition between early and latewood, the presence of ray tracheids and longitudinal parenchyma, and cross-field pitting.⁶³

All six samples were determined to be redwood (*Sequoia sempervirens*). Redwood, also referred to as coast redwood, California redwood, and sequoia, grows primarily in California. Old-growth redwood, which is moderately strong, stiff, and hard, has highly decay resistant heartwood. Second-growth heartwood can have a much lower decay resistance.

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Redwood lumber is typically used for building, with its potentially high durability making it ideal for outdoor construction such as decking. Old-growth redwood has a specific gravity of .40 SG. Green old-growth redwood has an average moisture content of 86% in the heartwood and 210% in the sapwood. As it dries from green to ovendry, old-growth redwood typically shrinks 2.6% radially, 4.4%, tangentially and 6.8% volumetrically.

Characteristics which can be used to identify redwood include its course texture, generally straight grain, and lack of odor. Growth-rings vary from narrow to moderately wide. The transition between latewood and earlywood is abrupt. The heartwood ranges from red to mahogany in color, while the sapwood is nearly white. Redwood is also characterized by large taxodioid cross-field pitting, a lack of ray tracheids, and abundant and diffuse longitudinal parenchyma.

Taxodioid cross-field pitting was the most defining feature of the samples. When a

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65 Ibid., 4-2 - 4-6
sample is viewed radially, cross-field pitting is visible as the area of intersection between ray parenchyma cells and the axial tracheid walls. There are five types of cross-field pitting which may be used in wood identification: fenestriform (or window-like), pinoid, piceoid, cupressoid, and taxodioid.\textsuperscript{67} Taxodioid cross-field pitting appears in several species other than redwood including Japanese Cedar (\textit{Cryptomeria japonica}) and bald cypress (\textit{Taxodium distichum}).\textsuperscript{68} The presence of taxodioid cross-pitting in conjunction with other characteristic features confirmed that the samples are all redwood.

3.2.2 Finish Analysis

Samples were taken from 15 different elements for finishes analysis (see Appendix D). All but four samples were taken from the interior. Samples were taken with two goals. The first was to understand how the structure had previously been treated. This included wanting to better understand how the structure appeared during earlier periods for later interpretation, as well as to understand what treatments had been needed in the past. Multiple layers of paint may illustrate changing desires over how the space looks, but it can also be indicative of areas that have undergone repairs or damage that resulted in the need to repair. The second goal of the finish analysis was to confirm the chronology that was developed using archival documents by comparing the stratigraphy of elements form different periods. It was recognized going into the sample process that the use of paint analysis to meet this goal would be limited as the structure was not painted until the late 1950s, after the majority of the present elements were added.

Because color discrepancies occur when photographing samples or analyzing them with a computer monitor, all samples layers were observed and documented directly


through the microscope, rather than through the photographs. While an effort was made to
document the observed colors from the samples as accurately as possible for the purpose of
comparing the stratigraphy of the samples, the noted observed colors should not be taken
as a true representation of the finishes. The effects of metamerism, warm or cool lighting,
optical changes from the embedding process, and individual perception can alter how a
color is perceived. If possible, color matching should be derived reveals of early layers on
site rather than through a small stratigraphy sample. Color readings can be taken to quantify
and standardize revealed colors, like the readings taken of the most recent layers around the
south doorway described below. Color readings should be compared to the hues in the 1955
Martin-Senour pallet, as some of the colors found during the paint analysis appear similar to
the swatches of Cherokee Red, Deep Rust, and Pottery Red.69

The stratigraphy’s found can be divided into two categories based on the colors
found. The first includes samples with stratigraphy’s limited to colors resembling Taliesin
Red. This includes the exterior portions of Beams 2 and 3 (BX203 and BX305), the icicles
(IC001 and IC002), and the sampled ceiling boards (CI010, CI013, CI015, CI07, and CI022).
Each of the ceiling boards had the same first layer, a slightly darker shade than the present
finish color (Table 2). This shade likely dates to the late 1950s when the structure was first
painted as there is no evidence or record of that any stripping of paint occurred which
would have removed the original layers. The second layer of CI013 is a red-brown color
which does not appear on any of the other ceiling boards or in any of the other samples
taken. This layer may date to the insertion of the cove lighting, as the cutting of holes into
CI003, CI004, CI017, CI009, CI012, and CI013 would have likely been followed by repainting
the board. The next layer on boards CI012, CI013, and CI010 is a brighter shade of red than

the present finish. It is suspected that this finish was added to unify the boards around
the cove lighting as the darker shade used to paint CI013 after the holes were added likely
did not blend with the surrounding boards. The theory that these layers are related to the
insertion of the cove lighting is supported by the layers found on other ceiling boards. Both
CI015, located near the east wall, and CI017, over the south wall’s easternmost clerestory
window, contain only two layers: the same shades as the first and last layers of CI010, CI013,
and CI022. Because CI015 and CI007 did not undergo changes after they were first painted
like the boards around the cove lighting, it was not necessary for them to be repainted as
often.

<table>
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<table>
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<td>Layer 3</td>
<td>Layer 4</td>
<td>Layer 3</td>
<td>Layer 2</td>
<td>Layer 3</td>
</tr>
</tbody>
</table>

The other sampled elements to contain shade similar to Taliesin Red are the samples
from the exterior portions of Beams 2 and 3 (BX203 and BX305). The first layer observed in
these two samples differ, suggesting that there had been more than two finishing campaigns
as it is unlikely the beams would have been painted two different shades originally, though
this is possible if the paints were inconsistently mixed. It is more likely that the exterior
had been painted more than twice and that previous layers had either unevenly failed, been
eroded with the decaying wood, or removed during the preparation for repainting.

The second category includes samples with stratigraphies that include Mandarin
Red, a shade which is brighter and closer to orange than Taliesin Red. All of the samples
taken from the shutters and skylight include Mandarin Red layers (Table 3). Four layers were found on laylight tri-panel SK044. The first and third resemble a pale version of Taliesin Red, and the second and third resemble Mandarin Red. Only two layers were found on tri-panel SK008, with the first being the same as the first and third layer on SK044, and the second being the same as the second and fourth layer on SK044. While it is possible SK008 and SK044 are both original and that SK008 was painted less often, perhaps in an effort to paint different panels different colors, it is more likely that SK008 is a replacement panel added between the period in which SK044 received its second and third layers.

<table>
<thead>
<tr>
<th>Layer</th>
<th>SK008</th>
<th>SK017</th>
<th>SK044 (SIDE)</th>
<th>SK044 (TOP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While on site, the top of pyramid SK044 was sampled and analyzed. Samples of the side of SK044 were taken for later analysis in the lab. Both the top and sides of pyramid SK044 were found to have the same first two layers as the tri-panels. The last three layers of the top and side of SK044 are the same, consisting of the bright Mandarin Red-like color, a duller red, and the present Mandarin Red. The top features two addition layers between the first two and last three, suggesting that the tops of the pyramids were once changed to a different color than the sides, then later returned to the same color.

The shutters also feature the Mandarin Red color (Table 4). The three shutters sampled, SH009, SH017, and SH018 all have Mandarin Red as their first layer. These are the
only elements tested that have Mandarin Red as a first layer, and also the only elements with no layers resembling Taliesin Red. SH009 and SH017 both have a paler red-orange color as their second layer. SH017 has a third layer that resembles Mandarin Red. The most recent color of all three shutters is the same. It is unclear why the shutters vary in stratigraphy. Some may have been individually painted as repairs, or the shutters may have been painted different colors by choice, similar to the top and sides of the sample pyramid.

<table>
<thead>
<tr>
<th>Layer 3</th>
<th>Layer 4</th>
<th>Layer 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH009</td>
<td>SH017</td>
<td>SH018</td>
</tr>
<tr>
<td>Layer 3</td>
<td>Layer 4</td>
<td>Layer 2</td>
</tr>
<tr>
<td>Layer 2</td>
<td>Layer 2</td>
<td>Layer 1</td>
</tr>
<tr>
<td>Layer 1</td>
<td>Layer 1</td>
<td>Layer 1</td>
</tr>
<tr>
<td>SUBSTRATE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

In addition to finish samples, color measurements were taken using an X-Rite CAPSURE. Readings were taken within the southern doorway on RS013, RS014, and RS017 (Table 5). Measured areas were selected due to its lack of fading and soiling. Color readings were compared to Benjamin Moore’s Classic Color Collection. The closest match determined using the CAPSURE color meter was Seminole Brown 1183 for all three samples. Data was also collected using both CIE L*a*b* and L*C*h color space coordinates.

<table>
<thead>
<tr>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>C*</th>
<th>h*</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.5</td>
<td>17.4</td>
<td>14.6</td>
<td>22.7</td>
<td>40.1</td>
</tr>
<tr>
<td>42.6</td>
<td>16.6</td>
<td>14.1</td>
<td>21.8</td>
<td>40.3</td>
</tr>
<tr>
<td>42.5</td>
<td>16.9</td>
<td>14.2</td>
<td>22.0</td>
<td>40.0</td>
</tr>
<tr>
<td>42.2</td>
<td>17.0</td>
<td>14.3</td>
<td>22.2</td>
<td>40.1</td>
</tr>
</tbody>
</table>

Table 4. Comparative stratigraphy of Shutters

Table 5. Color Readings

Approximate L*a*b* Approximate L*C*h*
3.4 Environmental Monitoring

Four SensorPush Humidity and Temperature Smart Sensors were placed in the Original Dining Room to monitor temperature and relative humidity on January 10, 2019 (see Appendix H). The wireless have the capacity to collect data at 1 minute intervals which is stored on the sensor for two weeks, as well as uploaded via a WiFi gateway for remote monitoring and longer storage. Data was analyzed using 15 minute intervals starting at noon on January 11, 2019 to noon on April 26, 2018 (Table 6). While monitoring should ideally be conducted for a full year in order to collect data for each seasonal cycle, monitoring for this thesis was limited to 106 days.

For consistency, all four sensors were installed along the second-westernmost beam (Beam 3). SP-1 was placed on the north side of CI025 between CI004 and CI022, near the doorway and southern clerestory window. SP-3 placed on top of CI003 between the fireplace and mural. SP-4 is the only sensor which was placed on the eastern side of Beam 3. It was placed in the skylight on top of CI007 near tri-panel SK014. The fourth sensor (SP-2) was placed on the exterior on the south facade between the doorway and western clerestory window.

Table 6. Datalogger Findings: 01/11/2019-04/26/2019

<table>
<thead>
<tr>
<th>Logger</th>
<th>Temperature (°F)</th>
<th>Relative Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>SP-1</td>
<td>49.02</td>
<td>97.92</td>
</tr>
<tr>
<td>SP-2</td>
<td>39.76</td>
<td>106.79</td>
</tr>
<tr>
<td>SP-3</td>
<td>55.32</td>
<td>92.56</td>
</tr>
<tr>
<td>SP-4</td>
<td>11.91</td>
<td>109.24</td>
</tr>
</tbody>
</table>

Instrument Range: Temperature = -40°F to 140°F; Relative Humidity = 0-100%. Accuracy: Temperature = ±0.5°F typical / ±0.9°F maximum at 2°F - 140°F, ±1.3°F typical / ±2.2°F max at full range; Relative Humidity = ±3% typical / ±4.5% maximum at 7°F from 20% - 80% RH, ±4.5% typical / ±7.5% maximum at 77°F from 0% - 100% RH.
Expectedly, the datalogger that experienced the greatest daily variation in temperature and relative humidity was the exterior logger, SP-2 (Figure 13). It was not unusual for this logger to undergo temperature changes of 60°F or more throughout the day. With the temperature changes came the largest fluctuations in relative humidity. Because SP-2 was located in an area that receives shade for most of the day, the highest temperatures recorded were those during the evening when the sun is low enough to shine directly on the sensor. The hottest day recorded occurred on April 19, where temperatures reached 106.71°F at 8:45 PM. The exterior wood is likely to reach much higher temperatures during the warmer months and in areas where it is exposed to direct sunlight for a longer period.

Figure 13: Excerpt of data collected using for dataloggers showing typical daily relative humidity and temperature changes in the Original Dining Room.
Overall, SP-4, located in the skylight, had the greatest daily changes of temperature and relative humidity of the interior dataloggers, though the three followed similar patterns. Each had an average relative humidity of around 33%, with a range from about 10% to the high 60s. This range in temperature was not just seasonal, as the interior relative humidity changed by approximately 20% throughout the day, instigated by the changing interior and exterior temperatures. Such changes in relative humidity can cause rapid cycling in the moisture content of wood, causing it to shrink, swell, and crack. Though the average temperature falls near the recommended 35-40% relative humidity range for wood in the southwest, each interior logger was only within the 35-40% relative humidity range for 13-14% of the time data was collected. Only 10% of the exterior data collected fell within this range. A relative humidity below 35% can result in splitting. Over 40% of the readings from each monitor fell below 30% relative humidity, which can cause glue to desiccate, finishes to become brittle. As temperatures increase in the summer, the wood is likely to be exposed to a relative humidity below 30% an even greater percent of the time.

<table>
<thead>
<tr>
<th>Logger</th>
<th>% of readings within the</th>
<th>% of readings within ± 5% the</th>
<th>% of readings within ± 10% the</th>
<th>% of readings within ± 15% the</th>
<th>% of readings &lt;30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-1</td>
<td>13%</td>
<td>39%</td>
<td>67%</td>
<td>84%</td>
<td>45%</td>
</tr>
<tr>
<td>SP-2</td>
<td>10%</td>
<td>31%</td>
<td>51%</td>
<td>70%</td>
<td>46%</td>
</tr>
<tr>
<td>SP-3</td>
<td>13%</td>
<td>45%</td>
<td>74%</td>
<td>91%</td>
<td>40%</td>
</tr>
<tr>
<td>SP-4</td>
<td>14%</td>
<td>41%</td>
<td>67%</td>
<td>84%</td>
<td>43%</td>
</tr>
</tbody>
</table>

4.0 CONDITION ASSESSMENT

A condition assessment was conducted on January 10, 2019 (see Appendix E). The scope was limited to the wooden elements of the Original Dining Room, though adjacent non-wooden components of the structure which may be contributing to the deterioration of the wooden elements were noted. The survey included the interior and exterior of the space. The interior of adjacent rooms which share walls with the Original Dining Room, such as the Dishwashing Area, were not surveyed. Eleven conditions were noted including cracks, caulking, biological growth, deformation, fungal decay, mechanical damage, paint failure, pest activity, previous repairs, ultraviolet damage, and water staining.

4.1 Environment

The potential conditions that may be found in a structure are influenced by its internal and external environment. Climatic patterns including temperature and relative humidity, freeze-thaw cycles, and precipitation events affect how a space is used and the likelihood of different types of deterioration. The environment will also determine the types of organisms which can survive in and around the structure.

Scottsdale, Arizona is located in a hot-dry climate zone. The region is characterized by a monthly average outdoor temperature over 45°F throughout the year and less than 20 inches of precipitation annually. Scottsdale, Arizona receives an average of 12.8 inches of rain per year. The average annual temperature is 73.2°F, with December being the coldest month (average of 53.4°F) and July being the hottest (average of 93.6°F). The annual extremes are 30.7°F and 112°F.

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The Original Dining Room is presently used year-round as both a classroom and board room. The building envelop consists of a concrete slab foundation, masonry walls, a wooden deck roof with a skylight, and fixed single-glazed clerestory windows. The chimney in the northern wall is capped. Doors and windows are not airtight, with openings present where glass meets masonry or wood. Operable shutters exist on the west wall. Heating and cooling is achieved using a mini-slit system located between the fireplace and northern doorway. No plumbing exists within the Original Dining Room, though the Dishwashing Area has multiple sinks located outside of the northern wall of the space.

4.2 Decay Mechanisms

To recognize the properties of wood and its associated decay mechanisms, an understanding of the composition of wood is needed. Wood can be broken down into two major groups: hardwoods and softwood. Each is unique in its structure. However, because the species of primary interest in this thesis are softwoods, the makeup of hardwoods will not be discussed.

Both hardwood and softwood cells are comprised of cellulose, hemicellulose, and lignin. Cellulose, a long, stringy polymer of glucose molecules form the microfibrils which are the main structural component of a tree. Lignin, the most complicated polymer found within the cell wall, cements cells together and reduces their ability to absorb water. Hemicellulose, a branched polymer made up of multiple types of sugars, surrounds the microfibrils and helps to bind them with the lignin. Hardwoods have more hemicellulose than softwoods. The inner, empty part of a cell is referred to as the lumen.

Softwoods are formed of two types of cells. The first, tracheids, make up the majority

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74 Harboe Architects, PC., Taliesin West Preservation Master Plan, 526.
75 Jeffery J. Morrell and Robert A. Zabel, Wood Microbiology: Decay and Its Prevention, 141-151.
of the wood. These cells are elongated in shape and can be over 100 times longer than they are wide.\textsuperscript{76} In a living tree, the function of these cells is to provide structure as well as to conduct water between neighboring cells through holes called boarded pits, which can function like valves.\textsuperscript{77} Tracheids in early wood have larger interiors, increasing their ability to transport water. The cell-walls of tracheids tend to be thicker in latewood, resulting in increased strength.\textsuperscript{78} The other type of cell found in softwoods are called parenchyma, which serve protective functions and store food.\textsuperscript{79} Parenchyma may be oriented radially or axially. Radial parenchyma are found within the rays and are responsible for synthesizing, sorting, and transporting materials and water laterally. Axial parenchyma, which are only present in some species of softwoods, form vertically. These cells may also produce resin, which can be found in vertical voids called resin canals.\textsuperscript{80}

4.2.1 Moisture

The presence of moisture can result in deterioration of wood by enabling fungal decay, supporting insect activity, and causing dimensional changes. As noted above, a moisture content of 15\% or below is considered dry, while a moisture content of 15\% or higher is considered wet.

Moisture can exist within wood as either bound or free water. Water is considered bound when the hydrogen in moisture binds to the cellulose and hemicellulose within the wood cells by molecular attraction. The amount of bound water within wood will increase as the moisture content increases until there a no longer any molecules for the water to attach to. At this point, the wood has reached its fiber saturation point. For most species,

\textsuperscript{77} Ian McCaig and Brian Ridout, \textit{Practical Building Conservation: Timber} (Farnham: Ashgate, 2012), 11.
\textsuperscript{78} Forest Products Laboratory (U.S.), \textit{Wood Handbook: Wood as an Engineering Material}.
\textsuperscript{79} Morrell and Zabel, \textit{Wood Microbiology: Decay and Its Prevention}, 139.
\textsuperscript{80} Forest Products Laboratory (U.S.), \textit{Wood Handbook: Wood as an Engineering Material}, 3-9 - 3-10.
this occurs at around 30% moisture content. Past the fiber saturation point, any additional moisture that the wood absorbs will accrue within the lumina in the form of free water. Free water will continue to accumulate until the maximum possible moisture content is reached, which is dependent on the specific gravity of the species. While free water is required for wood to decay, it is not needed for weathering.

Wood is a hygroscopic material, meaning it can absorb or desorb moisture from its surroundings in response to changes in atmospheric humidity. The amount of vapor that can be absorbed by a piece of wood, and the rate at which this occurs, depends on a variety of factors including species, cut, finishes, air temperature, and relative humidity. As long as a piece of wood has not reached its fiber saturation point, it will continue to absorb or desorb moisture in response to the surrounding environment until it reaches its equilibrium moisture content. At this point the moisture content of the wood is in balance with that of the environment so that it no longer absorbs or desorbs moisture.

Dimensional changes occur within wood as the moisture content increases or decreases. Swelling occurs as a result of bound water pushing apart the microfibrils. Once the fiber saturation point has been reached the wood will no longer increase in size. The rate at which dimensional changes occur varies tangentially, longitudinally, and radially. Most species shrink or swell vary little along the grain, changing their dimension by approximately 0.1%. The exception to this is juvenile or reaction wood, which can have changes as high as 2% along the grain. Dimensional changes in the transverse direction are

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82 Forest Products Laboratory (U.S.), *Wood Finishing: Weathering of Wood*, 141.
typically higher, averaging at 8%. However, this can vary significantly between species. Dimensional changes also vary depending on the cut of the wood, with radially cut timber being the most stable. In interior environments with only minor variations in temperature and relative humidity, dimensional changes are unlikely to be significant or damaging. Large changes will usually only occur at the surface, with fluctuations deeper within the wood following seasonal cycles. However, sudden changes in moisture content or rapid cycling can result in cracking, checks, and displacement. Cracks are most likely to occur if movement of the wood is restricted as it shrinks and swells.

4.2.2 Biotic Agents

Fungi, bacteria, and insects, the three major forms of biotic agents which can lead to wood deterioration, all require varying levels of moisture content within wood to survive. Wood-inhabiting bacteria, which are heterotrophs, are capable of decomposing, discoloring, and damaging the cells of wood. Insects may use wood for food or shelter. Mold-fungi can cause stains and soft-rot, and include the subdivisions Fungi Imperfecti. Decay fungi, which includes the Basidiomycotina, are of greatest concern as they are most likely to cause structural failure.

Termites are social insects of the order Isoptera. Several castes make up their colonies, including soldiers, workers, the king and the queen. Reproduction is carried out by the king and queen, with up to four thousand eggs being laid in a day. Termites feed on wood, as well as any other material which is soft and non-toxic enough, including some plastics. There are over two thousand identified species of termites world-wide,

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89 McCaig and Ridout, Practical Building Conservation: Timber, 31-33.
91 Morrell and Zabel, Wood Microbiology: Decay and Its Prevention, 29.
with most residing within tropical climates. 17 species can be found in Arizona, of which three are the greatest threat to structures: Incisitermes minor, Reticulitermes tibialis and Heterotermes aureus. Reticulitermes tibialis and Heterotermes aureus are the two most destructive species of subterranean termites found in Arizona. Heterotermes aureus is the most common. Subterranean termites reside in the soil or within extremely wet wood. They will infest wood which is in contact with the soil or build earthen tubes to connect to wood higher up. They prefer earlywood over late wood. Incisitermes minor is the most destructive and common species of drywood termite found in Arizona. Unlike subterranean termites, drywood termites do not need to be in contact with soil and do not require wood to have a high moisture content. They can survive in wood with a moisture content as low as 13%.

Ants are also of concern in Arizona. Carpenter ants (Camponotus) do not consume wood but do infest it for habitation. They create large tunnels up to 1.5 inches in diameter and nearly 10 inches long where they lay their egg within cells made of wood dust and saliva. Once they hatch they will reside within the wood for several weeks until they emerge, creating more damage in the process. In order for carpenter ants to colonize, the wood must have a moisture content over 15%. Ants not part of the Camponotus genus can also infest and cause damage to buildings.

A specialized group of fungi have the enzymes required to digest wood and are largely responsible for its decay. These decay fungi can attack wood in a variety of ways leading to different forms of decay, all of which lead to changes in physical and chemical properties, including significant loss of strength. Some decay fungi consume cellulose and

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94 Feilden, Conservation of Historic Buildings, 145.
95 Morrell and Zabel, Wood Microbiology: Decay and Its Prevention, 39.
hemicellulose but leave behind the tan-colored lignin resulting in brown rot. White rot results from fungi which consume both celluloses and lignin. Wood with high moisture contents and proximity to soil may undergo decomposition from microfungi which attack the $S_2$ portion of cell walls, resulting in soft rot. Bacteria and non-decay fungi such as molds and stains are less of a threat structurally than decay fungi. Bacteria are mostly found on the surface of wood and can create tunnels, cavities, and etchings in wood. Molds, which require wood to be very wet, also primarily inhabit the surface of wood. Like stain-causing fungi, molds do not typically result in significant loss of strength. However, both can severely alter the appearance of wood and increase wood’s absorbency, resulting in issues with finishes as well as an increased likelihood of inhabitation by decay fungi.

4.2.3 Photodegradation and Weathering

Weathering refers to the degradation of materials in an outdoor environment, including that caused by moisture and exposure to ultraviolet radiation. Ultraviolet radiation that reaches the earth’s surface has a wavelength between 295 and 400 nm. Visible light falls between wavelengths of 400 to 800 nm, and infrared radiation ranges from 800 to 3000. While all three forms of light can cause wood to weather and degrade, UV radiation has a higher amount of energy per photon than visible light and infrared radiation. When wood absorbs a UV photon, the bonds in lignin polymers can disassociate and form a free phenoxy radical (an uncharged molecule with an unpaired valence electron). These free radicals react with oxygen and water to create a hydroperoxide, which then further react to form carbonyls (carbon atoms double-bonded to an oxygen atom). These reactions occur on or near the surface and vary depending on species and the orientation of the wood.

Color and other physical changes follow UV exposure and other forms of weathering from moisture, wind, and freeze-thaw cycles. Yellowing can occur following the chain reactions which occur as lignin degrades.\textsuperscript{100} Wood may also darken or lighten as UV radiation interacts with extractives. As lignin is lost, the white cellulose fibers remain. However, wood does not often remain white, as colonization by biological growth changes the appearance to grey or silver.\textsuperscript{101}

Both cellulose and hemicellulose are susceptible to changes from exposure to moisture, which may cause wood to roughen, the grain to raise, warping or cupping to occur, and cracks and checks to develop. Cellulose and hemicellulose, which are resistant to UV degradation, delaminate from the surface and slowly erode. This is a slow process, with redwood early wood eroding 1.385mm and late wood eroding 0.835mm over sixteen years.\textsuperscript{102} The loss of lignin and resulting delamination of cellulose fibers can result in coating failure.\textsuperscript{103} If wood is exposed to sunlight before it is painted, a process known as preweathering, the service life will be of the finish will decrease.\textsuperscript{104}

\section*{4.3 Findings}

\subsection*{4.3.1 Interior}

The interior is in overall good condition, with water staining and cracks being the most prevalent concerns. Both conditions are found primarily on the ceiling and cove lighting. Fungal decay, pest activity, deformation, and ultraviolet damage occur in isolated areas. Mechanical damage was also observed, though it was limited to the ceiling above the

\textsuperscript{101} Forest Products Laboratory (U.S.), Wood Handbook: Wood as an Engineering Material, 16-11 - 16-12.
\textsuperscript{102} Ibid.
\textsuperscript{103} Beatrice, Suttie, Merlin, and Deglise, “Photodegradation and Photostabilisation of Wood - the State of the Art,” 268–74.
\textsuperscript{104} Forest Products Laboratory (U.S.), Wood Handbook: Wood as an Engineering Material, 16-12.
southern doorway. Overall, the most conditions were found on the western side of the space.

Water staining can be found on both the west and east interior elevations of the skylight. The stains are concentrated around Beams 2 and 3, and where the trusses (SK002-SK005) begin. Though tide lines are most prevalent in the skylight around Beam 2, the ceiling and cove lighting around Beam 3 have the most severe staining. On the west side of Beam 3, a large stain occupies half of CI021, the northern end of CI022, and the neighboring plywood panels [Figure 14]. The stain continues below this on the west side of Beam 3 within the cove lighting, leading to tide lines on the northern end of CI05 and CI07. Stains can also be found on the ceiling below the eastern elevation of the skylight around Beam 2, though it is not as severe as near Beam 3. A small portion of the east side of Beam 2 within the cove lighting, CI023 and CI024 are affected. All the stains on the ceiling, beam, and cove lighting member appear to originate at the skylight. Because moisture appears to be entering across a wide area of the elevated portion of the skylight, the moisture is most likely a result of precipitation. However, a series of mechanical systems do run across the roof near the chimney, and water has been observed to pool on the northwest corner of the roof [Figure 15]. The wide distribution of the stains indicate that large amounts of water are entering the structure during a short time period of time. Because the region is characterized by a dry climate, if only a small amount of moisture was entering the structure during precipitation events, the moistened areas would be able to dry in between rain events and would likely not stay wet long enough for the moisture to migrate through as many building elements.

Water staining on the east elevation of the skylight’s interior is accompanied by fungal decay and pest activity near the fireplace [Figure 16]. The eastern ends of SK022 and SK046, as well as the northern ends of SK062 and SK063 show signs of termite infestation.
Figure 14: Moisture staining on the ceiling and the cove lighting to the west of Beam 3.

Figure 15: Water pools on the roof at the southwest corner of the chimney, directly above the mural.
SK002 is the most severely damaged. Though the damage resembles that of subterranean termites, drywood termites are most likely responsible for the deterioration, as they can survive with no access to the ground and at a lower moisture contents than subterranean termites. However, they do require at least 13% moisture content. While moisture content readings were not taken in this area of the Original Dining Room, infrared thermography (see Appendix G) suggests that the affected areas are holding more moisture than surrounding members. Though decay is severe in this region of the skylight, pest activity is not a widespread concern for the exposed interior wooden members. Though signs of mice were observed throughout the structure, the only other area of insect activity detected during the conditions survey was on the east end of CI016, located above the western clerestory window on the south wall.

Figure 16: Skylight members damaged by fungal decay and termites.
A small section of fungal decay noted in this condition survey was on the east elevation, affecting shutters SH011, SH014, and SH016. Though no other signs of moisture damage or fungal activity was noted on these shutters, evidence of past biological growth or nesting in the form of plant matter could be seen within the gaps of the shutters. Removal of the shutters for further investigation did not occur as a part of this condition survey.

The last area where water staining was observed during this condition survey is the plywood panel with the mural on the north elevation and the ceiling directly above it [Figure 17]. As shown above, water was observed pooling on the roof over this area [Figure 15] and is likely the source of the water staining. Alternatively, water may be entering the Original Dining Room through plumbing and sinks in the Dishwashing Area on the other side of the northern wall. Water also appears to be entering where the clerestory window meets the northern wall. In addition to water staining, the plywood panel with the mural has signs of

*Figure 17: Water stains and ultraviolet damage on the mural (Fearon).*
ultraviolet damage. Damage is worse closest to the clerestory window, where UV energy readings were 550 µW/Lm, and less severe near the fire place, where readings were 286 µW/Lm.

Like water staining, cracks are widespread throughout the Original Dining Room. Approximately half of the ceiling boards and cove lighting members have one or two cracks which run parallel to their grain. Cracks typically originate at the end of the boards, and range in length from under 1 foot to over 10 feet long. This type of cracking is characteristic of wood which has shrunk as a result in a decrease in moisture content. The most severely cracked members are CI001, CI002, CI003 and CI017. The cracking of CI003 is present in conjunction with deformation in the downward direction on its northern end. This deformation, as well as the severity of the cracks on CI001, CI002, and CI003 may be related to their proximity to Beams 3 and 4, which are both severely deformed at their exterior ends. The deformation on the north end of CI003 may also be related to water infiltration towards the center of the board, or simply a result of gravity and insufficient fastening.

4.3.2 Exterior

Wooden fabric from 1938 has survived on the exterior, likely a result of the dry climate. However, the structure is not free from moisture-related decay mechanisms such as fungal decay, biological growth, and weathering. The exterior wooden elements of the Original Dining Room are in worse condition than the interior elements. In addition to all of the conditions noted in the interior, which are occur more severely on the exterior, paint failure and previous repairs were observed on the exterior wood during the condition assessment.

The exterior portion of the four beams are in the most critical condition. Each beam is comprised of one main center member, with one, two, or three additional boards lapped
onto both of its sides, and an additional board below these. In all four beams the boards immediately to the left or right of the center members were found to have areas of advanced fungal decay, particularly near the roofline [Figure 18-20]. In Beam 3, where board BX303 was completely decayed to a depth of at least 5 inches, two fruiting bodies were found growing within the member [Figure 21]. Infrared thermography and moisture content readings showed high levels of moisture in these areas, with readings moisture contents as high as 32%.\textsuperscript{105} The high level of moisture in these members is likely a result of precipitation directly on the members and roof run-off, which becomes trapped between the boards. Caulking, which is present between the connections of the lapped beam members, reducing the ability for moisture to evaporate. While the center members are not as severely decayed on their visible surfaces, it is anticipated that there may be a high level of decay where they are covered by other boards. In Beam 1, ant activity was observed in conjunction with the high moisture content and fungal decay.

Though not severely decayed, the outer members of the beams each are affected by a variety of conditions. The eastern most beam, Beam 1, has areas large areas of paint failure on BX101, likely accelerated by moisture infiltration along the end grain. This member also has mild fungal decay at its base and along the end grain on its southern side, where moisture content readings were as high as 31%. BX104, which is adjacent to BX101, has similar fungal decay and paint failure towards it’s end grain. On the opposite side of the beam, BX105 both paint failure and severe cracks are present, but fungal decay is minimal. The top of this beam also had an accumulation of bird feces. Off the four beams, Beam 2 is in the best condition. Paint failure is the most prevalent condition, and is present on both sides of the beam, concentrated towards the end grain. Paint failure is worst on the east

\textsuperscript{105} The Wagner moisture meter used to take these readings can detect moisture readings up to 32%. The actual moisture content of these members may have been higher.
Figure 18: Beam 3 has sever areas of decay. Several inches of material have been lost.

Figure 19: Probing within the center members of Beam 4 revealed decay similar to that in Beam 3 (Fearon).
Figure 20: Probing helped to understand the extent of decay within the center member of Beam 1 (Fearon).

Figure 21: Fruiting bodies found in Beam 3.
elevation than the west. Previous repairs are evident on Beam 3 in the form of additional boards lapped on the east and west sides, secured by bolts (BX308 and BX307). BX308 has a crack on its southern end, and there is a small area of fungal decay on BX307. Paint failure is present on the remainder of the beam. The addition of these repairs may have been in response to the severe decay of BX303, or the repairs may have been an attempt to stabilize the deformation of the beam, in the form of a clockwise twist. Beam 4 features a similar form of deformation as Beam 3, but less severe. The east elevation of this beam has few additional concerns, except for a crack in BX401 originating at its southern end and fungal decay near the roofline. Fungal decay is also present on the BX401 on the west elevation, in addition to paint failure on BX405 and BX402. Like the other beams, this is concentrated near the end grain and is likely accelerated by moisture infiltration.

The remainder of the south facade is in generally good condition. This can likely be attributed to the sheltering of the southern facade’s elements from ultraviolet radiation and precipitation by the roof overhang. However, the severe decay of Beam 3 has allowed moisture to enter the roof overhang below. Significant advances have been made in the fungal deterioration of the ceiling boards of the overhang between Beams 2 and 3 since the condition assessment conducted by Harboe Architects in 2014. Above the roof overhang, both the fascia boards and dentils have areas of paint failure. Many of the dentils are cracked.

The west exterior elevation is in fair condition. Cracks and paint failure were found to be the predominate conditions. Large areas of paint failure exist on the dentils, the north end of BX506, the south end of BX504, and the south end of BX502. Both BX504 and one of the shutters are feature cracks and cupping. The cracking in BX504 is not recent, as it

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appears in images from the 1940s. Caulking is present below BX504 and BX506, though this does not appear to be associated with any of the identified conditions. There is a small area of fungal decay over the southern roof support.

The east elevation is the only exterior portion of the Original Dining Room which abuts another structure. The enclosure of the terrace in 1971 lead to alterations to the elevation, including additional framing around the roof support and alterations to the shutters. Thin plywood was added onto the side of BX104 to the north of the roof support at an unknown period [Figure 22]. Microbiological growth and insect activity was found at the base of the plywood and BX104, likely sustained by water runoff from the roof that abuts it. Ant activity was also found on the north side of the roof support. Like the south and east elevations, cracking and paint failure were common, especially on the dentils.

5.0 PRESERVATION ASSESSMENT

5.1 Significance and Integrity

The Original Dining Room is a significant part in the Taliesin West Complex, as well as in consideration as a structure by itself. Residing within preservation Zone 1, the space has significance for both its association with Wright, the events of the Taliesin Fellowship, and in its design and construction. It was in the Original Dining Room that the Fellowship and Wright ate their meals during the first decade of Fellowships existence in Arizona, and it was later in the Original Dining Room where Wright met privately with friends and clients. The construction in dimensional lumber and few interior finishes illustrate a site that was born tangentially with Wright’s Usonian architecture. The evolution of the site into a more private, domestic space, though always in connection to the landscape around it, express both Wright’s concept of the organic, as well as the changing atmosphere of what once was little more than a “camp.”

Most of the fabric in the space likely dates to the 1938-1959 Period of Significance (see Appendix B). The hands of the apprentices and eye of Wright can still be observed in the crafted woodwork, as nearly all of the material that survives dates to Wright’s period. (Figures 23-26). Among the remaining fabric includes the core member of each of the four beams, original to the 1938 constructions, including at least BX100, BX105, BS200, BX204, BX205 BX400, BX504, BX506. The only areas which likely do not derive from Wright’s period are the northern doorway, bulletin boards, shelves to the east of the fireplace, skylight’s fiberglass, and plywood ceiling members. The present icicles are likely are also not original to Wright’s period, though they are similar in design. Two features which are no longer present include the built-in to the west of the fireplace and portions of the chair rail.
5.2 Preservation Philosophy

While it is recommended that the retainment of fabric from Wright’s period be prioritized, it is also recognized that Taliesin West is a living site. The balance between continuing to embrace change, meeting the needs of a modern school and museum, and preserving Wright’s design intent will undoubtedly need to take different forms across the site as the significance and integrity and needs of each structure varies. Many areas have

Figure 23: View of the western side of Beam 1, likely late 1940s. Annotation added. (Maynard L. Parker, photographer. Courtesy of The Huntington Library, San Marino, California.)

Figure 24: Wood members from Wright’s period are present today, as evident by knots on several wooden members which are visible in photographs from the 1940s
Figure 25: Removal of a pyramid revealed unpainted wood behind it, showing that the pyramid had been in place since the late 1950s when the structure was first painted.

Figure 26: Removal of a tri-panel revealed unpainted wood. Investigation through disassembly in conjunction with the finishes analysis suggests that most of the fabric of the interior wooden elements are which were designed by Wright date to 1959 or earlier.
undergone extensive changes since 1959, with some taking on new levels of significance in the last six decades which may challenge the established period of significance. These areas are in contrast to the Original Dining Room, which as one of the areas which was not heavily altered after Wright’s lifetime, as well as a structure that did not undergo total reconstruction by Wright and such still maintains fabric from 1938, the appropriateness of the site’s established period of significance and decision to preserve the present fabric can be made in confidence.108

The development of recommendations for conserving the wooden elements of the Original Dining Room have developed out of several principles and guidelines. In accordance to the Preservation Master Plan, in addition to the materials and elements from Wright’s period should remain, later modifications should be kept and preserved if they are determined to be significant and do not detract from Wright’s intent or cause other adverse effects. While construction techniques and materials should be in keeping with Wright’s intent, elements should not be added or designed in a way which may result in the interpretation of the site as something it never was. Additional principles which guided the recommendations include prioritizing restoration and repairs over full replacement or reconstruction.109 Efforts should be made to keep as much of the original fabric as possible, with full replacements made only when material is severely deteriorated, lost, or no longer able to function. Maintenance, management, and ongoing care of the structure are also considered integral to its conservation, with inspections and periodic care integrated into the recommendations.110

108 Harboe Architects, PC. Taliesin West Preservation Master Plan, 133.
110 Ibid.
6.0 CONSERVATION RECOMMENDATIONS

Recommendations are often made in the form of immediate, short-term, intermediate, and long-term interventions. In the case of the Original Dining Room, in which a project is currently underway, providing recommendations based on a timeline which anticipates future projects is not fitting as the current project offers an opportunity for treatment and repairs. Rather, recommendations will be presented as options to address specific conditions. Long-term preventive measures will also be included as appropriate.

6.1 Addressing Conditions

6.1.1 Water Infiltration and Stains

It is imperative that water infiltration is addressed as quickly as possible, as the presence of moisture provides the necessary factors for a variety of deterioration mechanics including fungal decay, insect activity and biological growth. All leaks on the ceiling and skylight should be identified and sealed immediately. Any repairs and replacements to the roofing material during the project should be designed to reduce areas of water pooling as well as redirect water aware from the exterior wooden members, including the tops of the beams. It is also recommended that water is redirected form the neighboring roof of the former terrace or that a barrier is put in place to prevent moisture from contacting the eastern exterior wall where biogrowth and insect activity have been observed. The present thin, plywood panels in this area are insufficient in preventing moisture-related issues to the structure.

No action is recommended in areas where moisture enters the structure but have not been shown to be causing any damage, such as gaps where the clerestory windows meet the masonry walls. Sealing these gaps may have adverse effects by altering the ability
for water to escape or negatively influencing the temperature and relative humidity of the space. The exception to this is in the northwest corner where water staining is evident near the mural at the base of the clerestory windows.

While water stains are unsightly and can be detrimental to the aesthetics of a space, they do not pose a risk to the structure themselves. While no intervention is required and stains can be left as is, removal is desirable due to their impact on how the space is experienced. Testing should be carried out in an inconspicuous spot, such as areas within the cove lighting that are not easily visible. Alternatively, stained boards may be repainted to hide the tide lines. This should be a last resort, as it is recommended that all interior finishes be preserved as much as possible. However, it is recognized that repainting may already be necessary as a result of other work being conducted during the project.

6.1.2 Fungal Decay

Fungal decay is responsible for a significant amount of damage within the Original Dining Room, especially on the exterior beams. The elimination or reduction of moisture sources must be carried out prior to any fungal decay treatments. Small areas of fungal decay found on the western shutters can be treated with biocides. Unless severe damage is found past what can be seen on the surface, repairs and replacements beyond repainting will likely not be necessary. In the skylight, where fungal decay is more severe and is in conjunction with pest activity dutchman repairs are recommended.

One the exterior, fungal decay within the inner members of the beams near the roofline has already resulted in a severe loss of historic fabric. It is likely that the decay is not limited to what can be seen on the surface and that neighboring members have interior deterioration as well. The removal of caulking here and at other areas of the structure may slow the rate of decay, but deterioration will continue as long as a source of moisture is
present. While dutchman repairs could be used to replace areas off loss and flashing could be installed to reduce the intake of moisture, the deterioration is likely to continue at the expense of the historical fabric. Such repairs are also unlikely to be sufficient enough to repair the deformation and potential structural problems of Beams 3 and 4. Because of this, it is recommended that the most at-risk exterior members be retired to storage

6.1.3 Deformation

Any interventions to correct deformation should be undertaken with the aid of a structural engineer. Deformation of the exterior beams may be addressed with the removal and replacement of members of Beams 3 and 4 as recommended above. Any reinforcement method should be carefully considered as it should not be visible, but should also be sensitive to Wright’s desire for honesty in the expression of structure.

6.1.4 Interior UV and Visible Light Damage

Ultraviolet protection is needed on the interior, particularly near the mural in the northwestern corner. The easiest way to reduce UV exposure would be to close the shutters. While this is a practical option, it is recognized that it will have a significant impact on how the space is interpreted and experienced by reducing the connection between the interior and the exterior. While the space is not always used on the interior, the closing of the shutters could change how visitors who regularly pass the exterior of the Original Dining Room during tours will view the space. This is also only a partial solution as not all areas of windows are shuttered. The closing of shutters will also aid in reducing the amount of visible light in the space, which while less destructive than UV light, can still cause damage to wood and its finishes.111

Alternatively, ultraviolet filtering films may be applied to the glass of the clerestory windows and southern doors, though this should be done with caution and testing should be conducted to ensure these films are reversible when applied to any historic glass. It may also be possible to design new UV blocking glass or acrylic inserts within the openings of the shutters on the western wall without removing any of the historic glass. If this option is pursued, tests for visual impact from both the interior and the exterior should be conducted. Filters should also be considered for the artificial lighting in the space.\textsuperscript{112} The addition of removable filters behind the acrylic of the cove lighting and around the bulbs near the skylight is less likely to have a visible impact than filters applied to windows.

While the skylight's present material is aiding in the blocking of ultraviolet radiation, upgrades are recommended as the current material and sealant system are not sensitive to Wright's original intent and are failing to prevent water infiltration. The chosen material should continue to block UV radiation.

\textbf{6.1.5 Exterior UV Damage and Weathering}

There have been debates over if Wright truly wanted to Original Dining Room painted as the painting of wood goes against his expressed philosophy for the honest use of wood as a material.\textsuperscript{113} However, the structure was painted during Wright's lifetime and continuing to paint the structure will greatly increase its resilience to weathering and insect infestation.

All exterior woodwork which is to be retained should be repainted in accordance with the results of the paint analysis. Coatings should be treated as sacrificial with the primary goal of preserving the wooden substrate. While the durability of finishes are

\textsuperscript{112} Ibid.
\textsuperscript{113} Patterson, \textit{Frank Lloyd Wright and the Meaning of Materials}, 48.
important, they should not interact with the substrate in any way which may accelerate its deterioration, such as by trapping moisture. Because the exterior wood has had decades to preweather, and the preweathering of wood can lead to a reduced service life of any finishes applied, all surfaces should be properly prepared. Any loose or peeling paint should be removed and the surface should be thoroughly cleaned prior to repainting. Any replacement boards should be primed on all sides. Painting should be timed so that it occurs when the wood is at its average moisture content to minimize any stresses put on the paint as the wood shrinks and swells, and the moisture content should be no higher than 12%. Special attention should be paid to the end grain to ensure that it is properly sealed.

6.1.6 Biological growth

Biological growth in the Original Dining Room can be found in the form of plants on the eastern wall. On the exterior, plants were noted along the roofline of the enclosed terrace. Plants were also found within the shutters on the eastern wall. While some of these plants may be the result of nesting pests, the presence of a green, rooted plant suggest the germination of seeds within the structure. On the interior, the shutters should be removed in order to access the space behind them and all plant materials and other debris should be carefully cleared out. Plants along the roofline of the enclosed terrace should also be removed. Biocides are not necessary. It is recommended that this is followed by the redirecting of water from the eastern wall to prevent future growth. If any areas are known to accumulate plants or seeds, regular clearing should occur.

6.1.7 Pests

Drywood termites are most likely the cause of the most pest-related damage in

the Original Dining Room, though confirmation of the species responsible for damage in each area is needed. A variety of treatment options exist for drywood termites, including localized or whole structure interventions. Options such as heating, freezing, or use of electrical current are not recommended as they may pose a risk to the historic fabric. Drywood termite infestations are often localized, with the members neighboring an infested one left untouched. Where this is the case, such as SK002, replacement of infected members or dutchman repairs of the compromised portion of a member may be possible. These replacements should be in kind. As much historic fabric should be retained as possible while still ensuring that enough compromised material is removed to eliminate the infestation.

Fumigation is also an effective treatment, though this typically involves tenting the entire structure, which may prove to be difficult at Taliesin West. However, removal of individual members may be possible during the project’s construction, allowing for individual treatment of at-risk members. If subterranean termites are found within the Original Dining Room, treatments should first include eliminating their access to the ground, as they will die if they are unable to reach their nest. Soil treatments may be necessary.

Ant activity was limited to Beam 1 and the exterior eastern elevation. Elimination of ants in the overhanging portion of Beam 1 should be conducted in conjunction with the treatment of fungal decay or retirement of members described above. The roof support on the eastern elevation should undergo farther inspection, including removal and inspection of the elements underneath. The visible wood likely covers members similar to those on the western facade. The inner members should be inspected for pest activity and other forms of decay. The outer layers was likely added following the enclosure of the terrace, though it may also date to a later time. If the outer layers are determined to date to Wright’s time, the

115 Feilden, Conservation of Historic Buildings, 150.
116 Ibid., 148.
holes should be injected with a preservative or poison and plugged.\textsuperscript{117} If the covers date to a later period, such as during a campaign of roofing repairs, full replacement of the outer layers is recommended.

Prevention of pests is also an important step in the conservation of the Original Dining Room. Inspections for pests should be carried out at least twice a year to look for holes, frass, tubes, areas of damage, swarmers, and areas of high moisture. While the desert masonry walls are already functioning as a barrier from the soil to the wooden elements in most areas of the Original Dining Room, inspections for termites should still be carried out regularly to ensure no access is being gained through constructed tubes or other materials which may serve as a passageway. The north wall, where wooden elements extend the lowest and moisture is known to be present are of most concern. It is more difficult to prevent the infestation of drywood termites, as they are airborne and do require ground access. Painting can often reduce the likelihood of termite and ant entry, but as seen in the Original Dining Room, it does not guarantee that infestation will not occur.

\subsection*{6.1.8 Cracks}

The presence of cracks on the interior are a cosmetic issue as they do not likely impact the structural integrity of the space, nor are they likely to lead to further deterioration. The sealing of exterior cracks with caulkiling as has been done in the past should be avoided due to the potential of trapping moisture.

\subsection*{6.1.9 Mechanical Damage}

The only area of significant mechanical damage observed in the Original Dining Room was found on the ceiling over the southern doorway, where the locking mechanism of

\footnote{\textsuperscript{117} Ibid., 145.}
the door has left two arc-shaped indents where they contacted the boards while the door is opened and closed. It is recommended that no action is taken to repair this damage as it is mild and any interventions would be unnecessarily intrusive.

6.1.10 Cleaning

The condition assessment and investigation of the Original Dining Room revealed an accumulation of dirt on members of the laylight, within the cove lighting, and on the top of members CI008, CI017, and CI019. Dust and other dirt should be removed with a soft brush, such as hogs hair or banister brush, and be collected into a HEPA vacuum. Care should be taken to not damage any surfaces, including avoiding scratching painted surfaces or snagging brush bristles on the grain on rough, unfinished areas. Following vacuuming, light cleaning can be achieved using a low percentage of a pH neutral non-ionic detergent, agitated with a brush and blotted with cotton pads. Additional cleaning may be necessary in areas to remove water stains, which should be completed following cleaning tests. All cleaning methods and specifications should be approved by an architectural conservator.

6.1.11 Relative Humidity Control

Heating and cooling is presently achieved using a mini-slit system located between the fireplace and northern doorway. While additional monitoring is needed to determine its performance year-round, the data collected reveals that system is not functioning to maintain the recommended range of relative humidity, 35-40%. As mentioned above, the interior relative humidity fell within this range only 12-13% of the time during the period which was monitored. The interior relative humidity fell below 30% over 40% of the time which was monitored, putting the wood at risk of splits, loosened joints, and finishes

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becoming brittle. To maintain a relative humidity, heating and cooling should be kept on throughout both the day and night. This may be regulated by a humidistat which will change the temperature in response to the relative humidity to aid in keeping the relative humidity between 35-40%. A humidifier may also be required for keeping the relative humidity from dropping too low. While better environmental control may be gained by making the space more airtight, further study is recommended prior to sealing the structure as this may have adverse effects including accelerating the movement of water vapor through the masonry and wood.

6.1.12 Replacements

An “organic” site since its founding, Taliesin West has undergone continuous changes in designs and materials over the last eight decades. Replacement of materials was integral to the development of the site during Wright’s period and continued in the years after his death. This has included the substitution of much of the original wooden fabric with both newer wood and metal. Though replacement is part of what makes Taliesin West a “living site,” interventions in the form of material changes or over-replacement of material risks falsifying history and an expression not in line with Wright’s original intent. While this is not as great of an issue in areas which have little historical fabric from the period of significance remains, the Original Dining Room is extraordinary in the level of integrity it has retained. It is critical that each remaining element of the space is treated with care, that all interventions are made with caution, and that the integrity of the space is retained as much as possible. Each individual member’s replacement should be carefully considered prior to its removal. Replacements should only be made when it is necessary for the retention of fabric from the period of significance and of survival the structure as a whole.

All exterior beam replacements should be made in kind using quartersawn, old-growth redwood. They should be sympathetic to Wright’s design intent, reversible, and distinguishable from the original fabric. Ideally these replacements will have a similar grain, moisture content, and crafting methods as the original. All new members should be documented and marked so that they can be identified in the future. Modern construction and fastening techniques may be used only if found to be necessary for durability or structural reasons. Modern methods must be compatible and proven to perform well over time without any adverse effects to the structure. All removed members should be treated as artifacts and should be documented, labeled, and treated.

Replacements are also recommended on the interior at the northeast corner of the skylight. Dutchman repairs are recommended for the north ends of SK063 and SK062 where termite damage and decay are not severe. SK022, which is severely decayed, should be replaced in full using redwood, especially if the decay is determined to have any structural effects on the skylight. SK046, which likely does not date to Wright’s period, can be fully replaced using plywood of the same ply and thickness, or removed altogether.

6.2 The Project

6.2.1 Qualifications of Team Members

It is recommended that the chosen contractor has a minimum of fifteen years of experience working in preservation projects and that the selected licensed preservation engineer have at least twenty years of experience working with historic structures. In addition to providing a description of their professional qualifications, both the contractor and the engineer should be able to provide at least three examples of their prior work on

projects of a similar scope and scale which involve either National Historic Landmarks or Frank Lloyd Wright structures, ideally including those of wooden construction.

The selected architectural conservator should have at least ten years of experience, be a professional associate of the AIC, and specialize in the conservation of both interior and exterior wood. All portions of the scope of work, submittals, completed mock-ups, and specifications must be reviewed by the architectural conservator prior to any work being done. The architectural conservator should also review any changes to the scope of work or specifications which are made throughout any phase of the project. Throughout the project, the architectural conservator must meet on site with the project team at least three times.

6.2.2 Submittals

Drawings should be submitted and reviewed by the architectural conservator and design team during the schematic, design development, and construction document preparation phases. The final drawings should also be reviewed and stamped by the preservation engineer. A work plan should be submitted before work begins. Technical specifications should be reviewed by the architectural conservator.

The contractor should provide submittals for all materials to be used during the project, including samples of all wood and paint, or other materials to be used. Samples should also be provided for all hardware and replacement skylight materials, such as acrylic or glass. Mock-ups should be submitted of a dutchman repair, an example of painted timber with its end grain sealed, and any cleaning or treatment methods to be used. All wood samples and mock-ups should be of the same species, cut, and grade which will be used during the work. Cleaning and treatment mock-ups should be conducted under the same conditions they will be applied to the actual structure and should be produced at least six months prior to applying them to the structure to ensure that adverse effects such as color
changes do not occur. Material safety sheets and manufacturer data should be provided for all products to be used for cleaning and treatments.

6.2.3 Documentation

Prior to beginning work, the entirety of the structure in its existing condition should be documented using a digital camera with minimum lens distortion. Photographs should be taken in both raw and JPEG format. This should include orthorectified photographs of all interior and exterior elevations. Samples of these photographs should be provided prior to work beginning. Photographs should be taken following work at the same angles as those taken prior to the work beginning. As-built drawings should be completed to HABS standards following the conclusion of the work.

6.2.4 Care and Protection During Repairs

All team members should be familiar with relevant conservation and preservation standards, including but not limited to the Secretary of the Interior Standards, ICOMOS Principles for the Conservation of Wooden Built Heritage, the Venice Charter, Nara Document on Authenticity, and AIC Code of Ethics. These standards should guide all work and decisions regarding the preservation and conservation of the Original Dining Room.

It is expected that repairs may include the need to remove elements from the structure. In order to ensure the safety of the wooden fabric, care and planning will be necessary. All areas in which work is to be done should be carefully documented prior to beginning any interventions. Each piece should be labeled with an aluminum tag and keyed to a plan, with the tag not to be removed for the duration of the work. Disassembly should be done with hand tools whenever possible, with fasteners carefully removed, labeled, and stored with the removed members. No member should be cut or otherwise damaged at any
point during the work. All wooden members should be stored in an environment with a constant temperature and relative humidity that is the same as the average temperature and relative humidity of the Original Dining Room, away from sources of moisture.

A protection plan should be provided for all removed materials and all portions of the structure kept intact. The Original Dining Room should remain weatherproofed throughout the duration of the work. Interior surfaces should be protected from moisture, dirt, abrasion, and any other forms of damage, with special care taken around the glass, laylight and mural. Environmental monitoring should occur within the Original Dining Room and where any storage of removed members occurs. Fire safety should be discussed with the owner and planned for prior to work beginning, with precautions and preventive measures known by all team member and incorporated into the daily routine. Before any work begins, all protection plan details and installation should be reviewed by the architectural conservator.

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BIBLIOGRAPHY


______. Alfie Bush at Taliesin West, 1940. Photograph. Pedro E. Guerrero Archive, Frank Lloyd Wright, 1940.


______. *Taliesin West. Dining Room. Scottsdale, AZ*, 1940s. Photograph. Object photCL MLP 1587


APPENDIX A: BUILDING CHRONOLOGY
THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ
DERIVED FROM THE HISTORIC AMERICAN BUILDING SURVEY, NATIONAL PARK SERVICE, UNIVERSITY OF TEXAS AT SAN ANTONIO, SURVEY NO. AZ-218
SHEET: UNIVERSITY OF PENNSYLVANIA BUILDING CHRONOLOGY GRADUATE PROGRAM IN HISTORIC PRESERVATION MIA MALONEY SPRING, 2019

By 1939
By 1945
By 1946
By 1947
By 1949
By 1950
By 1954
By 1955
By 1958
By 1960
Unknown

EXTERIOR VIEW LOOKING NORTHEAST AND UP (NEIGHBORING STRUCTURES NOT SHOWN)
EXTERIOR WEST ELEVATION (NEIGHBORING STRUCTURES NOT SHOWN)
THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ

DERIVED FROM THE HISTORIC AMERICAN BUILDING SURVEY, NATIONAL PARK SERVICE, UNIVERSITY OF TEXAS AT SAN ANTONIO, SURVEY NO. AZ-218

SHEET: UNIVERSITY OF PENNSYLVANIA

BUILDING CHRONOLOGY
By 1959
By 1955
By 1950
Unknown
By 1959
By 1949
By 1947
By 1946
By 1940
By 1939

EXTERNAL SOUTH ELEVATION (NEIGHBORING STRUCTURES NOT SHOWN)
INTERIOR LOOKING NORTHWEST
By 1939
By 1940
By 1946
By 1947
By 1949
By 1950
By 1955
By 1958
By 1959
Unknown

INTERIOR LOOKING NORTH
APPENDIX B: INTEGRITY ASSESSMENT
THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ

DERIVED FROM THE HISTORIC AMERICAN BUILDING SURVEY, NATIONAL PARK SERVICE, UNIVERSITY OF TEXAS AT SAN ANTONIO, SURVEY NO. AZ-218

SHEET: UNIVERSITY OF PENNSYLVANIA INTEGRITY ASSESSMENT GRADUATE PROGRAM IN HISTORIC PRESERVATION MIA MALONEY SPRING, 2019

EXTERIOR VIEW LOOKING NORTHEAST AND DOWN (NEIGHBORING STRUCTURES NOT SHOWN)
EXTERIOR VIEW LOOKING NORTHEAST AND UP (NEIGHBORING STRUCTURES NOT SHOWN)
INTERIOR LOOKING WEST

From 1959 or earlier
Likely from 1959 or earlier
Possibly from 1959 or earlier
Unlikely from 1959 or earlier
From after 1959
Unknown
INTERIOR LOOKING NORTHWEST

- From 1959 or earlier
- Likely from 1959 or earlier
- Possibly from 1959 or earlier
- Unlikely from 1959 or earlier
- From after 1959
- Unknown
APPENDIX C: WOOD IDENTIFICATION
APPENDIX D: FINISHES ANALYSIS
Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3190-3200 K)
Total Magnification: 100x
Imaging: Nikon DS-FI1 camera with NIS Elements BR software

Microscope: Leica MZ16a
Light source: KL2500 LCD + Intralux 5000-1
Total Magnification: 50x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Leica MZ16a
Light source: KL2500 LCD + Intralux 5000-1
Total Magnification: 50x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3190-3200 K)
Total Magnification: 100x
Imaging: Nikon DS-FI1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3190-3200 K)
Total Magnification: 100x
Imaging: Nikon DS-FI1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3190-3200 K)
Total Magnification: 100x
Imaging: Nikon DS-FI1 camera with NIS Elements BR software

THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ
SHEET: UNIVERSITY OF PENNSYLVANIA
FINISHES ANALYSIS
GRADUATE PROGRAM IN HISTORIC PRESERVATION
MIA MALONEY SPRING 2019
Microscope: Leica MZ16a
Light source: KL2500 LCD + Intralux S500-1
Total Magnification: 50x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Leica MZ16a
Light source: KL2500 LCD + Intralux S5000-1
Total Magnification: 50x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3100-3200 K)
Total Magnification: 100x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux S5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3100-3200 K)
Total Magnification: 100x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux S5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3100-3200 K)
Total Magnification: 100x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
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MIA MALONEY SPRING 2019

SUBSTRATE

SUBSTRATE
SH009

Microscope: Leica MZ16a
Light source: KL2500 LCD + Intralux 5000-1
Total Magnification: 50x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

SH017

Microscope: Leica MZ16a
Light source: KL2500 LCD + Intralux 5000-1
Total Magnification: 50x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

SH018

Microscope: Leica MZ16a
Light source: KL2500 LCD + Intralux 5000-1
Total Magnification: 50x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3190-3200 K)
Total Magnification: 100x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

The Original Dining Room (Boardroom) at Taliesin West
12621 Frank Lloyd Wright Blvd Scottsdale, AZ

Substrate

SH009

Substrate

SH017

Substrate

SH018
Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3190-3200 K)
Objective: 10x
Total Magnification: 100x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3190-3200 K)
Objective: 10x
Total Magnification: 100x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software

Microscope: Nikon Alphaphot-2 VS2 Compound Microscope
Light source: Volpi Intralux 5000-1 (quartz halogen, reflected dual gooseneck fiber optic, 3190-3200 K)
Objective: 10x
Total Magnification: 100x
Imaging: Nikon DS-Fi1 camera with NIS Elements BR software
ON-SITE ANALYSIS

SK017

SK044 (Top)

SK044

IMAGES: FEARON

FINISHES ANALYSIS

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MIA MALONEY     SPRING 2019

THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ

SUBSTRATE

SUBSTRATE
APPENDIX E: CONDITION ASSESSMENT
**Crack**
Definition: Visible splits or fractures caused by internal and/or external stress with no loss of material

**Caulking**
Definition: Presence of caulking used as a sealant of cracks, or between two or more wooden members

**Biology**
Definition: Colonization by organic organisms including algae, lichens, mold, and plants

**Defacement**
Definition: Peeling, shedding, or detachment of a film or coating from the wooden substrate, or between subsequent layers or sections

**Deformation**
Definition: Scratches or abrasions resulting from physical contact with another material

**Deformation**
Definition: Loss of material resulting from fungal activity

**Deformation**
Definition: Warping, misshaping, or shifting of building elements or assemblies

**Fungal Decay**
Definition: Scratches or abrasions resulting from physical contact with another material or from fungal activity

**Fungus**
Definition: Loss of material resulting from fungal activity

**PEST Activity**
Definition: Observation of active insects, or evidence of their past or current presence (i.e. holes, tunnels, loss of surface, frass, and insect parts)

**Previous Repair**
Definition: Evidence of earlier conservation or mending of earlier damages or defects; previous repairs do not include work for aesthetic purposes

**Paint Failure**
Definition: Peeling, shedding, or detachment of a film or coating from the wooden substrate, or between subsequent layers or sections

**Water Staining**
Definition: Soiling, discoloration, or tide marks resulting from the presence of water
THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ
READINGS TAKEN WITH A WAGNER MMC 210 MOISTURE METER
SHEET: UNIVERSITY OF PENNSYLVANIA MOISTURE CONTENT GRADUATE PROGRAM IN HISTORIC PRESERVATION
MIA MALONEY SPRING, 2019

MOISTURE CONTENT
THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
15471 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ

READINGS TAKEN WITH A WAGNER MMC 210 MOISTURE METER

SHEET: UNIVERSITY OF PENNSYLVANIA MOISTURE CONTENT
PESI MILONEY SPRING, 2019

MOISTURE CONTENT
APPENDIX G: INFRARED THERMOGRAPHY
APPENDIX H: ENVIRONMENTAL DATA
SP1 T (°F)  | SP1 RH (%)  
SP2 T (°F)  | SP2 RH (%)  
SP3 T (°F)  | SP3 RH (%)  
SP4 T (°F)  | SP4 RH (%)  

**SP-1**
- TEMP
- RH

**SP-2**
- TEMP
- RH

**SP-3**
- TEMP
- RH

**SP-4**
- TEMP
- RH

**BEAM 3: INT BEAM 3: EXT MURAL SKYLIGHT**

**ACCEPTABLE RANGE FOR DRY CLIMATES**
35-40% RH

THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ

DATA COLLECTED WITH SENSORPUSH TEMPERATURE AND RELATIVE HUMIDITY SMART SENSORS
SHEET: UNIVERSITY OF PENNSYLVANIA ENVIRONMENTAL MONITORING GRADUATE PROGRAM IN HISTORIC PRESERVATION
MIA MALONEY SPRING, 2019

SP-1, SP-2, SP-3, & SP-4: 01/10/2019-04/26/2019
DATA COLLECTED WITH SENSORPUSH TEMPERATURE AND RELATIVE HUMIDITY SMART SENSORS

SP-1 (BEAM 3 INTERIOR): 01/10/2019-04/26/2019

SP-1 TEMP

DATE & TIME

AVG TEMP: 69.44°F AVG RH: 33.32%

TEMP RANGE: 49.02 - 97.92°F RH RANGE: 10.24 - 69.41%

THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ

ENVIRONMENTAL MONITORING
PAM MALONEY SPRING, 2019

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DATA COLLECTED WITH SENSORPUSH TEMPERATURE AND RELATIVE HUMIDITY SMART SENSORS

H2
SP-2 (BEAM 3 EXTERIOR): 01/10/2019-04/26/2019

TEMPERATURE (°F) & RELATIVE HUMIDITY (%)

DATE & TIME

SP-2 TEMP

AVERAGE TEMP: 66.95°F  AVERAGE RH: 35.43%

TEMP RANGE: 39.76 - 106.79°F  RH RANGE: 8.22 - 86.99%

ACCEPTABLE RANGE

FOR DRY CLIMATES

35-40% RH

THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD  SCOTTSDALE, AZ

DATA COLLECTED WITH SENSORPUSH TEMPERATURE AND RELATIVE HUMIDITY SMART SENSORS

SP-2 T (°F)

SP-2 RH

DATA COLLECTED WITH SENSORPUSH TEMPERATURE AND RELATIVE HUMIDITY SMART SENSORS

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ENVIRONMENTAL MONITORING GRADUATE PROGRAM IN HISTORIC PRESERVATION
MIA MALONEY SPRING, 2019
### Temperature (°F) & Relative Humidity (%)

<table>
<thead>
<tr>
<th>Date</th>
<th>Temp &amp; Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/10/19</td>
<td>Average Temp: 71.18°F, Average RH: 33.56%</td>
</tr>
<tr>
<td>1/11/19</td>
<td>Temp Range: 55.32°F - 92.56°F, RH Range: 11.91% - 64.01%</td>
</tr>
</tbody>
</table>

#### The Original Dining Room (Boardroom) at Taliesin West
12621 Frank Lloyd Wright Blvd Scottsdale, AZ

Data collected with SensorPush temperature and relative humidity smart sensors.
TEMPERATURE (°F) & RELATIVE HUMIDITY (%)

SP-4 T (°F) SP-4 RH

THE ORIGINAL DINING ROOM (BOARDROOM) AT TALIESIN WEST
12621 FRANK LLOYD WRIGHT BLVD SCOTTSDALE, AZ
DATA COLLECTED WITH SENSORPUSH TEMPERATURE AND RELATIVE HUMIDITY SMART SENSORS
SHEET: UNIVERSITY OF PENNSYLVANIA ENVIRONMENTAL MONITORING
GRADUATE PROGRAM IN HISTORIC PRESERVATION
MIA MALONEY SPRING, 2019
SP-4 (SKYLIGHT): 01/10/2019-04/26/2019

DATE & TIME
AVERAGE TEMP: 71.56°F AVERAGE RH: 33.38%