Louis Kahn, Salk Institute, La Jolla, California, USA, 1959-1965. Overall view, looking southeast across the plaza, following completion of project. © Elizabeth Daniels, 2017.

Conserving the Teak Window Wall Assemblies at the Salk Institute for Biological Studies

BY SARA LARDINOIS AND KYLE NORMANDIN

In 2013 the Salk Institute for Biological Studies partnered with the Getty Conservation Institute (GCI) to commence development of a conservation program for the long-term care of the teak window walls. Phase 1 of the program included preliminary historic research and an assessment of significance, surveys and investigative inspection openings, wood and fungus identification, and analyses of past surface treatments. Guidelines were then developed based on three treatment approaches, ranging from ***in situ*** cleaning and treatment, to selective repairs, and finally in-kind replacement of teak wood. In Phase 2 of the work, the GCI and Wiss, Janney, Elstner Associates, Inc. (WJE) developed a trial mock-up program to assess the protocols of the three treatments. This article will review the overarching goal of the treatment approaches, integrating conservation and repair needs with select modifications to the window detailing to improve long-term performance, including surface treatments to protect the teak wood and retard fungal growth and weathering over time.

Each [Jonas Salk and Louis Kahn] lived partly in a poetic, intangible world and partly here on ground, making tangible things. Each was in touch, as Kahn came to say in the early stages of the Institute – with both the measurable and the immeasurable – the scientific and the poetic. Each thought and created at the level of absolutes, of purity, of, as each would often say, the cosmos. Yet individually, and together, they accomplished and made things of lasting value here in the physical realm[1].

Introduction

Situated on a Southern California bluff overlooking the Pacific Ocean, the Salk Institute for Biological Studies (the Salk Institute, 1965) is one of architect Louis I. Kahn's finest works. Among the major architectural elements of the complex are just over 200 prefabricated teak window wall assemblies, set within openings in the concrete walls of the studies and offices that flank the Institute's iconic plaza (figure 01). After 50 years in an exposed marine environment, the window assemblies were deteriorated, weathered, and in need of repair. The Salk Institute embarked upon a conservation-based repair program from 2013 to 2017 to address the deterioration of the window walls; the aim was to develop a conservation program in which the original window assemblies could be retained, as they are a critical part of the site's cultural significance. This article provides a brief overview of the history and design of the Salk Institute and then discusses the significance of the window wall assemblies, the approach taken to conserving them, and some of the key challenges of the work.

History and significance

The Salk Institute was founded in 1959 by Jonas Salk, the creator of the first successful polio vaccine. His goal was to establish an institute where biologists and scientists from other specializations would explore questions about the basic principles of life and, through their collaborative work, consider the wider implications of their discoveries for the future of humanity. Over 50 years later, the Institute is home to internationally renowned and award-winning scientists whose main areas of study and research include the neurosciences, genetics, immunology, and plant biology.

The buildings that would house Dr. Salk's institute were a key part of his vision as a place of collaborative science and individual contemplation. For their creation, he turned to architect Kahn. Dr. Salk first met and visited Kahn in Philadelphia in December 1959, where they discussed the relationship of science and the humanities. Given the desired design program to build a laboratory complex, Dr. Salk visited Kahn's work at Richards Medical Research Laboratories at the University of Pennsylvania in Philadelphia. The visit marked the beginning of their work together on the Salk Institute, as a well as a friendship and collaboration between the two men that was to last until Kahn's death in 1974. Dr. Salk was an involved client and both men regarded one another favorably throughout their collaboration on the project, with Kahn calling Dr. Salk "my most trusted critic"[2].

The City of San Diego made a gift of a 27-acre parcel of land in La Jolla, north of San Diego, to establish the Institute. Initial design work began in 1959; the first concrete was poured in 1962; and construction was completed in 1965. Kahn originally conceived of a tripartite design for the campus complex, consisting of laboratories, meeting places, and living places; however, only the laboratory complex was constructed. It consists of two nearly identical wings of laboratory space, free-standing study towers,

and office space, each wing mirroring the other on either side of the paved central plaza. In the early 1990s, the East Buildings were added to the complex to provide additional space for the Institute, in part to provide programmatic spaces originally proposed for the original tripartite design.

The recently completed conservation management plan (CMP) for the site found the Salk Institute to be culturally significant as 1) an outstanding building by one of the most important architects of the late 20th century; 2) an outstanding example of an innovative research laboratory; and 3) an outstanding example of landscape design, with the juxtaposition of the buildings and paved plaza with the canyon and ocean. This significance is further enhanced through its association with Jonas Salk and other leading scientists, and with the architect Kahn, as well as the landscape architects who contributed to the design[3].

Teak window wall assemblies

The teak window walls are prefabricated assemblies consisting of different combinations of horizontal sliding window sashes, louvers, and/or paneled shutters, with an internal pocket where required to accommodate these sliding components (figure 03). They were constructed using teak structural members and softwood stud framing, with asbestos-cement (transite) board which performs structurally similar to sheathing. The exterior face of the wall is clad in vertical tongue-and-groove teak siding, and the interior face is clad in oak paneling or gypsum board, installed over the transite board (figure 04). In some locations, the design includes oak shelving for the office occupants. Narrow glazed lights at either side of the assembly served as shim space when the assemblies were set in the wall, and allow for additional light to wash the concrete walls of the work spaces. Prefabrication was selected as both a means of reducing project costs and increasing quality, as the units were partially assembled in a local cabinetmaker's shop prior to being transported to the site and lifted into place by crane.

The window wall assemblies are an exceptionally significant element of the Salk Institute, expressing a human scale element within the monumental structure. One of the design features of the Salk Institute is the physical separation of the singular "domestic" cells of the study towers — which Kahn often referred to as the "architecture of the oak table and the rug" — from the collective work space of the laboratories, with their "architecture of cleanliness and area adjustability"[4]. The use of individual window walls, in contrast to the large expanses of metal-framed window walls at the laboratories, is an exterior expression of these different spaces. The focus on the individual in the studies is further expressed through the functionality of the various sliding components: occupants are able to modulate light and ventilation within their work spaces.

The use of wood and concrete, "often conceived of as materials of opposite character", for the window walls results in a contrasting but complementary effect[5]. Their fine-grained detailing, with narrow vertical tongue-and-groove boards and horizontal trim set in multiple planes, contrasts with the larger expanses of relatively flat planes of concrete walls.

Although research carried out to date has not produced any statements directly attributable to Kahn on the choice of teak for the exterior cladding, the consensus among Kahn's design associates, as well as scholars of his work, is that the teak was specified because it was thought to be a durable, relatively maintenance-free material requiring no finish coating, and that its natural bleached white to gray weathered appearance would be compatible with the color of the adjacent concrete, contributing to the overall subtle palette of building materials[6].

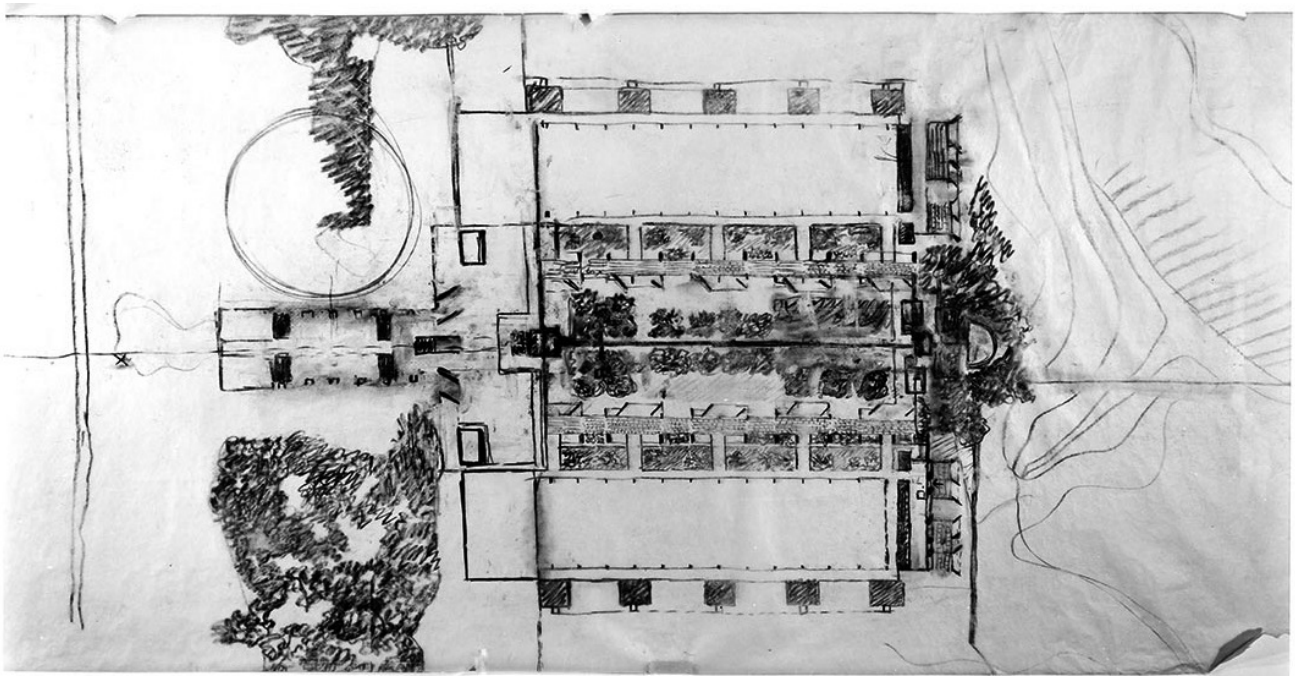
The use of natural materials such as the teak also demonstrates Kahn's architectural philosophy of using and honoring the unique properties of materials. Wood, a natural material, reveals its origins through color, texture, grain, and natural finish, with subtle to moderate differentiations in appearance. The natural weathering of the exterior wood elements results in a character of age and patina that would have been anticipated by Kahn.

Though the window walls are prefabricated units — often thought of as an industrialized process — Kahn innovatively synthesized industry and craft through the customization of the units and the detailing of the teak by carpenters to fit many different concrete openings in the building complex.

The design of these window walls is also significant within Kahn's larger body of work, as they expand upon a language of custom exterior millwork designed and established in his office; remarkably, custom designed wood materials also survive today in Kahn's residential projects as seen at the Margaret Esherick House (1959–1961) and the Dr. and Mrs. Norman Fisher House (1960–1967), both in the Philadelphia area (see figure 06, p. 45 – Fisher House), and in institutional buildings including the Class of 1945 Library at Phillips Exeter Academy (1965–1972) in Exeter, New Hampshire. While different woods are employed at these sites, the Library at Philips Exeter also makes use of exterior teak for its windows set within its brick walls[7].

The Institute has a long history of good stewardship of the site. Over time, it has carried out minor to moderate maintenance efforts and repairs to address localized deterioration and aesthetic concerns at the window assemblies. However, as the Institute approached its 50th birthday – an age when many modern buildings require their first major repair or intervention – the window assemblies were weathered, deteriorated, and in need of a major repair and maintenance program. The long-term exposure to the marine environment and sunshine in La Jolla had led not only to surface erosion but overall degradation of the window assemblies that varied significantly across different elevations of the building. The assemblies also suffered from air and moisture infiltration, which resulted in preferential termite damage dependent on the degree of sunlight and exposure. A mildew or fungal biofilm appeared on the surface of the wood as early as 1967, spreading from nearby Eucalyptus trees and resulting in a black appearance that varied considerably by exposure. At that time, the presence of this fungus was particularly troublesome to Dr. Salk, and

01 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959–1965. Overall view, looking west toward the Pacific Ocean, prior to commencement of project. © Leslie Schwartz, 2015.



02 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959–1965. Preliminary site plan sketch indicationg a planted central court. © Louis I. Kahn Collection, University of Pennsylvania and the Pennsylvania Historical and Museum Commission.

it became a unique challenge for the Institute, whose desire was to retain the appearance of freshly milled teak.

Given these challenging conditions over time, the Salk Institute had originally assumed that total replacement of the teak might be necessary. Yet the Institute realized that such a project would result in the loss of a significant amount of the buildings' original fabric and that this loss would also raise questions about whether replacing such a quantity of a rare natural resource, Southeast Asian teak, was necessary.

Conservation approach

In 2013, the Salk Institute partnered with the Getty Conservation Institute (GCI) to determine if there was way to conserve, rather than to replace, the existing teak window assemblies and better protect the site's significance. The resulting project, the Salk Institute for Biological Studies Teak Window Conservation Project (2013–2017) demonstrated how a conservation-based approach could be applied to address the care of the window assemblies and place in a comprehensive, long-term manner. The project utilized a standard conservation methodology that has long been applied to a variety of heritage sites, including modern heritage sites. This process can be summarized as:

- Understanding the place and what is significant about it.
- Gathering information about its physical condition, external requirements such as codes, client requirements, and feasible uses before.
- Developing principles or guidelines that retain that significance in future use or development.
- Applying principles to guide a design response and implementation.

The project was divided into four phases. Phase 1 of the program included preliminary historical research and an assessment of significance, surveys and investigative inspection openings, wood and fungus identification, and analyses of past surface treatments. Conservation principles and guidelines were then drawn up to guide the development of initial treatment approaches. In Phase 2 of the work, the GCI and the Salk Institute's conservation architect, WJE, developed a trial and mock-up program to assess the protocols of the three treatments. At the end of this phase, the treatment approaches were refined by WJE and developed into a project manual that included construction repair drawings and technical specifications (Phase 3). The construction project (Phase 4) was completed in June 2017.

For the Salk Institute, making the first shift from an asset management approach that included responding to issues as they arose, to a long-term asset management approach with conservation at its core, helped to provide much needed guidance in caring for the site. The second shift was in securing an approach that adopted a conservation methodology in developing and implementing the physical repairs. This shift included starting with documentation and research to understand the problems and their causes, and then developing solutions to address these problems. As part of this process, a trial repair program confirmed the efficacy of the solutions — this process presented a clear parallel with the scientific research process that the Salk Institute practices in its biological studies and research.

Conservation project

The following conservation principles were considered when developing the three different conservation treatment approaches – ranging from minor to major interventions – that were implemented across the site:

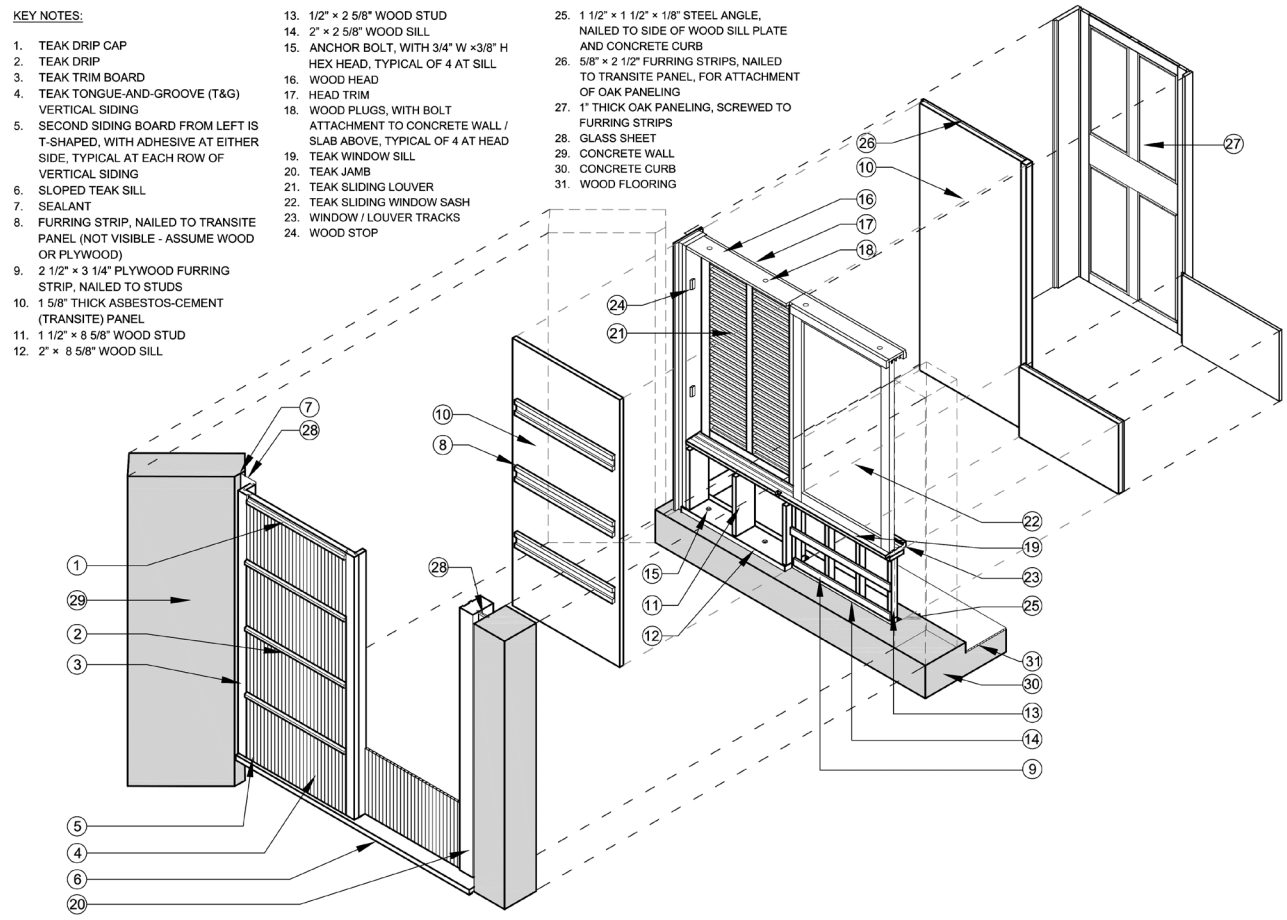
- Preserve the overall integrity of the wall assembly through preservation of the original teak cladding and sliding windows, louvers, and shutters to the greatest extent possible.
- Fulfill the assembly's primary purpose as functional windows and a barrier to the elements by retaining the functionality of the windows, encouraging improvements to enhance performance, and mitigating hazardous materials.
- Preserve and respect the natural characteristic of the wood and the complementary relationship between the select palette of materials.
- Allow for subtle to moderate variations in the exterior wood, but avoid high or extreme variations by retarding the growth of the fungal biofilm and removing past surface coatings.

Minor interventions included in-situ cleaning and repair of existing window wall assemblies exhibiting minor to moderate erosion (with no signs of termite damage) at the teak cladding. Moderate interventions included in-kind replacement of tongue-and-groove teak siding exhibiting erosion and minor deterioration in the internal framing. While major interventions included in-kind replacement of tongue-and-groove teak siding and other components exhibiting severe erosion, structural repair of major frame deterioration was also carried out at areas of severe termite damage. All three levels of interventions included cleaning and removal of past surface coatings, application of new surface treatments to retard the growth of the biofilm and better integrate existing and replacement teak, and preventive treatment to control termites. For moderate to major interventions, improvements to resist air and moisture infiltration were carried out, to enhance the overall and gain long-term performance in order to sustain and further protect the window assemblies.

Conservation challenges

Shortly after completion of original construction in the 1960s, various reports of challenges related to window construction detailing and overall performance of the wood materials began to emerge. For example, in 1966 water leaks were observed in the study towers, resulting from improper construction of the teak panels and window wall systems[8]. Throughout the early stages of the project, from 1963, the construction budget was under threat on numerous occasions; budgetary cutbacks had led to a reduced specification for the millwork of the studies and office wings and in particular, the omission of weather stripping and flashings that provided weatherproofing as originally designed by Kahn's office[9] (figure 06).

03 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959–1965. Window wall assemblies in the studies, prior to conservation. © Getty Conservation Institute, 2013.



04 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959–1965. Isometric of window wall assembly. © Getty Conservation Institute, 2014.

In addition, the window walls were exposed to weathering and ongoing moisture infiltration over time. Additional deterioration occurred due to termite infestation in both the internal framing and in some of the teak framing and cladding. Challenges related to the external teak woodwork also presented themselves once the building was in service. Only a few years after construction, beginning in 1967, the Institute started to wash the entire external woodwork of the teak wood window assemblies in an effort to consistently remove the surface accumulations of the black fungal biofilm; however, the fungal biofilm returned and routine washing of the teak wood continued routinely over 50 years. In the 1970s, surface treatments and coatings were tested and applied with the intent of protecting the wood; however, the treatments eventually gave the teak a deep red appearance that strongly discolored the wood and aesthetically contrasted with the adjacent concrete areas (figure 07).

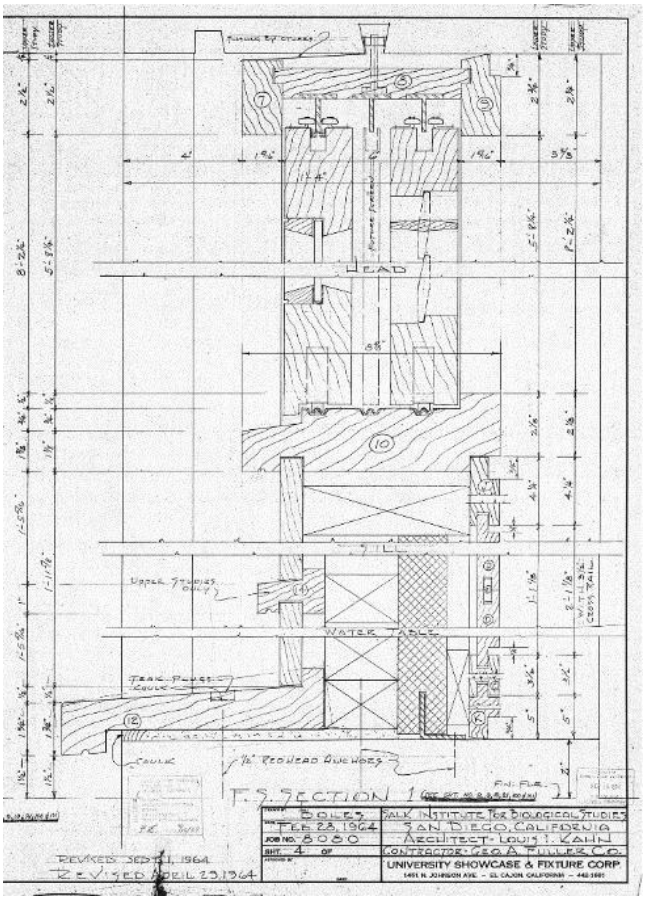
Solutions and remaining questions

In addressing these challenges, the project team grappled with how to balance technical and philosophical questions and arrive at viable solutions. One of the largest technical problems was how best to make the windows more weathertight, provide the flashings that had been omitted from the original design, and install other weatherproofing improvements, including an air and moisture barrier system in the internal wall cavity. Given that the flashings were part of the original design, integrating this detail in the conservation program was critical (figures 08 and 09). However, there remained a challenge of how to integrate a weather barrier system to improve the overall performance of the assembly without significantly altering the visual characteristics, construction detailing, and craftsmanship of the original design.

Perhaps one of the primary overarching questions was how to balance the need for material and visual integrity. As the Salk Institute is an architecturally significant site with high aesthetic value, it was important to maintain not only material integrity but also a high degree of visual integrity, to the extent that was possible and practical. The three treatment approaches that were developed for the project respond to the varying material conditions. In selecting a treatment for a specific window assembly, it was important to consider not only the physical condition of the material fabric but also how the treatment might impact the overall visual integrity of the site, particularly if different treatments would vary greatly in appearance. Consideration was given to applying a treatment to a particular area of the building or across an entire elevation. Ultimately, the differences in appearance between the three treatment approaches were minimized, and new surface treatments further helped to maintain visual integrity.

The project team also grappled with the question of how to treat the surface of the wood. Kahn had intended for the teak wood to be left unfinished and anticipated that as the natural material weathered, it would be somewhat varied in appearance and would remain aesthetically compatible with the adjacent concrete appearance. However, by contrast, given the environmental conditions along the coast of La Jolla, leaving the wood unfinished was not aesthetically successful over the last 50 years – primarily due to not being able to prevent or manage the black fungal biofilm accumulation that is present from the surrounding eucalyptus trees of the site. Given the Institute's preference for a more uniform pristine and fresh milled appearance of the teak wood, this ultimately led to the application of numerous surface treatments, some of which contrasted greatly with the building complex. Over the past 50 years, both the fungal growth that continued to return and the variety of surface treatments had resulted in extreme variations in the wood appearance that detracted from the architectural integrity and monumental form of the complex. The conservation team considered and evaluated a number of options for addressing these issues, from design improvements to reduce moisture accumulation in the wood that allowed the fungus to thrive, to a range of surface treatments to address the varying appearance of the teak and control the fungal growth. Ultimately, a balanced repair approach, with new treatments that retained the significance and the original design intent, was implemented. Minor design modifications were made to reduce moisture accumulation and a trans-

05 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959-1965. Under construction. © Louis I. Kahn Collection, University of Pennsylvania and the Pennsylvania Historical and Museum Commission.



06 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959–1965. Window Shop Drawing, University Showcase & Fixture Corp, 1964. © Salk Institute for Biological Studies.

07 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959–1965. Treatment discoloration and varied weathering patterns. © Wiss, Janney, Elstner Associates, Inc. 2015.

08 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959–1965. New metal flashing at top of window. © Wiss, Janney, Elstner Associates, Inc. 2016.

09 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959–1965. Folded metal flashing installation at top of window. © Wiss, Janney, Elstner Associates, Inc. 2016.

10 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959-1965. Overall view, looking southeast across the plaza, following completion of project. © Elizabeth Daniels, 2017.

lucent surface treatment with a fungicide and ultraviolet light inhibitors was applied to the teak, both to protect the wood and retard the growth of the fungus, giving it an appearance similar to freshly milled teak. This surface treatment also helped to integrate the appearance of the repair work which included both existing weathered and new un-weathered teak; this was considered particularly important where existing and new teak were used side by side within a single window wall assembly or area of the building. In selecting an appropriate surface treatment, it was critical to manage the Institute's expectations in terms of the continuing effects of environmental conditions and routine monitoring, maintenance, and reapplication would most likely be required in the years ahead.

One of the major successes of the project is that over two-thirds of the original teak wood was conserved in place, preserving not only material authenticity but also a rare natural material resource – Southeast Asian teak (figure 10). The conservation repair approach represented a dramatic shift from a complete window replacement program that had initially been anticipated by the Institute for the window wall assemblies.

The conservation-based methodology used for the window project successfully demonstrated that this approach can also be applied in caring for the palette of materials represented throughout the building complex and its setting – i.e., concrete, travertine, metal, and brick areas. And now, this approach is incorporated in the asset management process for the Salk Institute through the adoption of the recently completed conservation management plan for the setting and place, which will guide the care of the complex, including the buildings, spaces, and material fabric, for many years to come.

Acknowledgements

Susan Macdonald, FAPT, Director of Projects and Sites, with Getty Conservation Institute and Deborah Slaton, FAPT, a Principal with Wiss, Janney, Elstner Associates, Inc., are gratefully acknowledged for their constructive and detailed reviews.

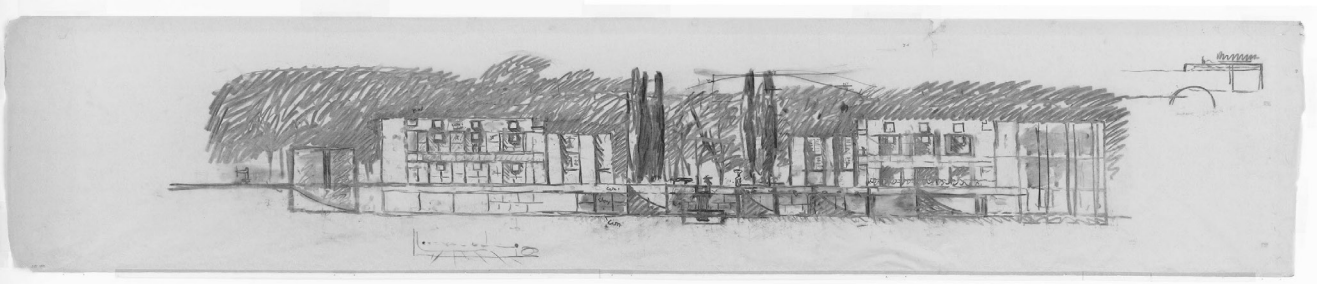
Notes

1 Jonathan Salk, son of Jonas, spoke at the DFC Technology and Innovation Summit in 2015, Design Intelligence, September 23, 2016 [https://www.di.net/articles/reflections-on-the-relationship-between-lou-kahn-and-jonas-salk].

2 David Brownlee and David DeLong, *Louis I. Kahn, in the Realm of Architecture*, New York, Rizzoli, 1991, 95.

3 Wiss, Janney, Elstner Associates, Inc., Inskip and Gee Architects, and Liz Sargent HLA. *Conservation Management Plan, Salk Institute for Biologi-*

11 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959-1965. © Louis I. Kahn Collection, University of Pennsylvania and the Pennsylvania Historical and Museum Commission.



12 Louis Kahn, Salk Institute, La Jolla, California, USA, 1959-1965. © Louis I. Kahn Collection, University of Pennsylvania and the Pennsylvania Historical and Museum Commission.

cal Studies, La Jolla, California, May 2017.

4 Louis Kahn, "Form and Design", *Architectural Design*, n. 31, 1961, 151.

5 David Brownlee and David DeLong, *op. cit.*, 100.

6 During the design phase, several alternatives to the teak were considered as a means of reducing project costs; however, the only viable alternative, Honduras mahogany, was rejected by project architect Jack MacAllister because it "is very red in color and would create problems of appearance with the color of the concrete. It would also have to be treated periodically with a preservative or have to be varnished", MacAllister urged that this substitution should be made only as a last resort. In April 1966, soon after the completion of construction, Louis Kahn himself noted, "I think the tone now, the concrete and the wood, blends together much". For quotation sources, see Sara Lardinois, *Salk Institute for Biological Studies Conservation Project, Phase 1: Research and Investigative Results and Preliminary Conservation Proposals*, Los Angeles, The Getty Conservation Institute, 2017, 23.

7 During Phase 1 of the conservation project, the GCI has included discussion with the facilities team at Phillips Exeter Academy about the repair work carried out at the library windows between 2002 and 2003. For details on these discussions see Lardinois, *op. cit.*, 321-327.

8 *Conservation Management Plan, Salk Institute for Biological Studies*, *op. cit.*, 214.

9 Reference memo dated March 9, 1967, to the Weather Stripping Company. MacAllister's memo of 3 April 1968 recorded that all the weather stripping in the studies and office wings was deferred to bring the construction cost in line with the budget. Salk Institute Archives.

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