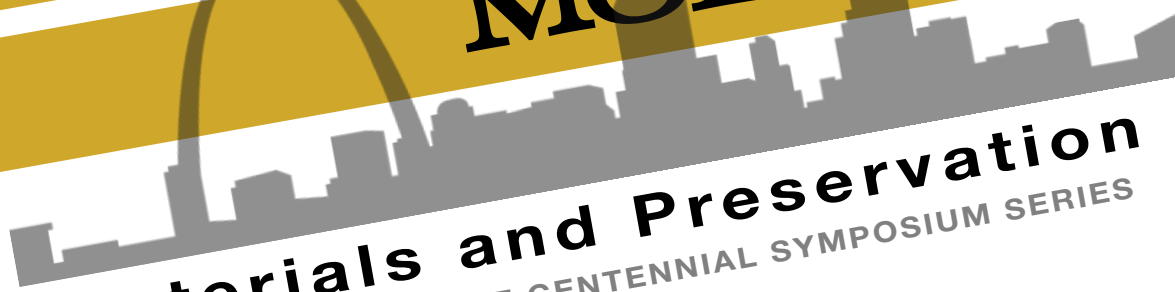


April 13-16, 2015
SAINT LOUIS, MISSOURI

PROCEEDINGS OF THE

MID-CENTURY MODERN



Materials and Preservation
NATIONAL PARK SERVICE CENTENNIAL SYMPOSIUM SERIES

Edited by
Kathryn Doyle, Andrew Ferrell,
Frank E. Sanchis III, Mary F. Striegel

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Proceedings of the
Mid-Century Modern Structures: Materials and Preservation Symposium
St. Louis, Missouri, April 13-16, 2015

Edited by
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FOREWORD

The mid-twentieth century brought innovation and change to the design and construction of buildings and sites. New materials, new applications, and new design principles brought dramatic change to the built environment. It was a time of exploration both in the race to space and in architecture and urban planning. The problems associated with the preservation of mid-century structures are complex, as new materials and new assemblies did not always perform as expected. The prevention of decay and the repair of aging materials still present major challenges, and the appreciation, or lack of appreciation, of the mid-century design aesthetic complicates efforts to preserve these structures.

In 2015, NCPTT joined the Jefferson National Expansion Memorial, the World Monuments Fund, the American Institute for Architects St. Louis, Washington University, and the Friends of NCPTT to hold a symposium on the preservation and conservation of Mid-Century Modern Structures. Experts from across the country convened in St. Louis in the shadow of Eero Saarinen's Arch and Dan Kiley's landscape. The symposium took place at the iconic 1967 American Zinc Building by HOK Architects, and included an intriguing presentation by the original designer, Gyo Obata.

Focusing primarily on the history, use, and preservation of materials found in Mid-Century Modern architecture, the three-day symposium explored the complex issues associated with the preservation of these structures, with a special emphasis on the Gateway Arch and modern architectural metals. Also included were presentations on other materials, such as concrete and curtain wall assemblies.

This book captures the content of the symposium. It includes Gunny Harboe's keynote paper on the way in which materials matter in the preservation of these structures and importantly, how materials play a role in the authenticity of the buildings we preserve. Readers are offered insights into St. Louis' mid-century structures in Mary Brunstrom's paper that includes the brick and terra cotta of the 1891 Wainwright building, the bisected parabola of the B'Nai Amoona Synagogue, and the reinforced concrete shell technology that allowed buildings like the Lambert International Airport terminal or the Priory Church for the Catholic order of Benedictines to be constructed.

The book features conservation treatments of the Gateway Arch, which was constructed between 1963 and 1965. The Arch has the basic shape of an inverted catenary curve, with legs that are equilateral triangles in cross section. The Gateway Arch was an engineering feat, requiring innovation and creative problem solving at every turn. Stephen J. Kelley and Al O'Bright provide a detailed history and study of the visible markings and stains seen today on the stainless steel surface of the Arch. Metallurgical expert Catherine Houska helps the reader understand the nature of the stainless steel used in constructing the Gateway Arch. Christine Freisinger and David Megerle show readers the extreme techniques used to repel from the top of the Arch in order to reach and study staining on its surface.

From materials to engineering, from homes to commercial structures, the publication covers a wide range of topics and structure types. Laura Kviklys and Holly Hope give readers insights into the Modern Ranch home. Carol Dyson shows us how this period influenced commercial structures such as stores and malls.

The papers mentioned here are just a few of the interesting narratives captured in the pages that follow. In addition to reading this publication, we invite you to visit our website at www.ncptt.nps.gov, where you can see the actual presentations through close-captioned videos captured at the symposium..

It was a great pleasure for NCPTT to host this symposium on the eve of the National Park Service Centennial. It is a time for us to look to the past with an eye on the technologies of the future so that we can safeguard our cultural heritage today. We hope you will find this publication valuable both now and in the coming years, as we work together to evaluate and preserve Mid-Century Modern Structures.

Kirk A. Cordell
Executive Director

December, 2015

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MATERIAL MATTERS

Keynote Address

Gunny Harboe, FAIA

Introduction

The title “Material Matters” can be interpreted in two ways that are relevant to the preservation field: the discussion of matters pertaining to materials; or the idea that it is the materials themselves that matter, or are important, in preservation. In the case of professionals engaged in the conservation of cultural heritage, as we are all dealing with actual physical “stuff,” the title should be seen as a “both/and” proposition. Whether we are dealing with individual iconic buildings, historic landscapes, urban ensembles, fast food restaurants, industrial heritage sites, or monumental civil works, we all are charged with preserving and protecting our collective cultural heritage. In working with the physical structures of the past that are still with us in the present, we must determine what should be kept for the future. In other words, the issue of materiality is central to what we do in preservation.

Considerations

The Standards

To guide us in dealing with these issues, we have come to use the Secretary of the Interior’s Standards for the Treatment of Historic Properties (Standards) as our rules of engagement for any interventions required at a historic site. The Standards, first created by the National Park Service in the late 1970s, are tried-and-true. Despite the times in which there may not be full agreement with the interpretation of State Historic Preservation Offices or the NPS, the Standards generally work well when it comes to guidance on the proper treatment of the physical fabric of a historic site, or what we think of as our tangible heritage.

Intangible Heritage

In the United States, the concept of intangible heritage does not seem to have fully entered into the conservation field, yet it continues to make itself more present. There is an acknowledgement of it through the evaluation of a site and in the attempts to understand the significance of a site through all of its associative values; a values-based approach to conservation seems to be the direction in which the field is headed. However, the discussion of intangible heritage does appear to be discussed more in some other countries. Although there

are over 160 signatories of the UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage, the United States is not one of them. Yet representations of American history such as Mardi Gras in New Orleans, gospel singing, or the delta blues are all worth celebrating and protecting as markers of cultural heritage. A regional or national food—for example, Texas BBQ, California viticulture, or even the Big Mac!—can represent intangible heritage.

The idea that intangible heritage is becoming more associated with tangible heritage will likely affect the way we think about modern sites in the future, although it is perhaps not yet clear how. Intangible heritage is much more connected to our present in the sense that it is about cultural traditions or practices that not only have a rich past but that are still practiced today, yet may be threatened. Buildings, or aspects of them, could certainly be looked at that way too. In some ways, we in the conservation field already do this, but it is not always clearly articulated. It is certainly evident in the case of the World Heritage tentative list nomination for the Civil Rights Movement Sites, which includes three churches in Montgomery and Birmingham, Alabama. These churches, although not universally significant for their architectural merits, are significant because of the events that occurred there—a direct connection to the Civil Rights movement—and thus could certainly be demonstrated to be of “outstanding universal value.” As it relates to the phrase *material matters*, it is the physical sites—the bricks and mortar—that are examined in the preservation profession.

Authenticity

When discussing the materiality of a building or site, what is the main concern for conservation practitioners? Does it center on the concept of “authenticity?” A discussion of authenticity goes back to Eugène Emmanuel Viollet-le-Duc and John Ruskin, who investigated how to treat historic fabric—the so-called “scrape vs. anti-scrape” debate—in the second half of the 19th century. Other theories and attitudes concerning how to deal with the physical fabric of our heritage were further developed by a number of people in the 20th century, including Alois Riegl, Paul Philippot, and Cesare Brandi. Their theories and concepts underlie the western attitude about material authenticity that is embedded in critical documents such as the Venice Charter of 1964, which in turn influenced the Standards. The Getty Conservation Institute’s publication of many of these texts,

Historical and Philosophical Issues in the Conservation of Cultural Heritage, has been extremely helpful in understanding the evolution of conservation.

The Nara Document on Authenticity of 1994 challenged the dominant western notions and laid claim to the importance of understanding what authenticity means in the cultural context within which an object or site was created. This document encompassed a broader view of values, which included intangible values particularly as they apply to the building arts and what the relationship is between the physical material of a building and its construction. Ise Shrine in Japan, which is literally rebuilt every twenty years, is often referred to as a classic case. Here, the physical structure holds relatively minor significance but it is the process of building, or rebuilding the building, that is of primary importance. The regular rebuilding is part of a Shinto religious ritual related to death and renewal and the structure is intended to appear forever new. The current shrine is supposedly the sixty-second rendition. The craftsmanship and the traditions related to the act of building, including the craftsmen themselves, are what are deemed to be authentic. Here, it is a case of intangible heritage with a tangible result.

Working with Modern Architecture

How does that thinking or attitude affect how we deal with modern architecture, which in some cases means working with buildings that are younger than 50 years old? Should it change how we think about that issue? In the international arena, as well as here in the United States, there continues to be discussion about the idea that modern architecture should be thought of as being different than traditional architecture—that the rules should somehow change. While there are clearly differences between an incredibly old structure as compared to one that is only decades old, in our practice, the process is always more or less the same. First, we must ask some essential questions: What about the site is important? Why is the structure significant? What is its physical and cultural history? How is the structure being used now? How will it be used in the future? What are its deficiencies from a functional standpoint? What are the building code issues that must be addressed and may have a negative impact on its conservation? Are there acute problems that put the public at risk? What are the patterns of deterioration? How can the structure be restored with the least amount of intervention so that the original artifact can read as truly as possible? Is it the goal to use the “gentlest means necessary?” There are of course many other questions we all ask when engaging with a site of historic importance, not least of which is the one to which every owner wants an answer: How much is conservation going to cost?

Sustainability

Despite these common questions, we as preservationists must address some factors that can make working with modern architecture more problematic than with traditional architecture. For example, many post-war structures were not necessarily built to last—there was an urgency to get things done, or an attitude of, *Get it up and start using it*. Many things of the time, including architecture, tended to be made as disposable rather than sustainable. In the case of architecture, much of this was related to the financing, in which large sums of money were borrowed to construct a building. Once that building had been amortized over thirty years, it was often seen as expendable.

In the present day, we have a new mantra of sustainability into which the attitude of disposable architecture does not fit. But the question of sustainability must be addressed on a project-by-project basis, as the answers depend on the specifics of the sites in need of preservation. Is it sustainable, for example, to replace all of the windows in a building in which they continue to retain service life, simply because they are not as energy efficient as new ones? The issue of energy efficiency was relevant when the GSA began to study the Hawthorne Federal Building in California (Pelli and Lumsden, 1973). The GSA and the NPS concurred with the determination that the building was of exceptional significance (Criterion G). As I understand it, the proposed window replacement program has been put aside for this site.

The issue of whether or not to replace whole curtain wall systems in modern buildings requires a qualitative investigation of a site. Understanding the value of the embodied energy in existing building fabric is a positive step forward, and has helped to level the playing field to some degree, but LEED (Leadership in Energy and Environmental Design) looks at buildings in a quantitative way rather than taking cultural value into account, perhaps leaving some questions unanswered. For example, replacement of a curtain wall might be more energy efficient, and it might even make economic sense, but what has been lost? What is the true value of our cultural heritage and its material authenticity? If we want to be truly sustainable as a society and a culture, we must include those issues in the discussion in a meaningful way.

Systemic Failure

With our aging post-war building stock, the question of how to treat high-rise construction in particular will continue to be an issue in terms of preservation. In some cases, existing systems are failing. Modern architecture was by its very nature experimental, as architects were inventing new ideas about building in terms of form and function, as well as pushing the industry to develop new technologies. This intensified through the second half of the 20th century, as new ways of making buildings be-

came standardized and economic models of “planned obsolescence” became common.

What can be done, though, when the fundamental problem is not readily fixable without complete disassembly? This was the case at Lever House (SOM, 1952) and the United Nations Secretariat Building (Niemeyer, Le Corbusier, Harrison & Abramovitz, et al., 1952). Designated a New York City landmark in 1982 and listed on the National Register in 1983—not yet at the standard 50 years of age—Lever House clearly has cultural significance. Because the structural support of the curtain wall had been deteriorating from the inside, the only option was full replacement, completed in 2001. From what I understand of the project, the building was saved and conservation work remained as true to the original detailing as possible while allowing for a modern system. The results look great. But, did we lose something? Like the Lever House, the United Nations Secretariat Building had revealed systemic problems with the curtain wall. Additionally, the conservation of this building faced the challenge of having to meet new security requirements for blast resistance. In this case, there was little choice but complete replacement combined with efforts to aesthetically match what was there as closely as possible.

Modern Attitudes

The Mid-Century Greats

Addressing certain types of fundamental or systemic problems begs the question, Did the great architects of the 20th century give weight to what would happen to their buildings after 50 or 100 years? An investigation of the leading modernists’ attitudes about the lasting materiality of buildings warrants discussion. Similarly, a look at older works, some seemingly built for the ages, may be a worthwhile comparison. For example, the Pantheon in Rome has lasted an amazingly long time—is that to be a standard reference point? If so, how would that be possible? When we landmark a building, there is an implied intention that it is to be protected in perpetuity. What does it mean to try to preserve something in perpetuity? Is forever, indeed, sustainable?

Current Works and Considerations

What about the buildings designed by today’s notable architects? Are the works of Zaha Hadid, Rem Koolhaas, or others sustainable? Will they one day be landmarks? Yes, certainly some of them will be. What will happen with time to these buildings—for example, if the fiberglass egg crate panels of the McCormick Tribune Student Center at the Illinois Institute of Technology (2003) become so discolored and frayed that they need to be replaced? Although the building was constructed just twelve years ago, photographs reveal that the panel

fibers are in fact frayed, while the orange plastic and black paint on the facade has faded. [Figures 1, 2, 3] When the problem is addressed, will the required materials still be available? If not, how will they be remade?



Figures 1, 2, 3: The McCormick Tribune Student Center, Rem Koolhaas, 2003

Michael Graves’ Portland Building, a city landmark in Portland, Oregon and a great postmodern pile, has many problems. It was “value engineered” when it was originally constructed, and it has not weathered well. What will happen with this building?

The latest technology that will likely impact the field of conservation is 3D printing. Recently, *Architectural Record* covered a group of Dutch architects who are building a house using plastic with a 3D printer. There are similar experiments going on in other countries using concrete materials. It seems only a matter of time before this new technology becomes commonplace. What will the durability of products made with the technology be? What will it mean for us, or the next generation of heritage practitioners?

Must Buildings Die?

In preservation, how do we decide what to save and what to let go? In *Buildings Must Die: A Perverse View of Architecture*, Stephen Cairns and Jane Jacobs ask whether we are willing to accept that some buildings cannot be saved. There are times when it may become clear that a threatened building cannot be saved, at least not in its current form. Although this may not stop attempts at conservation, we need to know the limits of what is possible. With many buildings, the deciding

factor is money. Preserving an existing historic structure requires significant financial investment. In some cases, the investment seems beyond reach. Often, there is not enough money to carry out the necessary work in the appropriate way.

HTCs

This is not a new situation; it is what gave rise to the Federal Historic Tax Credit (HTC) program administered by the National Park Service. The 20% HTCs have been helpful in saving thousands of buildings and restoring them to use. According to the NPS website, "It has leveraged over \$69 billion in private investment to preserve 39,600 historic properties since 1976." That is an amazing statistic; we would certainly be much poorer culturally without this program. Yet, from time to time, there are real threats to the program. A recent letter of petition reflects a call to the Senate Finance Committee for retention of the HTCs, as well as the importance of conveying to representatives in Congress the added value that this program brings to communities—both culturally and economically. As advocates for preservation, we should in fact all be members of Preservation Action or the National Trust.

In today's world, in which everything can feel sped up and the internet supports a seemingly endless need for instantaneous everything, our perceptions of the world can change overnight. This affects us and how we think about our cultural heritage. As postmodern buildings are beginning to be recognized as worthy of landmarking, the question arises: Should the standard 50-year rule become the 25-year rule? Should there be a limitation on a building's age? How much time is enough time to make a judgment about the significance of a great work of architecture? Uproar over the demolition of the American Folk Art Museum (Williams and Tsien, 2001), not even fifteen years after construction, speaks to this question.

In conservation, we must also consider the amount of building stock from the post-WWII boom. Although not all of it is worthy of protection, making good choices is not all that easy. We seem to still be applying the same criteria we have been using for the last 50 years. There is a good understanding of what the criteria are and whether a building meets the standards or not, yet the system does not always work.

Tragic Losses

We have seen some major losses of mid-century modern buildings in the last few years that are baffling. The protracted fight over Richard Neutra's Visitor Center at Gettysburg National Military Park, also known as the Gettysburg Cyclorama (1962), ended with the contested demolition of a structure that clearly met a number of criteria. [Figure 4] In Chicago, Bertrand Goldberg's po-

etic and precedent-setting Prentice Women's Hospital (1975) faced a similar fate. [Figure 5] The structure met four out of seven criteria for landmarking (only two are required) and the Commission on Chicago Landmarks did in fact vote to landmark it; however, at the same meeting, the same commission voted to de-list it and allow Northwestern to tear it down. What kind of precedent does that set?



Figures 4: Gettysburg Cyclorama, 1962-2013



Figures 5: Prentice Women's Hospital, 1975-2014

Paul Rudolph's Orange County Government Center in Goshen, New York (1967), which was on the World Monuments Fund Watch in 2012, appears to have been handed a death sentence by the county and is headed for the landfill, despite a long-fought preservation campaign and a seemingly reasonable alternative to buy and reuse it. Although the final fate of the building is as yet unclear, the outlook is grim. [Figure 6]



Figure 6: Orange County Government Center, 1963-2015?

There are many other examples of buildings that, despite opinions on aesthetics, demonstrate multiple cultural heritage values—at least enough that would meet the threshold of a landmark status by the standards typically applied. These are all losses, and what will take their place? If we are going to lose something of meaning and purpose, it should not be sacrificed in vain.

So, what is the problem? Why are we losing these things? Who should decide what stays and what goes? What factors play into it? Is it only about the money? Money that owners think they can make if they maximize the development of a site; money that isn't available for restoration or rehabilitation, so that buildings are left to deteriorate to the point that demolition becomes a matter of public safety? What do we value as a society? What is important? These are the questions that seem to shift and change with time as well.

Advocacy Organizations

These are the kinds of battles that organizations like DO-COMOMO and the International Scientific Committee on 20th Century Heritage (ISC20C) have been fighting for a long time. In 2015, DO-COMOMO US celebrates its twentieth anniversary. ISC20C has created some programs to help the cause on an international level. *The Madrid Document*, or, *Approaches for the Conservation of Twentieth-Century Architectural Heritage* (2011), has been well received in countries that do not have a developed methodology or guidelines for modern heritage such as the Standards. *The Madrid Document* has now been translated into twelve languages including Finnish, Hindi, and Mandarin. The Heritage Alerts advocacy program has been used effectively to save a number of threatened structures in places like Stockholm, Hong Kong, and Mexico.

Case Studies: Mies van der Rohe Buildings

In my own professional career, I have had the great honor and pleasure of working on over a dozen buildings by Mies van der Rohe, in one capacity or another, both at

IIT and elsewhere. Not all of them have been full restorations, but each has informed my work. The structural and functional problems seen in some of these buildings point back to the question of whether any of the great modern architects considered the permanence of their works. “Less” was not always enough.

Wishnick Hall

At Wishnick Hall (1946), Holabird and Root were asked to renovate the building to accommodate new state-of-the-art teaching laboratories. Wishnick has always been a lab building, but it was in need of many upgrades, including full MEPFP systems. The question of what to do with the windows came up very quickly. In this case, I was hired by IIT to consult with Holabird and Root about the windows and other restoration treatments. They were looking to improve the performance of windows, but also had to address the deterioration of the sills.

The rust jacking had turned the steel sills into a series of wavy lines. We took a window apart with the hope that we might be able to repair the sill and reinstall the window. Once the window was out, it was clear that we would have to do this everywhere. The corrosion build-up between the sill and the steel “T” that went down into the masonry was significant, as was the deteriorated condition of the window itself. The cost to try to save, restore, and retrofit the windows with some sort of additional insulating glazing was beyond the budget and was not determined to be a viable option. Replacement was the reasoned compromise.

As a point of comparison, at the ten-year younger “twin” building, Siegel Hall, Mies had altered the detail slightly using a heavier steel member, and had extended the sill so that the drip detail functioned better. Siegel Hall does not present the same level of deterioration as was evident at Wishnick. Once the decision was made to replace the windows at Wishnick, we had to work diligently to get as close to the original profiles and sightlines as possible. It took several attempts by the manufacturer to find an acceptable match that suited the client. [Figures 7, 8, 9]



Figures 7: Wishnick Hall, 1946



**Figures 8, 9: Wishnick Hall deterioration (left);
Wishnick Hall, 2009 (right)**

Crown Hall

Crown Hall, Mies' first physical manifestation of "universal space," was almost instantly an icon. Still the home of the IIT School of Architecture, the building is visited by countless architects every year. Crown Hall underwent a major renovation by SOM in the late 1970s, which had included replacement of all of the original sandblasted glass lower lights with new laminated glass that had an interlayer to mimic the original sandblasted glass. In the intervening years, the building was not well maintained and significant deterioration was beginning to show.

In 2003, Donna Robertson, then dean, sought to restore Crown Hall using sustainable practice. She called it the "greening of Crown Hall." Robertson hired Krueck and Sexton as the architects of record, with me (then still with McCluer) as the restoration architect, and Transolar and Atelier Ten as sustainability consultants. The greening study included the investigation of multiple glazing options intended to get better performance out of the building. Once the idea of double or triple glazing was dismissed as being too radical of an aesthetic change, it was determined that by going back to the original concept of sandblasted glass, the building would actually perform better.

Our investigation of the available glass options revealed that there were dozens of possibilities, including new

laminated solutions. When six options were mocked up at full scale, it was determined that the best solution was clear, sandblasted glass, which included a durable non-yellowing sealer to make it more durable and less susceptible to soiling and other damages. [Figure 10]



Figure 10: IIT S.R. Crown Hall, 2005

The issue then became how to address the need to increase the size of the stop for the extremely large upper lights that did not have enough bite with the original 5/8" steel stop. Several alternatives were examined and discussed in terms of functionality and authenticity. In the end, the mock-up proved that the introduction of a slight slope to gain the 1/8" additional bite—and thus varying slightly the original—was an imperceptible change when seen from a few feet away.

Throughout the process, there were some adjustments that had to be made, but the building was completed in time for the students to start a new semester, after only fifteen weeks of work.

860–880 Lake Shore Drive

Completed in 1951, 860-880 Lake Shore Drive is another of Mies' iconic works. Again, Krueck and Sexton were the architects of record, while I was restoration architect. Wiss, Janney, Elstner Associates provided the structural engineering and conservation and forensic services. In this case, the building did not need reglazing; in fact, its original aluminum window system is in surprisingly good shape. However, the steel required painting, and the concrete of the below-grade parking garage was failing. After a number of tests, it was determined that the building could in fact be painted at another time without having to fully strip all of the existing paint. [Figure 11]



Figure 11: 860-880 Lake Shore Drive, 1951

The travertine plaza, however, had been failing systematically for many years; the solitary drain in the flat space proved insufficient for proper drainage. The fundamental problem here was the depth of the setting bed, which would likely be designed differently with today's standards. Changes required the introduction of some positive drainage away from the building. The team conducted a number of workshops to come up with solutions. The result incorporated a series of subsurface drains that were invisible from the top, and introduced a slight slope to the pitch of the surface of the plaza that allowed the water to move away from the building.

The matching of the stone, always of major importance, required careful selection and observation. The selected stones were shaped so that they now had a slight valley or ridge, depending on where they were located. [Figure 12]



Figure 12: 860-880 Lake Shore Drive, Travertine selection

The other issue that had to be addressed was the storefront system. In a renovation in the 1980s, the original aluminum cladding of the storefront system had been completely replaced with stainless steel, in hopes that it would perform better. In the original design, the negative air pressure was poor and resulted in the whole skin

of the building leaking. Any time it rained, it sucked water in through every joint and crevice of the skin. While they were able to successfully apply sealant at the perimeter of all the windows to stop the water infiltration there, it hadn't worked well at the storefront, which resulted in extensive deterioration.

Because the base of the storefront was continuous, it is not clear to the eye that the inside and outside elevation of the top of the stone were intended to be the same. Additional slope was gained by moving the top of the outside stone approximately 1½" higher. This was combined with the shaving of roughly ¾" off the surface of the structural slab, creating a better depth for the setting bed of the new stone.

While the idea of returning the storefront cladding to its original aluminum was discussed, only the lower section of the stainless steel was removed to address the corroded steel framing. Full replacement did not fit in the budget.

There were a number of places requiring full depth concrete repairs inside and out. These were formed and poured in a conventional manner. The original stone was saved on the interior wherever possible; however, some new replacements were necessary at the perimeter of the inside of the storefront. There is a slight color difference, but it is not jarring. In an area in the back by the loading dock the best of the original stones were reused, to make clear the difference between old and new.

Case Studies: Current Projects

Taliesin West

The nomination of *Key Works of Modern Architecture* by Frank Lloyd Wright, as submitted to the World Heritage Committee, includes ten sites: Unity Temple, Robie House, Taliesin, Hollyhock House, Fallingwater, the Jacobs House, Taliesin West, the Guggenheim, Bartlesville Tower, and Marin County Civic Center. We are honored to be working on three of them—Unity Temple, Robie House, and Taliesin West. The Preservation Master Plan for Taliesin West, currently underway, has been an extremely interesting and challenging project.

There are some very difficult questions that need to be addressed to properly care for and sustain Taliesin West. Plans must account for the full story of the site: all that it was, all that it currently is, and all that it wants to be. Originally, Wright built the site in Scottsdale, Arizona as the winter camp for the Taliesin Fellowship (which Wright had begun in Wisconsin in 1932). Wright started to build in 1938. Nearly every winter for the rest of his

life, he would take the Fellowship to Taliesin West and, each time, would make changes and additions to the buildings. He didn't stop until his death in 1959. However, changes continued to be made by his wife Olgivanna and his son-in-law Wes Peters, who also ran the office (which became Taliesin Associated Architects).

The big challenges include the question of how to find a way to allow the rustic camp that was Taliesin West for its first decade to read through the changes that occurred in its second decade and beyond. Is there a way to do that that doesn't create a false sense of history or too greatly compromise what is there now? What is the best way to tell this important story? These are some of the key questions. [Figures 13, 14]



Figures 13: Taliesin West, 1938



Figures 14: Taliesin West, 2014

Luce Chapel

At the Luce Chapel at Tunghai University in Taichung, Taiwan, I am serving as a consultant. Originally designed by IM Pei and CK Chen in the mid-1950s, it was not built until 1963. The beautiful concrete building requires an intervention that will allow it to perform better and extend the life of its materials. Specific needs include but are not limited to new MEP systems, steel curtain wall repairs, and some restoration of the pews. The biggest challenge

is the failing glaze on the exterior golden tile. The whole surface of the exterior shimmers with the scale-like tiles, but something is causing the glaze to chip and flake off. Determining the proper treatment is likely to take some time and some experimentation. [Figures 15, 16]



Figures 15: Exterior of Luce Chapel, 1963



Figures 16: Interior of Luce Chapel

Conclusion

Dealing with mid-century modern architecture is, in some ways, the same as dealing with traditional architecture. However, in some ways it is more difficult. There are so many factors at play, that there is almost never a perfect solution. It always involves making informed choices and developing reasoned compromises. Close attention to detail can allow for conservation solutions that not only retain the heritage value of a building, but give it continued use and economic value—at least for another generation or two.

ST. LOUIS' MID-CENTURY MODERN ARCHITECTURE: THE MATTER OF MATERIALS

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There is more mid-century modern architecture in St. Louis in a rich array of types than most people realize.¹ In the immediate post-World War II years, architects, engineers and a host of related design and building industry professionals in St. Louis produced a significant inventory of what we now label mid-century modern buildings. We use the term mid-century to differentiate certain buildings from the output of the prewar years during which modernism was codified in a discourse, one strain of which equated modern design with style while the other tied modernism to social and political progress.² Mid-century modern is an interesting term. It links architecture to times that were characterized by surging growth and change resulting from postwar power and prosperity, even as the geopolitics of the Cold War cast a haze of uncertainty over the period. Like everything else at midcentury, architecture was shaped by these conditions.

What defines the new architecture of the period in question, and does it merit a stand-alone label—mid-century modern—to differentiate it within the broader framework of modernism? Does the period hold together as a coherent chapter in the history of architecture? Or, as one architectural historian asks, did the mainstreaming of modernism reduce the production of the mid-century decades to “the chaotic interregnum between modernism and postmodernism?”³ Certainly the architecture of the period is typified by, for example, the open flowing plan integrating interior and exterior, the advent of new materials and the expansive use of glass, and the use of standardized and prefabricated building products.

In St. Louis, architects adopted a client-focused approach aimed at meeting their clients' needs aesthetically, programmatically and efficiently, using up-to-date technologies and materials. This approach typically synthesized modern and historical ideas. The vitality and originality of architectural production in the postwar years in St. Louis were due in no small measure to the vision and talent of architects who were based in St. Louis, many of whom had grown up in the area and many of whom were associated with Washington University School of Architecture.⁴ There appears also to have existed a climate of experimentation among architects in St. Louis in the 1940s, one moreover that engaged directly or indirectly a number of the prodigiously

gifted architects of the day, including Eric Mendelsohn, R. Buckminster Fuller and ultimately, with his victory in the Jefferson National Expansion Memorial competition, Eero Saarinen.⁵

With these premises and questions in mind, I offer an overview of the region's modernist buildings. I will show that modernist ideas were pervasive in the building culture in both the public and private spheres. Since our symposium is organized around understanding materials, I highlight buildings in which materials were instrumental agents in the architects' processes of finding optimal, new architectural solutions.

Masonry Par Excellence

St. Louis' modernist architectural narrative is one of continuity and innovation, especially with respect to the use of brick. Nowhere is the persistence of brick as visible as in the robust, yet elegant and ordered, Brutalism-inspired facade of St. Louis Community College at Forest Park (1965) that unfolds as one drives along Interstate 40/64 and was designed by the Chicago-based architects Harry Weese and Associates.⁶ The infinitely varied brick construction in the region is an extrusion of its geology, literally a man-made formation on the surface that expresses the layers of clay beneath. Local abundance made clay products the material for high and low budget architecture alike. Brick and terra cotta were vital components of the Wainwright Building, which opened in 1891 and established St. Louis as a site where the challenges of the modern tall building were triumphantly addressed. Designed by the Chicago-based partnership of Dankmar Adler (1844-1900) and Louis Sullivan (1856-1924) in collaboration with the St. Louis architect Charles K. Ramsey (1845-1913), the Wainwright Building demonstrates mastery of brick and terra cotta applied over a modern steel skeleton. From the base course of red Missouri granite, through the brownstone ashlar-clad lower stories, the Wainwright Building soars, via a rhythmic arrangement of piers executed in pressed brick, to a foliated terra cotta frieze band of restrained but infinite visual complexity.

Further north, brick patterning and craftsmanship at the Neighborhood Gardens apartment complex bring to mind the masonry patterning of modernist housing developments in Holland during the period. The intricate interplay of surface colors and shapes at Neighborhood Gardens produced a modernist expression that mediated the potential for starkness and angularity over the city block-scaled complex, an outcome that flowed from the architects' willingness to give St. Louis' accomplished bricklayers artistic freedom in the execution of the scheme.⁷ Designed by the firm of Hoener, Baum & Froese, Neighborhood Gardens was completed in 1935 as a settlement home for white working-class, typically immigrant, families who worked in the downtown garment industry nearby.

Dutch masonry design was felt in another early modernist building by Isadore Shank (1902-1998), who had witnessed its potential while travelling in Holland in 1928 on an architecture fellowship. In his DeBaliviere Building of 1928, Shank integrated masonry and terra cotta tile with Frank Lloyd Wright-inspired textile blocks into a sumptuously worked facade perforated by bands of windows with metal mullions. Later, in 1940, in a gesture that was perhaps oppositional to the perceived coldness of Bauhaus orthodoxy, Shank worked recycled handmade brick from a demolished 19th-century St. Louis brewery into his modernist vocabulary in his own house in Ladue. Notwithstanding the abundance of brick sources in St. Louis, the architect Frederick Dunn (1905-1984) specified the "Chicago common" variety to achieve a soft, warm ambiance in Second Baptist Church in Ladue (1957). The sanctuary, finished on the interior with birch wood, was lined on both sides of the nave with 40-foot tall colonnades of this rose-hued brick alternated with imposing windows depicting the *Beatitudes* painted in monochrome iron brown by the artist Siegfried Reinhardt.

In the years 1932-1938, a seven-story medical complex that would serve black healthcare needs in a segregated St. Louis arose in the Ville neighborhood of North St. Louis. In time, the Homer G. Phillips Hospital became recognized nationally for its state-of-the-art medical training. For African Americans in the region, the facility was a powerful symbol of black achievement. Designed by city architect Albert A. Osburg, the complex was hailed for its sensitive accommodation to the surrounding residential architecture, an outcome that was aided by the disposition of the brick in horizontal courses that visually grounded the lofty structures. At the same time, brick in many colors—green, ochre and red—activated the walls, which were embellished with terra cotta Art Deco motifs. The complex was an example of how the beauty of masonry and terra cotta could be leveraged to turn a dominant institutional presence into an aesthetically pleasing community attribute.

Each of the two houses by Frank Lloyd Wright (1869-1959) in St. Louis is notable for coherent brick elaboration. Both are versions of Wright's democratic single-family dwell-

ing designed on organic principles and dubbed the Usonian house, but are markedly different from each other in their plans, sites, materials and construction methods. Situated on an undulating eleven-acre site in the suburb of Kirkwood, the Kraus House (1951-1955) features a plan based on an equilateral parallelogram module that is repeated throughout the building in a variety of scales, including on the slab floor and in the Wright-designed furniture. The atmospheric warmth of the Kraus House derives from its two signature materials, Tidewater Red Cyprus and Wyandotte brick, which Wright continued from the exterior to the interior. The Pappas House (1955-64) in west St. Louis County is classified as Usonian Automatic, meaning that the house was intended for construction by the owner. Based on Wright's masonry block invention that used steel rebar rather than mortar in the joints, the house is built of precast, red-tinted concrete blocks on a two-foot module, a geometric motif that is carried through to other aspects of the design, including the floor.⁸ The block patterning produced an integrated decorative scheme which was complimented by Philippine mahogany.

Wright's principles of organic design were taken up by William Bernoudy (1910-1988), who had learned from Wright first-hand as a fellow at Taliesin. In St. Louis, Bernoudy worked in partnership with Edouard Mutrux (1907-1999) to be joined later by Henry H. (Hank) Bauer (1922-). All told, the Bernoudy partnerships built an extensive inventory of houses (and other buildings) using brick and wood that translated Wright's ideas into comfortable, livable environments for the well-to-do.⁹ Bernoudy's own home in Ladue was an exquisite iteration of the modernist house, at relatively modest scale.

B'nai Amoona Synagogue (1945-50) was the first commission in the United States for the German émigré architect Eric Mendelsohn (1887-1953). Mendelsohn's widely acknowledged innovation in modernist design positioned him to make an impact on St. Louis' architecture community. His tenure was doubly significant for the city's standing as a venue for architectural experimentation because B'nai Amoona, as the first modern synagogue in North America, ushered in a period of reinvention of synagogue design across the country. Moreover, Mendelsohn's project prompted a corresponding design reappraisal among Christian denominations in the St. Louis area and elsewhere, one that concentrated on fostering a sense of community.¹⁰ B'nai Amoona is constructed of concrete block faced with buff Ohio brick set in a stack bond pattern, the vertical lines of which add to the lofty appearance. [Figure 1] The lightness of the color mediates the sense of weight and the geometric ordering results in a certain quietness in the masonry that cedes the drama of the design to the building's signature feature, namely, the sweeping roof that cantilevers out from the sanctuary wall.



**Figures 1: Eric Mendelsohn, B'nai Amoona, 1950
Mary Reid Brunstrom**



**Figures 2: Stack bond masonry detail and view of parabolic roof
W. Philip Cotton, Jr., The American Institute of
Architects/St. Louis Chapter**

mentation and produced unimpeded sight lines to the altar. Both changes were aimed at encouraging more active participation in the mass by the faithful, one of many tenets of modern liturgical reform that would be ratified by the Second Vatican Council (1962-1965). Hence, St. Ann's exemplifies how modern engineering responded to new spatial needs.

In the secular sector, the May Company, a national St. Louis-based retailer headed by Morton D. (Buster) May, rang in a new era of retailing with three new branches of its Famous-Barr store: the Clayton Famous opened in 1948 to the west of the city; Southtown Famous opened in 1951 on the city's south side (demolished 1995); and Northland Famous opened in 1955 in North County (demolished in 2005). Both the Clayton store—designed by May's uncle-by-marriage, Samuel Marx (1885-1964) with Marx's Chicago-based firm of Marx, Flint and Schonne—and the Southtown store, designed by John P. Hoener to resemble its Clayton sibling—repeated the signifying features of the May Company's ultra-modern west coast store on Wilshire Boulevard's Miracle Mile in Los Angeles (1939). Those features included the flat roof, the streamlined corner treatment, and the continuous band of display windows on the street. Following Mendelsohn's precedent at B'nai Amoona, Marx chose buff-colored brick for the facade.

May, a prominent art collector and philanthropist, turned his Clayton store into a showcase for modern, sophisticated taste, hosting art and design exhibitions that were viewed by St. Louisans as highly desirable events on the social calendar. Earlier, May had made explicit his commitment to modernism when he commissioned Marx in 1940 to design a large International Style resi-

Steel Skeletons

Mendelsohn enlivened his predominantly flat-roofed, horizontal scheme with the wing-like form of a bisected parabola, his own formulation of a daring tectonic gesture writ large against the sky to dramatize modernity for both the viewer on the outside and the worshipper in the sanctuary who could see it through the clerestory windows. [Figure 2] The soaring curve that projects some twenty-six feet from the wall was formed with steel I-beams that taper from the base to the termination of the cantilever.

Mendelsohn's formal bravura and clarity almost certainly influenced Joseph Murphy (1907-1995) in his design for St. Ann's Catholic Church (1952) in the northern suburb of Normandy, where Murphy enclosed the sanctuary with a clear structural steel span in excess of 110 feet. The resultant column-free design eliminated spatial seg-

dence for him in Ladue, a modernist landmark that was demolished in 2005.



Figures 3: Northland Shopping Center, 1955
TobyWeiss.com



Figures 4: J.C. Penney, Wellston, 1948
J.C. Penney Archives, DeGolyer Library,
Southern Methodist University, JC Penney Corporate records

The third Famous-Barr store was built as the anchor of Northland Shopping Center in North St. Louis County. [Figure 3] The phenomenon of one-stop suburban shopping that brought a department store onto a site with other retailers and amenities was new to the area. Designed in 1955 for the May Company by Russell Mullgardt Schwartz and Van Hoefen with Marx's firm consulting, Northlands Shopping Center was composed of cubic volumes of varying heights articulated by open walkways on a fifty-acre site that accommodated the increasing demand for automobile parking. For Famous-Barr, the rectilinear design introduced a different style of modernism from the streamlined aesthetic of the two earlier stores. Construction costs were reduced with the use of a welded steel frame, one of the first such applications in a multi-story project in the area.¹¹

To the south, in Wellston, modern design expanded the frontiers of shopping for lower-budget customers when, in 1948, a distinctive store based on International Style concepts was designed for the retailer JC Penney by the father and son team of William P. McMahon and Bernard McMahon. [Figure 4] Faced in smooth white

stucco incised with a rectangular grid relieved by rows of thin, metal sash windows, the JC Penney Store 1396 sported an open roof deck that evokes the terrace atop Le Corbusier's Villa Savoye (1925) outside Paris. A sculpted ceiling perforated by curvilinear forms through which the sky is visible is supported by pilotis that project upwards from granite-clad columns at the street-level entrance. The building has now been unoccupied for some four decades.

Concrete for Poetry and Prose

In the postwar years, as structural concrete began to enter the mainstream, reinforced concrete shell technology opened up seemingly unlimited possibilities for architects who exploited its plastic qualities to produce some of St. Louis' most remarkable buildings. Hellmuth, Yamasaki and Leinweber's futuristic Lambert International Airport Terminal, which opened in 1956, was one of the first modern terminals in the world to use thin shell concrete.¹² The terminal featured a series of three intersecting parabolic vaults, each thirty-two feet high at the apex and forming a 360-foot span over the passenger check-in and waiting areas. In addition to its economy and structural integrity over wide spans, thin shell concrete was chosen as an innovative design move, using materials and techniques in the service of a form in which St. Louis' role in shaping the future of air travel was unambiguously embedded.¹³ That the terminal was viewed by the city's administration as a showcase was reflected in the quality and distinctiveness of the art program. For example, on the interior, a 48-foot long, welded and painted metal partition screen crafted from brightly-colored, geometric shapes by the Cranbrook-trained sculptor Harry Bertoia (1915-78) underscored the modern vocabulary of the terminal design.



Figure 5: Schwarz and Van Hoefen,
Greyhound Bus Terminal, 1964
W. Philip Cotton, Jr./AIA St. Louis Chapter



Figure 6: Phillips 66 Station, 1967
St. Louis Post-Dispatch

An alternative gateway, one for bus travelers, arose in 1964 on Broadway in downtown St. Louis. Schwarz & Van Hoefen's design for the Greyhound Bus Terminal also deployed thin shell concrete to fashion a parabola-based roof that cantilevered over the passenger terminal in a dynamic, swooping gesture evocative of the dynamics of travel. [Figure 5] In 1992, this model of mid-century design, including its freestanding, space age-inspired signage tower, succumbed to demolition.

A more positive outcome was achieved for another of St. Louis' mid-century modern landmarks, namely, the former Phillips 66 station in Midtown, known colloquially as the Flying Saucer Building, or Del Taco Building. [Figure 6] Built in 1967, this eye-catching, historic structure survived a demolition threat in 2011 and is now renovated, with Starbucks and Chipotle as tenants, contributing amenities on the southern flank of St. Louis University. The gas station became the indispensable building type for the automobile in the 1950s as car ownership responded to the growth of suburbs, and architects strove to encode the aerodynamics of car travel in buildings. The glass and concrete Phillips 66 station was the smallest if most distinctive structure in a complex designed for the International Brotherhood of Teamsters Local 688 by Richard Henmi (1924 -) of Schwarz & Van Hoefen. Henmi envisioned the dynamic curvilinear form of the gas station as the focal point of the entire composition when viewed from on and off the site. The tectonic strength and spanning capability of thin shell concrete enabled the architect to use a hyperbolic paraboloid for the roof which was six inches thick over a span of 120 feet, and which was supported by angled concrete piers towards the center.

In 1956, as design partner in the newly-formed Hellmuth, Obata and Kassabaum (HOK), Gyo Obata (1928 -) started design on the Priory Church, the firm's first religious commission. [Figure 7] The site was an undeveloped tract of West County and the project a new venture in the area for the Catholic order of Benedictines. Obata was a graduate of Washington University School of Architecture and Cranbrook Academy of Art (which was then under the leadership of Eliel Saarinen). The chapel was envisaged as the spiritual and geographic focus of the monastic complex, which included a school for

boys and would also serve the surrounding parish. The Benedictine prior, Dom Columba Cary-Elwes, believed in the potential of the new architecture to shape modern Catholic faith. He had appended this in the white, vaulted structure of Lambert International Terminal, on which Obata had worked under Yamasaki and which was crafted from thin shell concrete. Consistent with the new liturgical requirements to optimize sight lines to the altar and seat the faithful in close proximity to the celebrant, the Priory Church is based on a circular plan with the altar as its liturgical and geometric focal point. Three concentric tiers of parabolic arches executed in reinforced, thin shell concrete rise in rhythmic circular ripples around the central altar. Obata's parabolic arches were effective reformulations of the medieval arch and as such encoded historic references for the Benedictines who typically chose Gothic Revival as their building style. The reinforced concrete arches were formed over plywood, over which reinforcing steel and steel mesh were placed. The contractor, McCarthy Bros., achieved monolithic placement by pouring the concrete ribs first, then blowing wet-mix gunite—concrete which is pneumatically projected at high velocity through a hose—onto the form to a uniform three-inch thickness. Correct water content was essential in keeping the concrete in place during the initial curing process.¹⁴ Instead of glass, Obata used Kalwall, an insulated, reinforced fiberglass product developed out of World War II, that appears black on the exterior but admits a suffused light to the interior.



Figure 7: HOK, Priory Chapel, 1956
George Silk



**Figure 8: Edward Durrell Stone, et al., Busch Memorial Stadium, 1966 with Eero Saarinen's Gateway Arch on the Mississippi River in the background
Mercantile Library at the University of Missouri-St. Louis**

Obata continued his exploration of thin shell concrete when, in 1962, HOK was retained to design a planetarium for Forest Park, the city's major municipal park. In the years following the selection of Eero Saarinen's defining form for the Gateway Arch, St. Louis Mayor Raymond Tucker challenged the architects to produce a substantial design that would signify St. Louis and would be different from any other planetarium in the world. The resulting hyperbolic paraboloid, 160-feet in diameter at the base and floating atop the projection dome, was hailed as unprecedented in planetarium design.¹⁵ Opened in 1963 at the height of the space race, this penetrating new access to the galaxies was named for James S. McDonnell, the aviation pioneer and co-founder of McDonnell-Douglas, a St. Louis-based leader in the aerospace field, which funded the project when the municipal bond issue amount fell short. Described as "looking like some strange craft spun down to earth from outer space," the structure in profile describes a parabolic trajectory against the sky.¹⁶

Busch Memorial Stadium, which opened in 1966 as the new home of the St. Louis Cardinals baseball team and was demolished in 2005, was part of the logic of the modernized riverfront and formally very much a piece with the Gateway Arch, from which it took its signature parabolic motif. [Figure 8] The curvilinear idiom, chosen by Edward Durrell Stone (1902-1978) with Sverdrup & Parcel in collaboration with Schwarz & Van Hoefen, echoed the form of the Roman amphitheater, while its graceful parabola-based roof which was realized in concrete, flowed from Saarinen's arch form.

In Illinois, Charles King (1919-1993), known chiefly for a large portfolio of modernist houses in the area, designed an elegant trio of thin shell concrete vaults to enclose the entrance lobby of the Belleville City Hall (1957).

In 1960, Washington University unveiled a modernist departure from the campus' predominantly collegiate Gothic style with Steinberg Hall, the first commission in the United States for the Japanese architect Fumihiko Maki (1928 -), who was working at Washington University School of Architecture at the time. Steinberg Hall exemplified the potential of thin shell concrete with a distinctive roof that remains a definitive exploration of folded plate structure. Aesthetically, Maki addressed the skyline with a dynamic graphic gesture executed in a wave of precision folded concrete.

In 1957, the building's patron, Etta Steinberg, had honored the memory of her late husband, Mark C. Steinberg, with another major gift, this time adding an outdoor skating rink to the public amenities in Forest Park. The architect Frederick Dunn integrated the building into the sloping site using coursed ashlar walls. On the facade, an aluminum and glass wall reflected the activity on the ice. The rink surface, some 230 by 120 feet, was poured and finished in a single continuous operation to within a tolerance of plus or minus 1/8 of an inch. The material covered some twenty-three miles of refrigerant lines that converted the summer roller rink for ice skating in winter.

Physicians and related professionals were early proponents of modernist design, both for its efficiency and relative economy and because of what the new architecture could represent to a public emerging from the strictures of the Depression, namely, a confident, optimistic future-oriented approach to medicine. Nowhere is this more evident than in the Orthodontic Clinic that Harris Armstrong (1899-1973) designed in 1935 for Dr. Leo M. Shanley in the future county business district of Clayton. Shanley had anticipated the demographic shift from city to county and located his practice conveniently for those who could pay for orthodontic care, then viewed as new and progressive dentistry. A pristine, white building on a prominent corner site, the Shanley Building is recognized as the first foray into the International Style in the area, although the unfolding drama of planes and cubic volumes from one elevation to another and the seamless integration into the site at the same time recall Frank Lloyd Wright's dynamic formal strategies. The building is made from poured concrete covered with a skin of fine white stucco. Floor to ceiling metal-frame glass windows are integrated with banks of glass block. Innovative approaches to functional issues such as climate control abound.

In 1961, Gyo Obata of HOK designed an airy, elegant residential tower on Lindell Boulevard in the city's Central West End, using an exposed reinforced concrete frame. Lindell Terrace exuded a modern sense of luxury in its material, white Texas shell stone, that bore the imprint of fossils even as it was precision cut into rectilinear modules for cladding a modern building. Of note is its unique floating concrete foundation designed by the engineer Albert Alper, which allowed the weight of the building to be evenly distributed across the bearing strata.¹⁷

Modular Modern

Returning war veterans created a demand for new housing that was met by suburban expansion in all directions from St. Louis. Developments made viable through increased car ownership offered housing to fit all pocket-books and tastes. The single-story, horizontally-oriented residence with a carport and a surrounding yard known as the ranch house was the dwelling type of choice for the middle-class family. In the St. Louis region, Burton Duenke (1919-1994), whose name was synonymous with the postwar residential subdivision, realized early that money could be made by serving the middle-income population using mass production with its economies of scale to address the challenge of affordability. While large houses for the well-heeled were literally spacious in terms of site, area and volume, the "sense" or illusion of space in a structure that was physically much smaller than it seemed or felt became an indispensable feature of the modern house.¹⁸

The Washington University-trained husband and wife architects Ralph (1922 -) and Mary Jane (1926-2008) Fournier, collaborated with Duenke in the realization of his vision, designing five subdivisions in five years in the St. Louis area. The Fourniers' architecture was characterized by spaciousness. Ralph's designs borrowed space from the exterior through strategic window placement in each room. In addition, his open-plan houses optimized ceiling heights in the living areas and featured space-saving, sliding doors. Mary Jane worked on all aspects of project development and handled interior design in the all-important display houses that opened up the potential of subdivision life to the consumer.

The prototypical house designed for Ridgewood (1952), a 258-dwelling housing development located in the suburb of Crestwood and the first such venture for Duenke and the Fourniers, featured a slab-on-grade foundation with post and beam construction. [Figure 9] Prefabricated wall panels manufactured locally by Duenke's company, Modular Homes, were designed to ship within a 550-mile radius of St. Louis. The unique modular system with open, free-flowing floor plans offered the buyer economical construction and unprecedented flexibility, even as the basic module was repeated throughout the development.¹⁹

St. Louis was deemed progressive by the editor of *House and Home*, who in 1953 placed "conservative St. Louis buyers" at the forefront of a national trend towards modernist housing, observing that the Duenke/Fournier models would be implemented across the country by them and by others following suit.²⁰ Prefabrication made a further version of the ranch house available to St. Louisans in search of affordable single-family homes in the form of the Lustron house, a mass-produced steel structure that was trucked from the factory at Columbus, Ohio and assembled on the site. Some seventy of the roughly 2,500 Lustron houses produced in the United

States were built in the St. Louis area on both sides of the Mississippi River.²¹

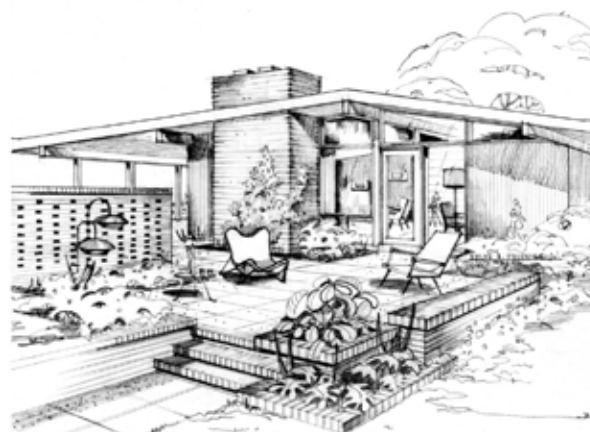


Figure 9: Burton Duenke, developer, Ralph and Mary Jane Fournier, architects, Ridgewood House, 1952

Drawing: Ralph Fournier; Image courtesy Maryville University

A novel modular wall system was introduced by Edouard Mutrux (1907-1999), working in partnership with William Bernoudy (1910-1988), for the interior and exterior of the house that he designed in 1950 for himself in a family enclave in Ladue. Demolished circa 2005, the Mutrux house featured walls of Cemesto, a fire-resistant board which the Celotex Corporation had introduced in 1937 for heat and sound insulation. Asbestos cement was applied to one or both sides of the panels which in Mutrux's house were then painted and mounted in wood frames.²² A notable, less aesthetically mediated application of Celotex panels can be found in the residential architecture of Isadore Shank in the house he designed in 1958 for Dr. and Mrs. IJ Flance on the grounds of Westwood County Club. Shank used structural insulation panels with exposed fir beams, which enhanced the solid look and feel of the house.

Experts on modular dome technology designed the Climatron at the Missouri Botanical Garden (opened 1960). The form of the Climatron encapsulated the institution's scientific mission and was readily associated with technological progress. [Figure 13] On axis with what was then the main gate and at the terminus of a formal water court, the rising dome, with its textured, surface geometry commanded the attention of the arriving visitor. The firm of Murphy and Mackey designed the Climatron, with Mackey heading the project and Synergetics, Inc. collaborating on the engineering design, which was based on a geodesic dome concept developed by R. Buckminster (Bucky) Fuller (1895-1983). Fuller had founded Synergetics, Inc. in 1954 with James (Fitz) Fitzgibbon (1915-1985). According to Fuller, the geodesic dome—executed with a grid of structural triangles over a sphere—was the most efficient way to enclose

space using minimal material.²³ The first application of the dome concept to a greenhouse, the Climatron enclosed a column-free space some seventy feet tall at its highest point and 125 feet in diameter. The dome was fashioned from triangular Plexiglass panels suspended from an aluminum frame and sealed by neoprene gaskets. This system pioneered the use of aluminum as a structural metal, a feat that earned Murphy and Mackey the 1961 RS Reynolds Memorial Prize for innovative use of aluminum.

High-rises for Public Housing

In the 1950s, as the downtown business core went into decline, efforts were made to implement redevelopment initiatives from the 1947 city plan drawn up by the architect and planner Harland Bartholomew. Plaza Square (1956-61), a complex that integrated six modern thirteen-story apartment blocks of limestone, brick and concrete with two historic churches on a four-block site, tested the premise that a blighted downtown precinct could be reinvented with modern, market-rate high-rise housing that would attract residents back to the urban core.²⁴ For the project, the newly formed HOK teamed up with Harris Armstrong. The unique color field of enamel paneling on the east and west walls of each of the towers was specified by Alexander Girard (1907-1993). Girard had worked with Eero Saarinen on two of modernism's iconic projects, the General Motors Technical Center in Detroit, Michigan (1948-56) and the Miller residence in Columbus, Indiana (1953-57).

On a fifty-seven-acre site northwest of downtown, the city of St. Louis erected public housing on a hitherto unprecedented scale in the US Pruitt-Igoe (1950-56), constituting an ensemble of flat-roofed, concrete slab high-rises faced with brick relieved by glazed galleries and metal sash windows. The architect Minoru Yamasaki (1912-1986) of Hellmuth, Yamasaki and Leinweber (who would design Lambert International Airport Terminal and later the World Trade Center in New York), drew his modernist urban planning inspiration from Le Corbusier, who had advocated slum clearance and a tabula rasa. High-density residential towers with good light and ventilation and communal amenities would be arranged on a landscaped "superblock," with automobile traffic restricted to the periphery. The development was intended to reinvigorate the urban environment and consisted of thirty-three eleven-story concrete slab towers, comprising Pruitt Homes (1,730 units), intended for black occupancy, and Igoe Homes (1,143 units), intended for whites.²⁵ When integration failed, Pruitt-Igoe transitioned to virtually all-black occupancy. With the implosion of the buildings from 1972 and 1976, Pruitt-Igoe came to associate St. Louis with a failed public housing experiment and, moreover, with the demise of European-style modernism itself. The 2011 documentary film di-

rected by Chad Freidrichs entitled *The Pruitt-Igoe Myth* challenges the conventional wisdom that attributes Pruitt-Igoe's demise to the self-destructive habits of its minority population and indeed to modern architecture itself. Rather, Freidrichs and scholars of Pruitt-Igoe point to large-scale disinvestment—economic, social, cultural—as population, wealth and jobs moved from the urban core to alternative business and residential centers in the adjacent counties.²⁶ Moreover, early deterioration of the buildings due to a curtailed construction budget was exacerbated in time by inadequate investment in maintenance of the physical plant.

Glass

From the late 1930s onward, innovative and extensive use of glass marked many a new building as modern. In St. Louis, Harris Armstrong featured glass block in the Shanley Orthodontic Clinic (1935) in Clayton [Figure 10] and the Grant Medical Clinic (1938) in the Central West End. While serving as a privacy screen, glass block produced suffused natural illumination that supplemented natural light from windows and made for an engaging visual field of fugitive light effects. In medical buildings, light and clarity telegraphed a transparent approach to medicine based on science. Glass blocks were used extensively in educational buildings as well, in keeping with emerging research into optimal lighting of classrooms. Murphy and Mackey's design for Bishop DuBourg High School, a large co-ed campus in South St. Louis for the Catholic Archdiocese, incorporated bands of glass block clerestory windows as the chief light source in a bilateral daylighting scheme.²⁷ [Figure 11]



**Figure 10: Harris Armstrong,
Shanley Orthodontic Clinic reception lobby, 1935
Courtesy Andrew Raimist**



**Figure 11: Murphy & Mackey,
DuBourg High School typical classroom, 1954
Theodore J. Wofford**



**Figure 12: Harris Armstrong, Magic Chef Building, 1947
Washington University Special Collections**

In 1947, Harris Armstrong designed a headquarters and display center for the American Stove Company (later Magic Chef). The building was praised for its strategic use of daylighting through bands of windows running the length of the north and south facades.²⁸ [Figure 12] Leveraging the building's site on a busy traffic intersection in South St. Louis, Armstrong embedded Magic Chef's marketing strategy—one that glamorized labor-saving, household appliances—into a modern, state of the art building with glass expanses that allowed the building to glow at night in a perpetual advertising cycle. The shopping experience unfolded in a display facility replete

with modern, vital forms including an artful play of biomorphic shapes by the sculptor Isamu Noguchi (1904-1988) on the ceiling of the entry lobby, which evoked a lunar landscape. The building exemplifies the commitment to craftsmanship in the period, nowhere more evident than in the soaring vertical plane of oversize, sand finish brick that constitutes the transverse north/south wall from which the office tower projects eastward.



**Figure 13: Murphy and Mackey, Climatron,
Missouri Botanical Garden, 1960
St. Louis Post-Dispatch**



**Figure 14: Olin Library, Washington University in St. Louis, 1961,
Murphy family papers**

Based on a square plan, Olin Library (constructed 1956-1961), is a five-story glass, limestone and granite structure which the architects, Murphy and Mackey, meticulously integrated into the Washington University site by staying below the height and general proportions of the prevailing collegiate Gothic structures, and by carrying through the campus' signature material—pink Missouri granite—in the facing. The transition to glass relieved the weight

of the masonry and accomplished a deft perceptual shift to the modern, as the building appeared to levitate atop Corbusian-style pilotis that took their diameter from the trunks of mature trees in the surrounding landscape. The canopy roof, which acted both as a promenade deck and a sunshade, mediated the impact of weather on the continuous glass wall on the ground level. [Figure 14] Visual continuity between the building's exterior and interior was brought about by this early large-scale application of double-glazed window panels.

Glass for Art's Sake

At mid-century, a number of St. Louis' most influential architectural firms adopted a team concept that involved architects and artists in a collaborative effort to produce a unified, comprehensive design and project a clear creative vision. This practice became well established on religious projects in particular, where liturgical objects were created by painters, sculptors, weavers and stained glass artists. The immediate postwar years saw an explosion in the use of stained glass, a field in which St. Louis was already known due to the operation in the city of one of the world's premier glass studios, named for its founder Emil Frei, Sr. (1869 – 1942). The studio, with origins in Munich glassmaking in the 19th century, responded to the modernist abstraction that swept through all forms of art and design in the 1920s and 30s, transitioning from representational imagery to more mannered, abstracted forms that often relied on symbolism to carry meaning.

Designed by Robert Harmon (1915-1999) and Emil Frei, Jr. (1896-1967), the 37-foot square window that frames the altar and occupies the entire chancel wall at St. Ann's Catholic Church in Normandy, Missouri exemplifies this modern style. Apart from its sheer size, the window's dominant attribute is the dynamism of the image, which is achieved by the interplay of curvilinear form and vibrant color. The elongated figure of Mary looking out toward the faithful in the pews is the one clear representational element among a field laden with symbols, such as the monumental cross centered over the altar. With this installation of stained glass behind the altar, the architect Joseph D. Murphy nodded to Gothic practice, which used the material to intensify light, color and line around the high altar. To avoid exposing the congregation to high luminosity and glare, Frei and Harmon invented an artistic form that integrated stained glass and painting. During the daytime, while the painted elements are cast in silhouette, natural light filters through the 10,000 fragments of colored glass to produce a richly chromatic, jewel-like effect. At night, or on gray days, when the red and blue translucencies read as black, artificial lighting on the interior highlights the opaque, painted passages of gold, silver and copper against the dark zones of the glass.²⁹ This innovative solution catapulted St. Ann's into the pages of professional and popular magazines alike. For example, in a color spread in 1952, *Time* magazine

noted the window's rare round-the-clock efficacy as a liturgical artifact.³⁰

Earlier, the architects Charles Nagel (1899 –1922) and Frederick Dunn had engaged the Frei Studio and Harmon to design an ensemble of windows flanking the nave of St. Mark's Episcopal Church in St. Louis Hills. Dedicated in 1939, St. Mark's is historically important as the first modernist sacred building in St. Louis. [Figure 15] Inspired by the social activism of Archbishop Scarlett (the Episcopal Diocese's progressive leader), the windows found a polemical edge with the inclusion of text and symbols that refer explicitly to social, economic and political concerns of the Depression, such as labor relations, war, greed and social inequality.³¹

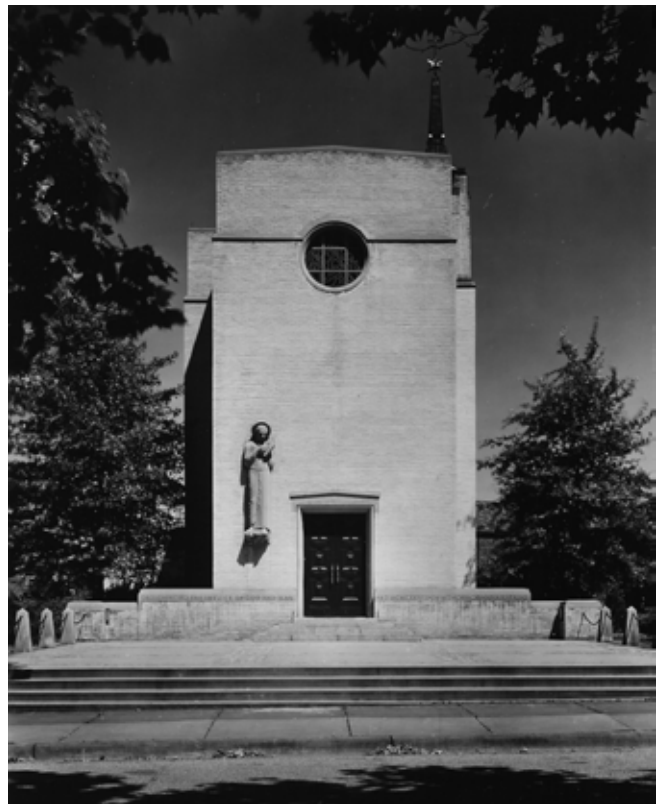


Figure 15: Nagel and Dunn, St. Mark's Episcopal Church, 1939
Courtesy of Quinta Scott



Figure 16: Dunn and Stinson, Lewis & Clark Branch Library, 1963, stained glass facade
Copyright © Andrew Raimist 2014

A signature secular application of stained glass happened also at the instigation of Frederick Dunn, this time in collaboration with Nolan Stinson, Jr. (1922-1977), for the Lewis and Clark Branch Library (1963) in North St. Louis County. Dunn inscribed local identity in the building, which was sited a few miles south of the confluence of the Mississippi and Missouri Rivers, where Meriwether Lewis and William Clark had set off in 1804 on their epic journey. Robert Harmon of the Frei Studio transformed the northern end of the main facade fronting Lewis and Clark Boulevard into a dazzling display of glass that integrated figurative representations of the historic protagonists with fields of saturated primary colors and textured panes of abstraction.³² [Figure 16] This modernist landmark was demolished by the St. Louis County Library in 2015 to make way for a new building.

Parabola City

In conclusion, I turn to the Gateway Arch—the centerpiece of the Jefferson National Expansion Memorial on the Mississippi riverfront and the indispensable symbol by which people everywhere identify St. Louis. Eero Saarinen's pitch-perfect, stainless steel expression of the times rises from a complementary landscape of biomorphic-shaped water features set in green space and designed by the landscape architect Dan Kiley (1912-2004). [Figure 17] Saarinen, in search of a form whose simplicity would render it simultaneously timeless and legible in the moment, started out with a parabolic concept in mind. A parabola is an open form with a central axis and arms diverging symmetrically on both sides from the vertex.

Saarinen was familiar with parabolic form since he had earlier worked with his father, Eliel, on the design of Kleinhans Music Hall in Buffalo, New York (1938-40), where the plan featured inverted parabolas connected through their bases by a sweeping lobby. When configured vertically, the parabola's impressive spanning capacity

and its constructability with up-to-date materials were also persuasive factors in Saarinen's choice. As built, the Gateway Arch is not a parabola, but a related form—a weighted catenary. A catenary is the curve assumed by a hanging chain with links that become progressively smaller towards the apex and are heavier at the feet. Le Corbusier's unbuilt proposal for the 1931 competition for the Palace of the Soviets in Moscow, which was widely publicized in the architectural press, seems likely to have influenced Saarinen's consideration of the form for the St. Louis riverfront, because the simplicity and visibility of the vertical parabola as the compositional anchor illustrated its potential for creating symbolism at urban scale.



Figure 17: Jefferson National Expansion Memorial, 1947-8.
Eero Saarinen, architect; Dan Kiley, landscape architect
Terrell Creative © Jefferson National Parks Association

The incidence of parabolic form in St. Louis in the post-war years continues to be striking and its imaginative applications continue to be exciting. The architects of these buildings embraced formal innovation using materials such as thin shell concrete and structural steel, even as brick was revitalized as a building material of choice. The result was a trove of unique, eye-catching

structures that attest to a spirit of inventiveness in the period. Because many of these historic structures are sadly gone, the loss of any one of those remaining should give us pause.

Endnotes

- 1 For a more comprehensive treatment of this topic, please refer to Mary Reid Brunstrom, *Four Decades of Modern Architecture in St. Louis, 1928 – 1968: An Expanded View*, In: Conradsen, David, and Genevieve Cortinovis. *St. Louis Modern*. With an essay and text by Mary Reid Brunstrom. St. Louis: Saint Louis Art Museum, 2015.
- 2 The former is associated with the Museum of Modern Art (MoMA) in New York, the latter with Bauhaus founder Walter Gropius, who after 1938 taught at the Harvard School of Design, Boston.
- 3 Goldhagen, Sarah Williams, *Coda: Reconceptualizing the Modern*, In: *Anxious Modernisms: Experimentation in Postwar Architectural Culture*, Goldhagen, Sarah Williams and Legault, Réjean, Eds. Canadian Center for Architecture, Montréal/Cambridge, MIT Press, 2000, 309.
- 4 See Eric Mumford, Ed, *Modern Architecture in St. Louis: Washington University and Postwar American Architecture*, Washington University School of Architecture, St. Louis, 2000.
- 5 James-Chakraborty, Kathleen, *In the Spirit of Our Age: Eric Mendelsohn's B'nai Amoona Synagogue*, Missouri Historical Society Press, 2000, 5.
- 6 Minor, Kristen, *Historic Context Statement/ Architectural trends, forms, materials and expression important in the St. Louis School of Modern Movement Architecture, c. 1945-1975, Thematic Survey of Modern Movement Non-Residential Architecture, 1945-1975*, in *St. Louis City, City of St. Louis Cultural Resources Office*, July 31, 2013, 92-3.
- 7 Heathcott, Joseph, *In the Nature of a Clinic: The Design of Early Public Housing in St. Louis*, *JSAH*. 2011, 70, 85-6.
- 8 Soren, Noelle, *Pappas House*, National Register of Historic Places Nomination Form, Department of the Interior, NPS, January 10, 1978, 1.
- 9 See Osmund Overby, William Adair Bernoudy, *Architect*, University of Missouri Press, Columbia, 1999.
- 10 See Kathleen, James-Chakraborty, *Moderate Modernism: Sacred Architecture in St. Louis & Its Suburbs*, In: *Modern Architecture in St. Louis*, 26-40.
- 11 *Westlake Builds Northland Shopping Center*. *St. Louis Daily Record*, January 1955, p 13.
- 12 *St. Louis' Terminal for Tomorrow*. *Aviation Age*, November 1952, pp 38-9.
- 13 *The New Lambert-St. Louis Air Terminal: The Theory and Criteria of its Design*. *St. Louis Construction Record*, 3 April 1956, p 11.
- 14 *Thin Shell Scallops Roof a Unique House of Worship*. *Building Construction*, December 1962, p 16.
- 15 *Creative Design in Contemporary Construction*. *St. Louis Construction Record*, 13 March 1962, p 6.
- 16 *Spool-shaped Planetarium for St. Louis*, *Architectural Forum*. 1963, 119, 95.
- 17 *Fruin-Colnon Starts Lindell Job*. *St. Louis Construction Record*, 13 September 1962, p 6.
- 18 See Sandy Isenstadt, *The Modern American House: Spaciousness and Middle-Class Identity*, Cambridge University Press, New York, 2006, 4-9.
- 19 See Jessica Senne, *Suburban Modernism: The Architecture and Interior Design of Ralph and Mary Jane Fournier*, Maryville University, St. Louis, 2014, 6.
- 20 *Is Public Taste Getting Ahead of Most Builders? House and Home*, February 1953, pp 106-114.
- 21 See Thomas T. Feters, *The Lustron House: The History of a Postwar Prefabricated Housing Experiment*, McFarland & Company, Publishers, Jefferson, N.C., 2002, 160-3, 168.
- 22 Overby, 76-7.
- 23 See Eric Mumford, *Climatron 50: Missouri Botanical Garden/A Celebration of 50 Years*, Missouri Botanical Garden, St. Louis, 2010, 22.
- 24 Bradley, Betsy H, *Historic Context Statement/St. Louis: The Gateway Years, 1940-1975*, 6.
- 25 Mumford, *Modern Architecture in St. Louis*, 49.
- 26 See Katherine G. Bristol, *The Pruitt-Igoe Myth*, *Journal of Architectural Education*. May, 1991, 44, no. 3, 163-171; and Joseph Heathcott, *Planning Note: Pruitt-Igoe and the Critique of Public Housing*, *Journal of the American Planning Association*. 2012, 78, no 4, 450-451.
- 27 Bishop DuBourg High School, St. Louis, Mo. Church Property Administration 19, October 1955, pp 161.
- 28 *Progress in St. Louis: The American Stove Company Puts Up An Enlightened Headquarters and Sales Display Building*. *Architectural Forum*. 1948, 89, 70-77.
- 29 Brunstrom, Mary Reid, *The Light Fantastic: Luminosity in Joseph D. Murphy's Architectural Renderings of Midcentury Modernist Catholic Churches in the American Midwest*, In: Berselli, S, Brunner, M, and Mondini, S, Eds, "Le jeu savant": *Light and Darkness in 20th Century Architecture*, Mendrisio Academy Press, Switzerland, 2014, 62.
- 30 *Inside-Out Window*. *TIME*, 15 December, 1952, pp 84-5.
- 31 See Kris Runberg Smith, *Reflecting an Era: Social Justice in the Windows of St. Mark's Episcopal Church Confluence* 6, no. 1, Fall/Winter 2014, 32-43.
- 32 Derrington, Lindsey, *The Lewis and Clark Branch Library: A Modern Masterwork Slated for Demolition*, *SAH Missouri Valley Chapter Newsletter*. 2014, XX no.1B, 1-4.

NEW CONTEXTS: PRESERVATION CHALLENGES OF MODERN ERA DESIGN

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Abstract

Modern designed resources bring a host of new challenges to historians, architects, landscape architects, engineers, communities, and other preservationists. To understand these challenges, new questions must be discussed and old standards debated. This paper poses many of these questions with supporting case studies, but it is up to the reader to contemplate and add to the discussion through individual experiences with research, collaboration, and preservation work on modern buildings and sites.

Discussion topics in this paper are organized into three general areas: strategies for documenting modern resources; adaptability, or maintaining their relevance in the face of changing 21st-century needs; and addressing the preservation and renewal of mid-century materials and assemblies.

Documentation and Eligibility

To document these resources, new contexts must be developed to address mid-20th-century trends and events like urban renewal and suburbanization. A new generation of architects needs to be identified and their works evaluated. The architectural vocabulary and nomenclature must be updated to account for styles and elements undreamed of in classical architecture. Beyond that, those who evaluate modern resources must grapple with the questions raised by the sheer number of modern buildings and landscapes.

How do we ensure the integrity of the National Register of Historic Places with so many potentially eligible buildings? Is the "fifty-year rule" in Criteria Consideration G still relevant? How do we separate the truly historic from the merely old?

The Urban Renewal movement of the 1950s and 1960s sought to remove blight from central cities in the United States under Title I of the Federal Housing Act of 1949,

entitled "Slum Clearance and Redevelopment." Under this act many downtowns were cleared of their old structures and the lands were sold to developers. These sites became urban plazas, office towers, and multi-family housing, or they remained undeveloped. The success of the movement was varied but today, close to fifty years later, we face a legacy of modern era buildings and parks that may now be considered historic and worthy of preservation. As the pendulum has swung towards growth within urban cores, these parks and buildings can become busy, important places. By recognizing their significance, preservation funds can help support their redevelopment.

Riverview in Toledo is one example of the Urban Renewal movement for which Quinn Evans Architects submitted a National Register of Historic Places Registration Form including Criteria Consideration G: "...less than fifty years old or achieving significance within the past fifty years." The period of significance for these two office towers, parking garage and plaza begins with the initial construction in 1969. It ends in 1977, with the completion of a new master plan for the downtown that represented the final abandonment of the Riverview Urban Renewal Plan.

Riverview, including the Fiberglass Tower, Levis Square, and the Riverview Parking Garage, is exceptionally significant at the local level in Toledo as the centerpiece and most fully realized portion of the highest profile downtown urban renewal project in Toledo (Criteria A). Although, like most urban renewal projects of the 1950s and 1960s, Riverview never lived up to its early promise, the construction of the tower, plaza, and garage was viewed as the "focal point" of an urban renewal project that would change the destiny of Toledo's downtown core, and [those buildings] were the only elements of that place that were completed much as they had been planned by architect IM Pei in the early 1960s (Criteria Consideration G).¹ [Figures 1, 2, 3]

Lafayette Park in Detroit is one of the best and most successful examples of a residential urban renewal development of the mid-20th century in the nation. The superblock has been nominated but not yet approved as a National Historic Landmark. The criteria used includes its place in the historic context of urban renewal and its significance as the collaboration between one of the 20th century's most influential modern architects—Lud-



Figure 1: Construction begins on Fiberglass Tower and Plaza, Toledo, Ohio



Figure 2: Circa 1970, recently completed Fiberglass Tower, parking garage and Levis Square, Toledo, Ohio

wig Mies van der Rohe—developer Herbert Greenwald, planner Ludwig Hilberseimer and landscape architect Alfred Caldwell. The period of significance (1956 to 1967) meets the fifty-year rule. Additionally, the reasons stated above, as well as the integrity of the site, support its significance which few, if any, challenge. Lafayette Park is an example of modern architecture that is truly historic rather than just old. [Figures 4, 5, 6]

And yet, while it may be time to celebrate and preserve modern era designs, should there be recognition of the buildings, communities, and history that was leveled in the name of Urban Renewal to create these sites?



Figure 3: Construction begins on Fiberglass Tower and Levis Square in 2012, Toledo, Ohio. QEA, 2012

Brutalism is another architectural style that is on the fifty-year cusp and one which elicits strong emotions from preservationists and the general public. The J. Edgar Hoover Federal Bureau of Investigation Building on Pennsylvania Avenue in Washington, DC is an example of a project whose eligibility to the National Register has recently been debated and determined to be not eligible. The FBI Building was designed by the Chicago-based firm CF Murphy Associates and constructed in several phases beginning in 1967. The building was dedicated in 1975, although some areas were not entirely completed until 1977. The building was almost immediately a failure on a number of levels. The completion of the building coincided with a publicly contentious period in the history of the FBI in the early 1970s, and the building became a symbol to many of the FBI's declining reputation during this period. Its final design met with harsh criticism from most contemporaries. Many in the design community viewed it as a conglomeration of disparate parts and opinions, a building “designed by committee” and ultimately realized in a form far from what was originally intended for this site in terms of planning principles and design ide-



Figure 4: Aerial view of Lafayette Park, Detroit, Michigan. Housing was intentionally concentrated in residential high-rise towers to allow for shared open park space

als. The building's Brutalist style did not find favor with the general public, which viewed it as cold and forbidding. Finally, the building was essentially obsolete as soon as it was completed. As the FBI continued to grow as an agency throughout the following decades, many of the key functions around which the building had been designed and constructed, including record storage, the laboratory, and the fingerprint division, could not operate and grow within the building and were eventually transferred to other facilities.² [Figures 7, 8]



Figure 5: Newly constructed townhomes at Lafayette Housing Park, Detroit, Michigan



Figure 6: The formerly thriving Black Bottom neighborhood is razed to create the Superblock for Lafayette Park, Detroit, Michigan



Figure 7: View of exterior of FBI Building, Washington, DC. QEA, 2013



Figure 8: Courtyard of FBI Building, Washington, DC. QEA, 2013

Adaptability

Architects are also facing new conundrums as buildings of the modern era begin to reach their functional limits. The exciting and iconic designs that drew praise or controversy at their completion may no longer function well in the context of 21st-century programming and technological needs. How do stakeholders reach a consensus that reconciles the two—or can they even do so?

Quinn Evans Architects prepared a feasibility study for re-use of the Lower Trout Lake Bath House buildings at Bald Mountain State Recreation Area in Lake Orion, Michigan. This small collection of five structures was designed by noted architect Gunnar Birkerts in 1964, completed in 1969, and listed on the National Register in 2013. Inspired by the National Park Service Mission 66 building program, the concession building and bath houses served the visitors who came to sunbathe and swim in the lake every weekend. In the 1970s, the area was packed towel to towel at the beach, along with long lines of cars waiting to get a parking space. In the 1980s and 1990s, use started to decline; visitors brought their own snacks and sunbathing was no longer as popular. Today, the concession building is closed, the pump house is used for boat rentals, and the bath houses are still open but are subject to vandalism. [Figures 9, 10, 11, 12]



Figure 9: Aerial view of Lower Trout Lake Bath House Complex, Lake Orion, Michigan. The complex consists of two circular bath houses with open air changing areas and showers and enclosed toilets. A large concession building is closest to the water and there is a small pump house, now unused. A contact station is located close to the park entrance



Figure 10: View from across the lake of Lower Trout Lake Bath House Complex, Lake Orion, Michigan. Note the distinctive conical roofs, stripped of original copper by vandals, and the circular concrete walls. QEA, 2013



Figure 11: View of bath house with entry spiral, open shower in foreground, enclosed toilet rooms and open changing area. QEA, 2013



Figure 12: View of the changing area with concrete stools and concrete partitions, behind which are individual changing spaces with smaller concrete cylinder stools. QEA, 2013

The strength of the design idea expressed in the circular forms and conical roofs does not lend itself easily to expansion, nor does the strength of the materials lend itself easily to adaptation. How much change is acceptable to make significant modern buildings such as these bath houses relevant to today's needs? If they cannot be altered so that they have a new functional role, what is the responsibility to maintain them as an architectural museum piece, saving them for some future role we cannot imagine today?

Materials and Assemblies

New materials and assemblies developed in the modern era require new approaches and solutions in their preservation and restoration. How do we "green" buildings designed in an era of cheap energy? How can we sensitively replace materials that may have been experimental in nature (and therefore no longer available) or were designed for planned obsolescence? How do we correct design flaws while still respecting the spirit of the original?

McGregor Memorial Conference Center was built in 1957-58 on the campus of Wayne State University in Detroit, Michigan. It is an iconic building, widely recognized as a masterpiece by Minoru Yamasaki, one of America's most renowned modern architects. The McGregor Center was Yamasaki's first executed design to incorporate a reflecting pool and sculpture garden, elements that would later become characteristic of his work.

Although the McGregor Center reflecting pool was never removed, it suffered severe losses to its integrity over the years due to structural failures and incremental changes. Perennial leaking left it empty for decades, while the introduction of shrubs around the perimeter blocked the site's free-flowing pedestrian circulation. Dull, brown pavers replaced the once-brilliant white, marble-chip surface of the three islands, and the reflecting pool in general had ceased to function as a gathering place for the campus and local community.

In 2011, Wayne State University embarked on a restoration of the reflecting pool and sculpture gardens, hiring Quinn Evans Architects to lead the work. The site was laser scanned to provide important information for the reconstruction, in particular to make sure the boulders were replaced in exactly the same location and orientation. As work progressed, it became clear that while typically first priority is given to the preservation of original material, in this case the original material was so problematic that salvage was not possible. The original concrete mix for the pools was so poor that it was not surprising that the pools had always been a problem.

At this point, the foresight of having a laser scan more than paid for itself as the preservation work became a complete reconstruction. The project no longer had anything to do with the retention of original materials, but instead with the retention or exact recreation of the design intent, the shape, the colors, and the original aesthetic of the plaza. Contemporary concrete mixes and reinforcing and pool technology recreated the pools. The islands and walks were built with exposed aggregate that matched the original in color and texture but was embedded in the paving so that it would not spill into the pools. The completed project looks on the surface like the original but the guts are all new, designed to better withstand the test of time than the original materials. [Figures 13, 14, 15]



Figure 13: McGregor Center, Detroit, Michigan. Restored pools and sculpture garden. Jim Haefner Photography, 2013



Figure 14: McGregor Center, Detroit, Michigan. Prior to restoration, pools had been coated light blue and brown pavers installed on the islands and surrounding walks. QEA, 2011

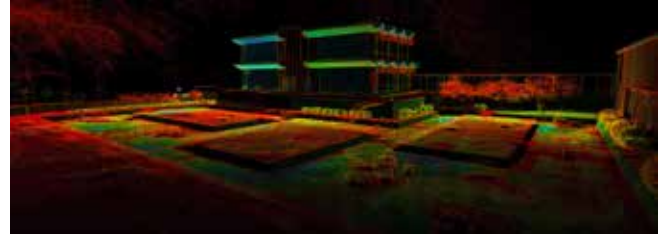


Figure 15: McGregor Center, Detroit, Michigan. Laser scan of site prior to restoration documented the location and orientation of the boulders that had been selected and sited by Yamasaki

The Knapps Centre (1938) in Lansing, Michigan is another Quinn Evans Architects project. At this site, it was deemed that the exterior metal cladding panels could not be salvaged and should be replicated and attached with a contemporary system. To create the Streamline Art Moderne design, the exterior of the Knapp's Centre was originally constructed of ribbons of porcelain-finished metal panels and glass block windows, a new type of construction at the time. However, as it was built with fasteners welded to the panels and then embedded in concrete formed in the panels, the system is not one that can be taken apart, restored, and reassembled. Water infiltration in the wall led to rusting of the panels, fasteners, and embedded lath in the concrete. The preservation decision for this building was to replace this very early experimental rain screen system with a contemporary system which, while very different in how it was constructed, could mimic the original exterior appearance. [Figure 16]



Figure 16: Knapp's Centre, Lansing, Michigan, Restored exterior with new porcelain-finished metal panels and glass block
Jim Haefner Photography, 2014

Where is the line drawn between salvage and restoration of original materials in modern era structures and the total recreation to match the original aesthetic with materials that have shown to perform better than the originals? Are the experimental materials what make the design significant? But if it is a failed experiment, is the aesthetic to be preserved as first built or preserved to show the trial and failure?

Conclusion

The goal of this paper has been to raise questions, not answer them. As our preservation profession develops a greater body of work related to modern era buildings, we have more opportunities to explore the unique context and debate eligibility, adaptability, and material conservation of these resources. We also have more opportunities to consider additional questions in order to continue the conversation. For example, as compared to 18th- or 19th-century structures, we know more about the modern era designers, have more published documentation about the resources and recognize many of the sites from our own lifetimes. Because of this, are we less objective in the determination of what is really significant? Or, because they are more recent and often more experimental in design, do we need to be more vigilant about saving these structures?

Endnotes

- 1 National Register of Historic Places Registration Form, Prepared January 2012, Quinn Evans Architects.
- 2 Draft DC State Historic Preservation Office Determination of Eligibility Form, Prepared 2014, Quinn Evans Architects.

THE SPACE AGE IN ARCHITECTURE

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Abstract

The influence of the machine age on architecture and design is well documented, as seen in the streamlining of Art Deco and modernist styles. By contrast, the Space Age is typically understood as more of a cliché or stylistic fad rather than an academic architectural influence. While there was a visual progression from the streamlined electric locomotives of the 1930s through the Avanti automobile of the 1960s, it did not continue into Skylab of the 1970s, although all of these were designed by Raymond Loewy. A stronger influence can be found in the architectural use of materials originally developed for aircraft and space flight than in the proliferation of *Jetsons*-type housing designs. The National Aeronautics and Space Administration (NASA) and the Defense Advanced Research Projects Agency (DARPA) explicitly encouraged the spinoff of innovations and materials developed for advanced weaponry of the Atomic Age and later space exploration for more humble commercial uses. Mylar wall coverings, foam insulation, solar panels and fire-resistant materials all had origins in space-aged uses. There is a direct line from the titanium skins used in the A-12 and SR-71 supersonic spy planes to Frank Gehry's titanium-skinned Guggenheim Bilbao.

One of the benefits of the space race would be that the vast sums of money spent on research would lead to the development of new technologies and services: products necessary to complete the goal of an actual lunar landing would also lead to improvements in the ordinary lives of all Americans. Many exotic metal alloys and synthetic materials were developed for the space program or evolved from aeronautical uses, and found their way into popular markets including the building arts. Interestingly, certain natural materials or older technologies that were adapted by the space program's unique needs found new applications in architecture as well.

While today we may associate many of the resulting materials with the Space Age, they are more accurately viewed as outgrowths of earlier 20th-century developments. Rapid progress in material sciences and

engineering was driven on all sides by the immediate demands of World War II. Necessity was frequently the "mother of invention" for many of the innovations that ultimately found their way into architectural uses during this period. To a large degree, the many technological advances made during the Space Age can be seen as an indirect benefit of the global conflagrations that devastated the planet during the 1930s and 1940s. This paper will explore these evolutions and present several relevant case studies in which the authors were tasked with understanding the deterioration of and ultimately conserving or restoring these modern materials.

Art Deco Design to Space Age Style: An Evolutionary History

Aircraft design in the late 1920s and the 1930s became more aerodynamic and made use of advancing technologies to increase speed and reduce drag. Industrial designers were heavily influenced by the new streamlined aircraft design: cylindrical forms and long horizontal windows, horizontal lines and curves—all conveying motion and speed—were successfully scaled down for use in locomotives and automobiles. [Figure 1] This look was in turn incorporated into the design and manufacture of consumer goods, from toasters, clocks and radios to telephones and furniture; the possibilities were endless. Leading innovators like Buckminster Fuller gave us futuristic designs like the Dymaxion car, the Dymaxion house and the geodesic dome during this period.



Figure 1: Raymond Loewy standing on one of his streamlined designs, the Pennsylvania Railroad's S1 steam locomotive. (Credit: Box 190 , Raymond Loewy Papers, Manuscript Division, Library of Congress, Washington, D.C.)

Post-World War II America was a period of tremendous optimism. The country was experiencing vigorous economic growth and a baby boom and witnessed great advances in science and technology. By the beginning of the 1950s, factories had converted back to the manufacture of consumer goods from war production. With the growing car culture of southern California and businesses trying to attract the attention of passing motorists, a new style of vernacular roadside architecture developed appearing as drive-ins, diners, bowling alleys and signage of all types.

A new design featuring aerodynamic elements, such as upswept and cantilevered rooflines, was emerging. Geometric, boomerang, amoebic, starburst and parabolic shapes came to characterize this style, as did the use of large expanses of glass, bright colors, neon lights and plastic paneling. Googie reflected the optimism of the time, and how society was embracing technology and science and moving forward into the future, while at the same time they were remaining accessible to the middle class. Though not considered seriously as an architectural movement, Googie design represents a lighthearted and whimsical aesthetic that helped to launch the Space Age style that ultimately grew out of it. [Figure 2]



Figure 2: Norms Coffee Shop in Los Angeles, designed in 1956 by architects Louis Armet and Eldon Davis. (Credit: Photo courtesy of Hunter Kerhart/L.A. Conservancy. Originally appeared in [L.A. Conservancy Fights to Preserve Googie Design at the Embattled Norms Restaurant](#) on March 4, 2015)

The beginning of the Space Age can be marked by the Soviet Union launching the satellite Sputnik I in 1957 and the subsequent decision by the US not to be surpassed by the Soviets. The impact on popular culture was immediate and pervasive. In television and film, *The Jetsons*, 2001: A Space Odyssey and *Barbarella* perpetuated the Googie visual style combined with space race themes. The 1960s brought increasing momentum in the space race and, with it, increasingly futuristic design employing new materials and experimenting with new shapes, masses and volumes. While Googie began as a fanciful marketing concept, the futuristic designs of the 1960s became more purposeful, studied and academic. World Fairs have always been a showcase of innovation, technology, science and culture, and this was exemplified in the pavilion architecture and the use of modern building materials to create new forms: the Atomium at the 1958 World's Fair in Belgium, the Space Needle at the 1962 Seattle World's Fair, the Tent of Tomorrow and the United States Space Park at the 1964 New York World's Fair and Buckminster Fuller's geodesic dome at Expo '67 in Montreal. Attractions at Disneyland even embraced the Space Age movement and futurism with Tomorrowland (introduced 1955) and the Monsanto House of the Future (built 1957).

The Space Age eventually inspired higher forms of architecture. Oscar Niemeyer's designs for the new civic buildings for Brasília included some of his most iconic works—the National Congress and the Cathedral of Brasília. Viljo Revell's design for the 1965 Toronto City Hall features two curved towers with a saucer-shaped council chamber in between. Even Frank Lloyd Wright's design for the Annunciation Greek Orthodox Church in Wauwatosa, Wisconsin was clearly influenced by a flying saucer. Appropriately, the stylistic influence of technology and flight is particularly evident in airport design; examples include the 1961 Theme Building at LAX, Eero

Saarinen's Washington Dulles Airport (completed 1963), and the former TWA flight center at JFK in New York (constructed 1962). [Figure 3] Saarinen's work includes numerous other examples of modern futuristic design: the MIT Chapel, in Cambridge, Massachusetts (1955); North Christian Church, in Columbus, Indiana (1964); and the Gateway Arch, in St. Louis, Missouri (1965).



Figure 3: TWA Flight Center, JFK Airport, NY,
designed by Eero Saarinen and completed in 1962.
(Credit: www.essential-architecture.com)

Modern Materials and Modern Design

Important elements of modern materials science are a product of the space race and the government's desire to make these advancements transferable to the development of commercial products and services for the public. These developments have been applied to numerous fields: transportation, communications, medicine, natural resources, energy and architecture. The understanding and engineering of lightweight metals and other materials that made space exploration possible also allowed these materials to be effectively appropriated into building construction materials.

It would be misleading to suggest that all these metals and materials were developed solely for the space race. Many, such as aluminum alloys and fiber-reinforced resins, had been developed and were already in use in aircraft and automobile industries earlier in the 20th century. This transfer of use progressed and increased during the space race, particularly as other materials such as spray polyurethane foam, Mylar and Tedlar—either developed for military and space uses or significantly improved for this purpose—became widely available to architects and consumers. [Figure 4] It was the cachet of the Space Age that made the selection and use of these materials a design goal as well as an advancement in technology.



Figure 4: Mylar wall covering offered in the Mirror Magic II line
by the General Tire & Rubber Company, Akron, OH.
This material is a spinoff from the space programs.
(Credit: NASA Spinoff 1978)

The most notable advances were seen in the development and proliferation of aluminum alloys. The development of aluminum alloys was closely tied to the development of aeronautics, as the earliest commercial uses of the metal arose to replace airframes that had previously been made of fabric or wood. The invention of the Hall-Héroult process in the 1880s had dramatically reduced the price of aluminum refining; before that development, it was priced higher than gold. Duralumin, an alloy of aluminum with copper added, had been developed in 1903 by German metallurgist Alfred Wilm. The addition of copper allowed the material to become stronger and more ductile, but created corrosion problems especially in salt water environments. The United States Navy funded the development of Alclad, which consisted of duralumin with a pure aluminum coating to protect the alloy from corrosion. Starting in the 1930s, it began to be introduced in architecture and was used extensively in the Department of Justice building in Washington, DC (built 1930 to 1932) primarily as a decorative metal used in the artistic night doors and railings as well as the utilitarian windows and personnel doors.

The Saturn V rocket (1966-1973) used aluminum alloys extensively in its construction. A complete three-stage Saturn V topped by an Apollo payload stood 102 meters tall, was 10.1 meters in diameter, and weighed 3,038,500 kg at lift off. [Figure 5] The incredible stresses it had to withstand during operation were overcome with various aluminum alloys in both sheets and extrusions, including an aluminum milled plate with an integral ortho-grid pattern. Forms of alloys 2014 T6, 2219 T87 and 7075 T6 were used, with each alloy assigned to the component and function according to weldability, strength and weight. [Figure 5]

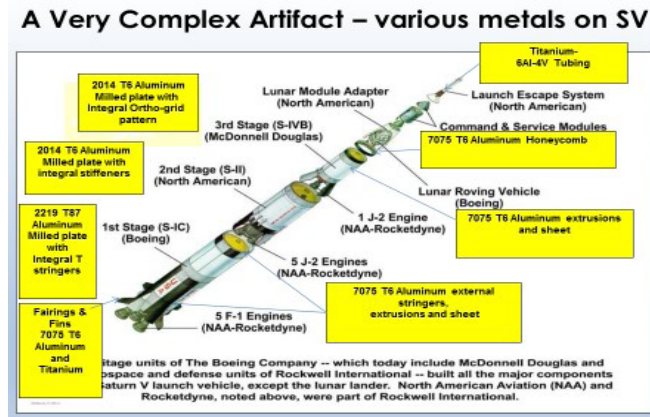


Figure 5: Various aluminum and titanium alloys present on the Saturn V rocket.
(Credit: NASA)

Some of these same alloys, such as 7075, are now often used in transport applications, including marine, automotive and aviation, due to their high strength-to-weight ratio. They also have architectural and engineering applications when high strength and light weight are required. Aluminum has a weight 1/3 that of the same volume of steel, copper or brass. The performance characteristics of some alloys exceed the strength of some structural steels. Everything from baseball bats to windows, electrical wiring, doors, siding and roofing are made from the various alloys of aluminum. Building construction products account for almost 1/3 of the use of aluminum.

Titanium is another low-density metal (60% the density of steel) and can be strengthened by alloying it to suit various purposes, including the bold architectural statements of Frank Gehry. Titanium has an extremely low rate of thermal expansion and has excellent strength-to-weight properties.

Other materials that were invented in the 1930s, such as polyethylene, were also transferred from military and flight use in WWII before becoming ubiquitous in the building world. Tyvek house wrap grew out of the invention of polyethylene. It was first a top secret material used as a coaxial cable insulator in WWII for ra-

dar antennas before being developed into a variety of commercially available products as a fiber in the 1950s. Closed cell polyurethane spray foam was developed for aircraft and military use in the 1940s and was used extensively as an insulator for spacecraft into the 1970s, when it was introduced for building and auto insulation.

Even some older technologies got a boost from the Space Age. When engineers were looking for means of strengthening and waterproofing the silica tiles used in the thermal protection system (TPS) of the Space Shuttle Orbiters, they turned to tetraethyl orthosilicate (TEOS), which had been discovered in the early 19th century and proposed as a stone strengthener early in the 20th century. It only began to be generally used for stone conservation after it was patented for use on the Space Shuttle in the late 1970s.

Although not a modern material at all, cork was used extensively as an insulator on the Apollo Command/Service/Lunar Module (CSLM) and many other locations of the Saturn V rocket, to the point that engineers were concerned that the world's supply of cork would soon be depleted for use in space travel! Fortunately, this did not happen, although its use as a sealant for wine bottles is no longer ubiquitous. The material has found other uses as laminate flooring, readily available at home improvement stores.

All of these developments shared a common history regarding their adaption into the building trades: innovation for military, flight and eventually space use first and then commercial application. We will now look at some of the treatments we have researched and performed on spacecraft that used these materials and present lessons that can be applicable to architectural preservation. Some of these materials, such as spray polyurethane foam insulation, are unlikely to be preserved in buildings, but the information gathered during these treatments can help in understanding deterioration within an architectural context even if replacement is the ultimate goal.



Figure 6: Saturn V rocket at Johnson Space Center, Houston, TX prior to conservation.
(Credit: Joseph Sembrat, Conservation Solutions, Inc., 2004)

Case Histories: Conservation of Space Age Materials

Just as NASA and DARPA encouraged the spinoff of innovations and materials technology transfer from their weaponry and space programs for commercial uses in the second half of the 20th century, conservators have used a similar technology transfer from the aerospace, corrosion engineering and coating industries to better understand the deterioration processes and the means and methods available to treat many of the iconic technological wonders of the Space Age.

The authors have unique experience assessing, studying, testing, researching and conserving several significant Space Age artifacts including Space Shuttles, Saturn V Rockets, Skylab, an A-12 spy plane and a Corona spy satellite. Through this they have gained knowledge on the preservation of these exotic materials that can influence the larger sphere of the use of these materials in architecture.

Aluminum

As cited earlier, the Saturn V rocket was built almost entirely of aluminum. Interestingly, Stage I (S-IC) of the rocket fired for just 168 seconds before being jettisoned and dumped into the Atlantic Ocean. The other two components of the launch vehicle experienced similarly short service lives and none of the three stages were ever intended to be recovered and reused. In spite of its disposability, chemical surface treatments to the aluminum and durable protective coatings were used during the manufacture of the various stages that have proven effective at preserving much of the historic aluminum on the two Saturn V rockets our firm treated, even after being exposed to the outdoors for more than thirty years. [Figure 6] Typically the majority of the aluminum elements were first anodized and then coated with Koropon, a chromium-based epoxy primer, before finish painting—all which would have been performed at the fabrication plant where the various components of the rocket were made.

Architectural applications that the authors have studied or treated include the doors and windows at the US Department of Justice, mentioned earlier, and the original American Airways entrance at Meacham Field in Fort Worth, Texas. These contemporary structures were each constructed circa 1933-1934. The aluminum elements were each fabricated from duralumin castings and/or Alclad sheets with pure aluminum facings that remained stable if not disturbed by aggressive cleaning. In the case of the American Airways entrance, the surface appeared to have been originally treated by a metal finishing process called “deplating” or Aluminite. These

processes resulted in the creation of a dark, stable layer of corrosion which was evident in the historic images that were provided by the client. Selective use of metal brighteners and carbon dioxide pellet blasting (CO₂) were found to be effective at removing soiling and loose corrosion without disturbing the original finish. [Figure 7]



Figure 7: American Airways Hangar doors.
(Credit: Joseph Sembrat, Conservation Solutions, Inc., 2014)

Stainless Steel

Like bronze or brass, which are generic terms for copper alloys that cover a broad range of metal combinations with differing characteristics, the term stainless steel is used to describe a range of alloys that all include some iron but can have widely varying properties and greater or lesser degrees of corrosion resistance. Used extensively in the F-1 and J-2 engines of the Saturn V rockets, types 304 and 316 stainless steel have proven stable and resistant to corrosion in normal terrestrial environments but have fared less well after decades of being submersed in salt-water. Typically, alloys like 304 and 306, more commonly used in commercial architectural settings, are naturally much less corrosion-resistant than 316.

It is important to note that improper handling can lead to corrosion in even nominally stable alloys. Stainless fab-

rications have been seen to develop extensive rust staining after exposure to the outdoor environment. This can be caused by contamination of the metals with iron filings contaminating the stainless during other work at the fabrication plant. Even in an ideal fabrication workshop, it is very difficult to isolate other work from that on stainless steel. Contamination from fine dusts of filings from the grinding and finishing of iron and mild steel is a common problem. If not removed by final brush blasting or other methods, the small bits of iron will rapidly corrode from galvanic action when exposed to moisture in an outdoor environment. Even normal fabrication methods of bending or welding can change the homogenous character of a stainless alloy, allowing corrosion through internally-induced galvanic reactions.

A recently installed work of public art on a bridge in Palm Beach Gardens, Florida developed extensive rust and corrosion shortly after installation, despite being fabricated entirely of stainless steel. Rust rapidly developed on posts and on the spring shapes at the joints and elsewhere. Analysis showed that this could be tied to the use of less stable alloys (304 and 306 instead of 316L), disturbance of the corrosion resistance from heating from welding during fabrication and installation, exposure to the marine environment of the seaside location and, most importantly, the lack of a passivation treatment on the finished stainless steel to remove iron fragments to prevent rusting.

Titanium

In researching the preservation of the Central Intelligence Agency A-12 spy plane located at its headquarters in Langley, Virginia, the authors encountered the following oddities associated with the preservation of titanium. The metal was initially refined in the early 19th century but it was not in common use due to the scarcity of sources until the third quarter of the 20th century. Although titanium is thought to be an indestructible material, it was found that the metal exhibits extreme sensitivity to contaminants such as chlorine, fluorine and cadmium. Even the cadmium plating on hand tools that comes into contact with the fasteners on the A-12 has been known to cause failure after exposure to heat. During the fabrication of the A-12 aircraft, it was discovered that the chlorine-based ink of a Pentel marker used to layout the titanium sheets had etched through the surface like an acid. The Skunk Works team also learned after much frustration that during the summer months when the Los Angeles water was heavily chlorinated to kill algae, it had caused the spot welds to fail on the titanium panels. All tools, chemicals and coatings that come in contact with the metal must be carefully assessed to ensure that they do not contain materials that could corrode or damage this susceptible metal. These findings will become applicable to architectural preservation in the future as there is no body of literature on titanium care in architectural practice and the like-

lihood of inappropriate treatments of titanium-skinned buildings is potentially high. [Figure 8]



Figure 8: A12 spy plane.

(Credit: CIA, <https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/a-12/Archangel-2ndEdition-2Feb12.pdf>, 2012)

Polyurethane Spray Foam

Early attempts to provide adequate insulation to prevent freezing of the cryogenic fuels used to power the Stage II (S-II) of the Saturn V rocket had included the use of polyurethane foam filled phenolic resin honeycomb which was then encased in a thin layer of Tedlar. The Tedlar facing mirrors a typical installation of sprayed-on closed cell polyurethane foam in building construction in which it is applied to a flat roof or walls prior to application of a waterproof membrane. In attempting to preserve both the Tedlar skin and its foam substrate of the Saturn V rocket on display at the US Space and Rocket Center in Huntsville, Alabama, the authors found that, after thirty-five years of outdoor exposure, the foam actually had become fully saturated from water through infiltration and condensation. Substantial and active bio-growth was found in areas where the Tedlar was removed. Weeks of tented drying augmented with forced hot air were not fully successful at removing all of this entrapped moisture, which migrated within and between the cells. Weep holes were left at low points on the rocket, from which water was found to continue to drip long after the artifact had been moved within a protective building.

Later attempts to provide adequate insulation of the Stage II (S-II) cryogenic fuel resulted in the use of spray-on polyurethane foam which was applied on a type of upright rotisserie, which was then tooled down to the appropriate thickness. The outer surface of the foam was then protected using a compatible coating system. The authors were tasked with conserving a Saturn V rocket located at the Johnson Space Center in Houston, Texas that had this type of external insulation system. Thirty years of exposure to the harsh Houston environment took its toll on the entire rocket, especially to

the UV sensitive polyurethane foam insulation. Although the foam product is touted as being "closed cell" and not subject to water uptake, solar gain experienced by the hot Houston sun can actually force moisture into the cell structure causing it to saturate. It was unfortunate that foam located on the upper areas of this stage were so heavily deteriorated and beyond saving that its removal and replacement with new urethane sheets was necessary. [Figure 9]

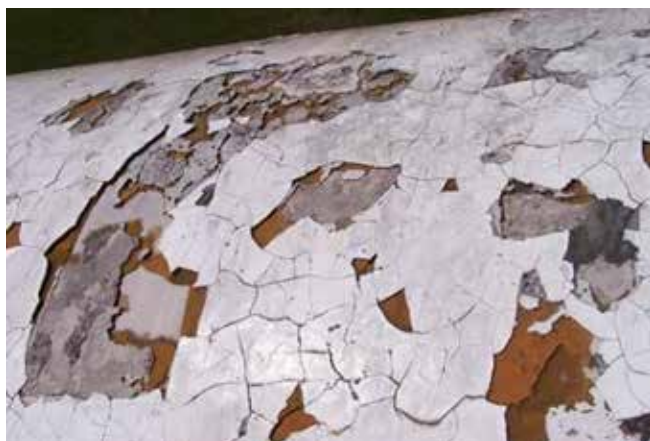


Figure 9: Heavily deteriorated polyurethane foam from Saturn V rocket.

(Credit: Joseph Sembrat, Conservation Solutions, Inc., 2004)

While it is unlikely that current closed cell polyurethane foam insulated roofs will be preserved with the same level of sensitivity as the foam of a rocket artifact, our findings are cautionary. Water may be entering and may become entrapped within these systems; this may express itself in deterioration of roof and wall structures below, even without direct evidence of failures of the membrane. Increased humidity, bio-growth and associated health issues may result from a condition not thought to be a concern with sprayed-on foam.

TEOS

Tetraethoxysilane (TEOS), also known as ethyl silicate, has an interesting use that bridges the preservation of both architecture and space artifacts. Synthesized in 1824, it was suggested for use in the 1860s as a stone consolidant for the houses of Parliament in London, although debate about its efficacy in general and on which materials continued over the next century. Serious testing and usage of TEOS on building stones began in earnest in the 1960s and 1970s. As TEOS' role as a legitimate masonry conservation product became solidified, alternate uses were still being developed concurrently. In 1980, NASA engineers applied for a patent to use tetraethyl orthosilicate as a densifier for porous refractory substrates. This application was used to great effect on the Space Shuttle Orbiters, in which aluminum space frames are faced with glass fiber mats (on upper surfaces) or ceramic tiles

(on lower faces) to resist extreme heat during reentry. Each custom fitted tile was provided with an injection port so that it could be redensified with TEOS as part of reconditioning between missions. This represents one of the most compelling examples of cross-industry pollination, whereby the same compounds that have proven so useful in the preservation of historic masonry were concurrently used to great effect to further space exploration. [Figure 10]



Figure 10: Space shuttle HRSI tile. (Credit: Joseph Sembrat, Conservation Solutions, Inc., 2004)

Hydrophobic penetrating consolidants that are now used to treat decaying stone or masonry were also developed to treat Reusable Surface Insulation (RSI) tiles that required rewaterproofing prior to each mission since the waterproofing compounds degrade at temperatures exceeding 1,050°F. Failure to rewaterproof RSI tiles could result in increased weight (from absorbed water) or tile damage. The initial damage could be caused by the destructive expansion of absorbed water freezing. During reentry, the absorbed water would convert to steam and complete the failure of the tile by loss of the de-waterproofed region previously fractured.

The authors were fortunate to participate in the preparation of the Atlantis Space Shuttle Orbiter for static display at the Kennedy Space Center. Careful inspection of the heat tiles showed a history of numerous repairs

carried out over the four decades of use. The maintenance manual allowed repairs of up to 50% of the surface of any tile using bulked ethyl silicate before it had to be replaced with a custom made replica. A curatorial decision was made during installation of the Atlantis within the museum to abandon this method in favor of the use of bulked methyl-methacrylate and standard conservation repairs. Although reversible, these effectively confirmed that the shuttle would never fly again.

As was the case with a 1912 saddle sewing machine, whose long throat was needed to repair the Flexible Insulation Blanket (FIB) elements of the Orbiter Thermal Protection System, the use of ethyl silicate and other silica formulas in the heat tiles represented a cross-pollination and use of an old technology for the newest spacecraft of its day. It was the investigations for space use that led to their re-introduction to building trades.

The number of spinoff technologies published by NASA since the mid-1970s exceeds 1800. The following products are but a cursory look at new technologies that were developed by NASA for space flight and landings that have been applied to consumer and commercial building products:

1. Cordless drills and other cordless tools: Developed jointly by NASA and Black and Decker for use by Apollo astronauts on the Moon.
2. Smoke detectors: A result of the development of a device to detect smoke and toxic gases in Skylab.
3. Rubber tire based paving: NASA's experience in fuel-related cryogenics helped develop processes to freeze used tires to below -200°F so that they crumble, separating the rubber from other materials and producing what's called "crumb," which is now used for highway and other paving.
4. Protective paints: Coatings originally developed by NASA's Goddard Space Flight Center to protect the launch structures at the Kennedy Space Center from corrosion due to the salt air in Florida are now used to protect exterior metal structures like the Golden Gate Bridge in San Francisco Bay and the Giant Buddha sculpture in Hong Kong.
5. Teflon fiberglass fabrics: Over forty years ago, engineers at NASA were hard at work developing the next generation of space suits. The suits required material that would be durable, strong, lightweight, flexible and noncombustible. They settled on a fiberglass fabric coated with polytetrafluoroethylene (PTFE), more commonly known as Teflon.

The same qualities that made the PTFE fiberglass fabric appealing to NASA also make it ideal for large scale, permanent tensile membrane roofs.

The material is pound-for-pound stronger than steel while weighing less than five ounces per square foot. It offers up to 24 percent solar translucency, letting in lots of natural light. At the same time, it provides as much as 75% solar reflectance, keeping out heat and making it an energy-efficient roofing alternative. It is also cost effective due to its durability and low-maintenance characteristics.

Conclusion

The Space Age represented monumental technological and human achievements, the influence of which ultimately extended far beyond the space program itself. In ways both large and small, the technical innovations and materials that are so synonymous with this period of exploration were disseminated to the American public through a variety of consumer goods and building technologies. From new alloys born out of improved mining, refining and alloying processes to synthetic materials engineered in labs, American design directly benefited from the increased variety and new range of properties afforded by these new materials. The architectural expression and innovative construction that resulted is increasingly becoming the charge of preservationists and conservators tasked with preserving the Space Age.

THE FARNSWORTH HOUSE FLOOD MITIGATION

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Abstract

Built by Mies van der Rohe in 1951, the Farnsworth House is revered by all who know it for its elegance, ingenuity, and originality. The challenges of the floodplain site are also well known as the building has endured numerous flood events over the past six decades. Flood waters have caused extensive damage- and costly repairs- to the structure, its systems and its furnishings. The rising waters of the Fox River represent a potentially devastating threat to Farnsworth's future. Given that reality, the owner, the National Trust for Historic Preservation, is analyzing the realities of the site conditions and developing solutions.

This paper presents options being explored for mitigating flood damages with a focus on the two most viable schemes; constructing a mechanical system in a pit below the house, completely concealed from view, to raise the house above any future flood by temporarily lifting it on a system of hydraulic jacks and steel linkages and lowering back down after the flood subsides and permanently moving Farnsworth to the farm field on the site and creating an appropriate setting. The integrity and significance of the landscape which has evolved from a farm field to a cultured park setting will also be discussed.

Background

The internationally recognized Farnsworth House, Mies van der Rohe's masterpiece located just outside of Chicago on the Fox River, is one of the most photographed pieces of architecture in the twentieth century. Designed in 1945 and built between 1950-51, it is the first fully realized 'glass box' and has a clear span interior. Like a ship, it has a lower deck and an upper deck that contains the house. When you are within the living space, you feel like you are hovering delicately above the river – like you could almost float away.

The dramatic setting in the flood plain of the river, so essential to the feeling of floating away, has resulted in regular flooding of the building. Mies established the finished floor elevation to be five foot above grade, which at the time of construction was one foot higher than the highest recorded flood. He intended the lower deck to flood occasionally while the upper portion would, theoretically, ride freeboard above the swollen river. Unfortu-

nately for the owners of the building, he underestimated this flood mark. The highest recorded flood, in 1996 inundated the house with five feet of water.

The National Trust for Historic Preservation and Landmark Illinois purchased Farnsworth at auction in 2003. The two organizations bought Farnsworth because of its extraordinary significance and the importance of saving modern architecture, but also because the other bidder expressed interest in moving the house out of state. The two preservation organizations wanted the building to remain at its current location and to be open to the public. Farnsworth was purchased for more money than was raised and consequently, the site has no endowment. In 2009 the Trust assumed the management of the property while Landmark Illinois became the easement holder.



Figure 1: 1951. Heidrich Blessing Photograpy Collection.
Courtesy of Chicago History Museum



Figure 2: 2008. ©NTHP

In the twelve years since the National Trust has owned the site, water has breached the interior once, causing very costly repairs. The previous owner, Lord Peter Palumbo, had a similar stewardship experience of constant repair, conservation and replacement after floods. There are also deferred maintenance issues with the building, notably the oxidation of the steel window frames and sills due to the wet conditions and the deterioration of the travertine pavers on the lower deck and stairs. These problems are exacerbated by the limited resources available in between floods to address the repairs. When it comes to insurance, after FEMA categorized the Farnsworth House as a "repetitive loss property", the Trust secured flood insurance for the buildings and contents through the federal government's National Flood Insurance Program as well as additional "excess" flood insurance with a private company. The rates went up 25% a year until they reached the actuarial amount that was ascertained during recent studies and surveys.

The flood history of the Farnsworth House from 1950-2003 is expressed on an Andy Goldsworthy sculpture, *Floodstones* (1991, 2003) commissioned by Peter Palumbo to mark the flood heights. The cairn was sited on the bank of the Fox River just west of Rob Roy Creek (it has been relocated to Pennsylvania at Kentuck Knob). The original top stone matched the height of the 1954 flood. Turns out, Goldsworthy didn't build it tall enough. He returned to make the sculpture taller after the 1996 epic flood. The sculpture has 13 flood lines carved into the rock, four of which represent water invading the interior of the house.



Figure 3: Andy Goldsworthy's *Floodstones*. ©NTHP

The Farnsworth Problem

The National Trust, along with Silman (formerly Robert Silman Associates), have been working for some time to find a flood mitigation solution. The process started three years ago, when an acquaintance of Edith Farnsworth

(the original owner), introduced herself to the National Trust's President, Stephanie Meeks, and bluntly inquired, "What are you going to do about the Farnsworth problem?" This woman then donated seed money that the Trust used to fund the initial studies to begin to solve the problem.

Hydrology engineers known for their international work on flood prone cultural sites quantified the Fox River and analyzed the flood data. Their study revealed that the Fox River has a 2,000 square mile watershed that originates in the western Milwaukee suburbs. Over the last 60 years, development within the watershed has greatly intensified and is expected to continue as an even greater pace in the future. Their flood models showed that the site is now expected to flood yearly, the lower deck every five years, and the house every decade. Additionally, their work showed that there is nothing that can be done on the site (or to the river or adjacent bridge) to alter this reality. A geo-technical engineer then demonstrated that the water table is very high; around five to six feet below grade and that the bedrock is less than twenty feet below grade. The property was surveyed and mapped to illustrate the 100 and 500 year flood lines. Thornton Tomasetti Engineers then created a feasibility study evaluating every solution that could be envisioned, nine options in total.

The Review Process

Once the studies and reports were completed, the Trust assembled a team of experts to evaluate the information and eliminate some of the solutions. The idea of relocating the building away from the site, in Chicago for example, was jettisoned and the team selected the most promising schemes to more fully develop. Dirk Lohan, Mies's grandson and an architect, advocated for a lift system and this was discussed at length. The panel agreed to hire one of the team members, Bob Silman and his firm, to evaluate moving the house farther from the river, adding fill and lifting the house, and hydraulically lifting the house.

The Hydraulic Solution

Only a mechanical solution maintains the original house in all of its present aspects including location on the site, elevation, relation to the river, and total landscape preservation. This option involves raising the house on hydraulic jacks only when required just prior to an impending flood. This would be accomplished by constructing a permanent concrete pit directly beneath the house with the eight main steel columns of the house resting on the cover of the pit just below finished grade. Upon alert of an impending flood, personnel at the house would

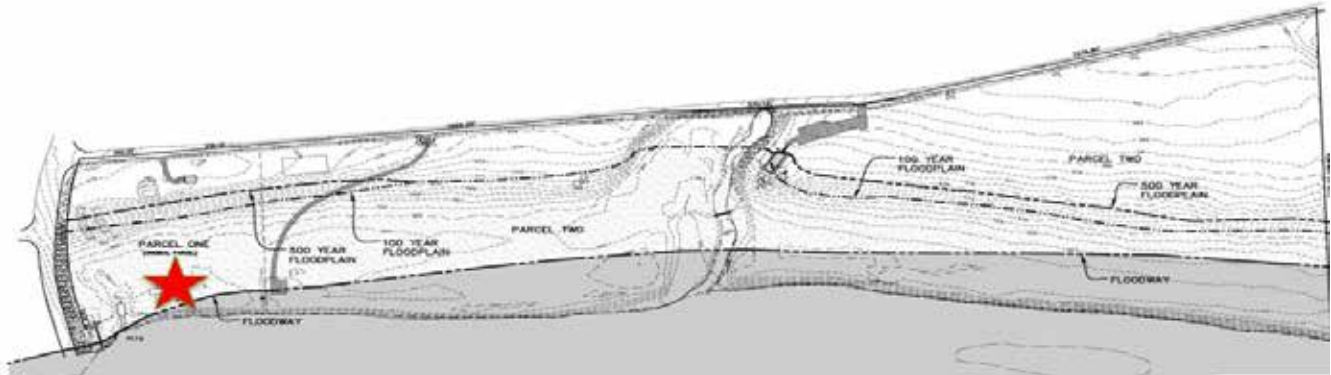


Figure 4: Site survey showing 100 and 500 year flood lines. Farnsworth House marked with red star. Courtesy of EEI, 2014

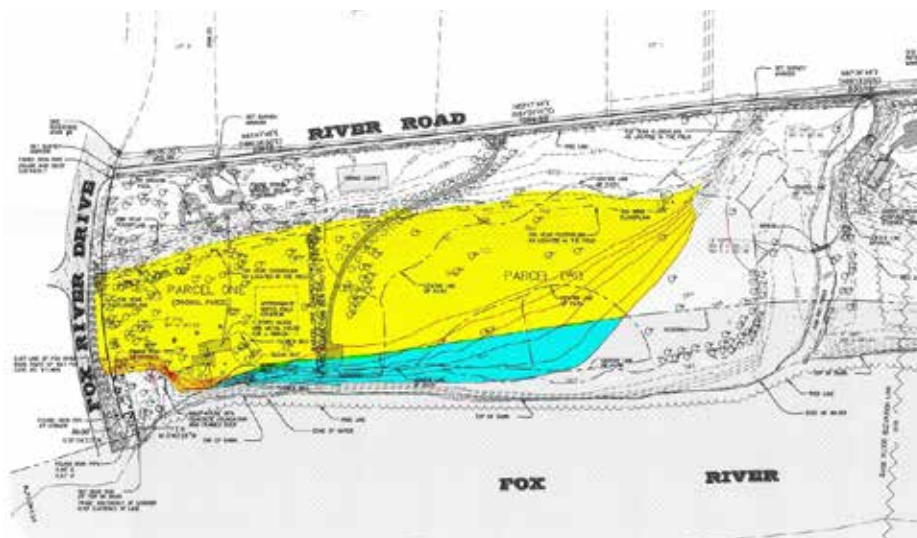


Figure 5: 93,000 cubic yards of fill (yellow) is needed to elevate the house above the 500 year flood line. Special permitting is required in the floodway (blue). Courtesy of Silman, 2014

activate the system by pushing a button and the cover of the pit would lift, simultaneously raising both the house and the earth beneath it to a height sufficient to take the structure out of harm's way. The utilities that service the house would be designed to extend and retract in order to accommodate the change in elevation.

Silman's office has proposed that the pit be approximately 12 feet deep, located directly beneath the footprint of the house which is some 29 feet wide and 78 feet long. In order to construct the pit, the house would be temporarily moved for the duration of construction to a location on the site that is above the highest projected flood elevation. At the conclusion of the construction of the pit, the house would be returned to its exact location and elevation and the eight columns fixed to the concrete below. This is not a difficult or unprecedented operation, even for a sensitive historic house like Farnsworth. The pit will require some mechanical tie-down

system such as rock anchors to help resist the uplift pressure from ground water.

Directly beneath the concrete cover of the pit, four linkage trusses would initially lie flat, parallel with the ground. When the system is activated, each truss rotates upwards ninety degrees until vertical, thus raising the concrete cover with the house fixed to it. It is anticipated that the house would need to be raised by some 7.5 to 9.0 feet in order to have the first floor located safely above the predicted 500 year flood level. Each truss is pushed by two hydraulic actuators contained in cylinders, much like those used in every automobile repair garage to lift the vehicle being worked on. These actuators or jacks operate using hydraulic oil pressure from a pump contained in the pit, with electrical connections as required including an emergency generator located remotely above the flood plain in case of a power failure. Once raised, the pit would be subject to flooding and at the conclusion of the flood event, would have

to be pumped out and cleaned, while the house remained temporarily in the raised position.

Hydraulic components such as those proposed for the Farnsworth House are commonly used in many everyday applications – automobile brakes, airplane controls, amusement park rides, movable bridges, etc. As such, the maintenance of the system can be readily performed by any mechanic trained in hydraulics, of which there are many. The system is designed so that no single point failure will result in the failure of the system as a whole. There are redundancies and safety mechanisms to assure that the house will not suffer any damage as a result of a malfunction of a single hydraulic or mechanical component. This too is a common procedure for sensitive hydraulic applications.

The system, when raised, is designed to resist not only the vertical weight of the house but also lateral forces due to wind and to river currents including floating debris. There is relatively little surface area exposed that might obstruct the flow of the flood waters and thus the design forces are minimized. Furthermore, the system is designed to be tested on a periodic basis, most likely several times per year, to insure that it will work, to inspect the components and to perform maintenance and cleaning as required. After a flood event, the water and mud in the pit will be pumped out using a heavy duty system designed for such applications. Final cleaning will be by removing any accumulated debris and then hosing down the pit and also pumping out that water.

When the system is in the dormant position, that is most of the time, there will be no signs of the installation visible that might detract from the visitor experience. Very thin steel curbs projecting upwards from the pit will retain the earth. The tops of these curbs will be just below the surface of the ground and earth can be raked over them to conceal them.

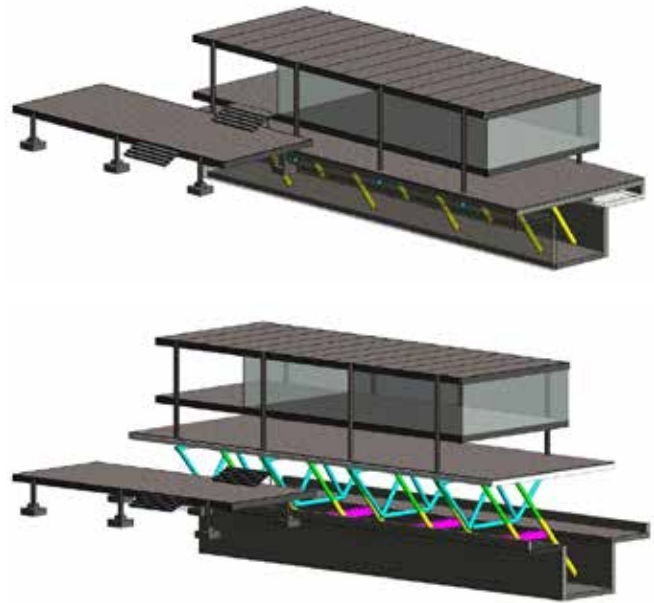


Figure 6, 7: Hydraulic solution illustrating the movement of actuators and trusses. Courtesy of Silman, 2014

The Public Process

The Technical Advisory Panel and other peer organizations vetted and deliberated the options presented in the Silman Report. Their feedback helped to finesse the final report for this phase. The hydraulic solution emerged as the favored scheme since it was the only option that maintained the connection to the land which is the singular element that evokes such strong feelings. It protects the architect's original intent. While Philip Johnson referred to the siting of Farnsworth as 'safe danger', Mies simply stated "*We should attempt to bring, nature, houses and the human being to a higher unity*".

As Chicago has a very engaged architectural community the Trust held public meetings last summer in Chicago and Plano to explain the study and findings. Informed and thoughtful suggestions resulted from all of these events. It was clear from the public feedback that each option had supporters and detractors. While there was strong support for the hydraulic lift option, it was not unanimous and there were a few strong public voices speaking out against this approach. The criticism was that the solution was not simple enough and was too dependent on mechanical parts.

Following this public input, the Trust assessed the feedback. The buoyancy concept was raised at three public meetings and options for moving the house elsewhere on the site was also mentioned. Silman was asked to review the buoyancy option in more detail.

The Buoyancy Alternate

There are two types of buoyant structures – one is a truly floating buoyant system similar to a houseboat that is moored to an anchorage while the other is an amphibious buoyant scheme in which the structure can exist either on dry land or floating should a flood event occur. Silman only investigated the latter as the former scheme is not applicable to Farnsworth.

“Let nature do the work; if there is a flood, let the rising waters lift the house.” This seemingly simple solution is easily understood by all. If there could be a method by which some sort of buoyancy system could be installed under the house, out of sight in a pit below the ground, then when flood waters entered the pit the house would begin to rise as soon as there was a sufficient head of water to provide displacement of water that exceeded the weight of the house. Buoyancy could be provided by any system that is very lightweight and would displace a sufficient volume of water, such as hollow tanks or rigid, closed cell foam.

However the actual details of such a system are almost impossible to achieve to the level of satisfaction required by the Farnsworth House. Following is a list of difficulties that cannot be overcome:

- There is no mechanism for testing the system or for inspecting it or performing maintenance. The house will rise only in a flood and if there are any problems, they cannot be detected in advance.
- There is no way to clean out the pit from the residue of debris and mud that will accumulate after a flood. The house will settle back down as the waters recede; it cannot be temporarily supported while the pit is cleaned.
- A sophisticated control system will have to be invented to make sure that the house does not rise in a minor flood that would not threaten the first floor.
- The guidance system that will insure that the house can be returned to its exact starting position cannot be engineered with sufficient precision so that the evidence of the pit and curbs below ground are invisible to the visitor. The guide rails will have to telescope up out of the ground and be enormously stiff to resist the lateral bending forces caused by river currents and wind. With the house floating, there is a huge surface area exposed to the current.
- Although amphibious buoyant systems are beginning to be used for simple houses in flood-prone areas such as the Netherlands and Louisiana, there

is no precedent for the type of precision required or the need to hide all elements as in Farnsworth.

- There is no control for the accelerations that the house might experience, either in its movement up or down. This could lead to the house wanting to pitch unevenly, causing potential damage to brittle elements such as glass or marble.
- The depth of the pit would place it either right on top of the rock or actually into the rock, requiring some blasting. There is then a greater head of water causing uplift on the pit than in the hydraulic scheme.

Many of these shortcomings could be overcome were there a supplementary system of hydraulic jacks that would assist in lifting the house for testing and maintenance, in guidance to return the house to its exact original position, and in cleaning out the pit after a flood event. However, once there is a hydraulic system capable of supporting the entire weight of the house and pit cover, then why consider the amphibious buoyant system at all.

Moving the House to the Farm Field Alternate

The Trust examined the possibility of moving the house to two other locations on the site, looking beyond the original suggestion to move the house directly away from the river towards the road. The first option, near Rob Roy Creek, about the same distance from the river as the road, was determined to be lower than the existing site and also in a floodway, offering no advantages. The second option was at the eastern end of the property, in what is now the farm field. As the Trust studied it, advantages revealed themselves: the 500 year flood line is closer to the river at this point than it is at the location near the road, an appropriate landscape could be developed without substantial changes to an historic landscape, the site is farther away from the noise created by traffic, and the land surrounding this portion of the site is protected state land.

As the Trust gathers more information about the landscape, it is determining the integrity and significance of both the Farnsworth landscape and the Palumbo landscape. The Farnsworth landscape was one of little management or care, while the Palumbo period is one of professional stewardship and design. It was Palumbo and his landscape architect, Lanning Roper, who added most of the plants and trees seen today. Over his thirty-one year stewardship, Palumbo created a park to view the Farnsworth House and to display his mod-

ern sculpture collection. He planned the meandering walk, the forests, and the bridge over the creek and the Visitors Center. He and Roper also added vegetative screens in an attempt to mitigate the intrusive noise and sight lines that the roads bluntly inserted. Palumbo even convinced the park directly across the river to allow him to add flowering plants and to change the light fixtures at his cost.

The compromised state of the original site has to be acknowledged when evaluating the farm field option. Mies definitively situated the house beneath the protective umbrella of the gigantic Black Sugar Maple tree, referred to as the Witness Tree. In the words of Lord Peter Palumbo, the tree "*caressed the house*", but due to its age, that tree is no longer standing. The one-lane bridge (1884) that crossed the Fox River upstream of the property was demolished in 1969 and replaced by a wide, graceless highway that allows traffic to cross the river at high speeds. The new bridge is 175 feet closer to the

house and required 11 feet of fill. Edith Farnsworth unsuccessfully fought the condemnation of her land citing the 2,000 years old Hopewell Indian pre-historic sites on her property and stated "this high fill and its [the bridge] location will destroy the seclusion and privacy of the Farnsworth House". She was planning to live full time at the Farnsworth House and told the Beacon Newspaper that she would be forced to look elsewhere for a retirement home as she felt she would not be able to stay in her glass home, "with cars whizzing by daily overhead with their occupants able to look down thru the glass house". She lost the fight and the highway department gained control of an acre and a half of her property as part of the condemnation. Peter Palumbo told the Trust that he did not believe Edith Farnsworth cashed the check given to her for her land in the mitigation process as she was so disgusted by the project. The site today is very different than the site that existed when the house was built. The bridge that hems in the house is elevated to be above the rising flood waters of the Fox River.

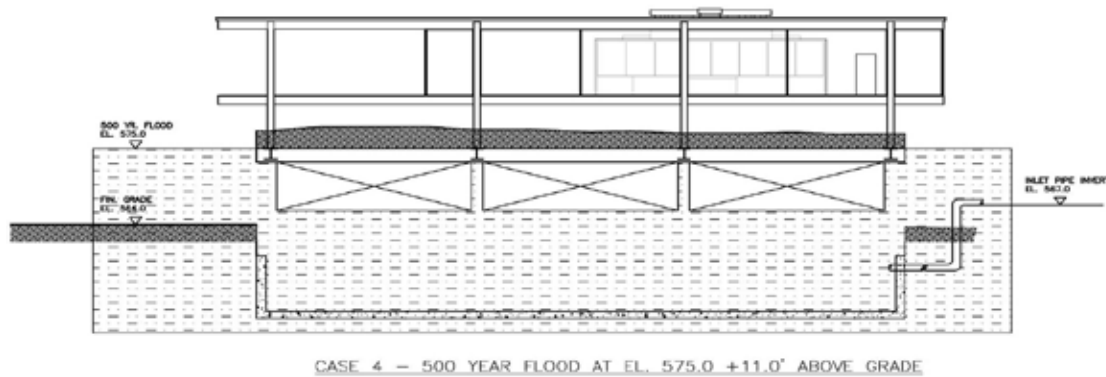


Figure 8: Buoyancy study sketch. Courtesy of Silman, 2015

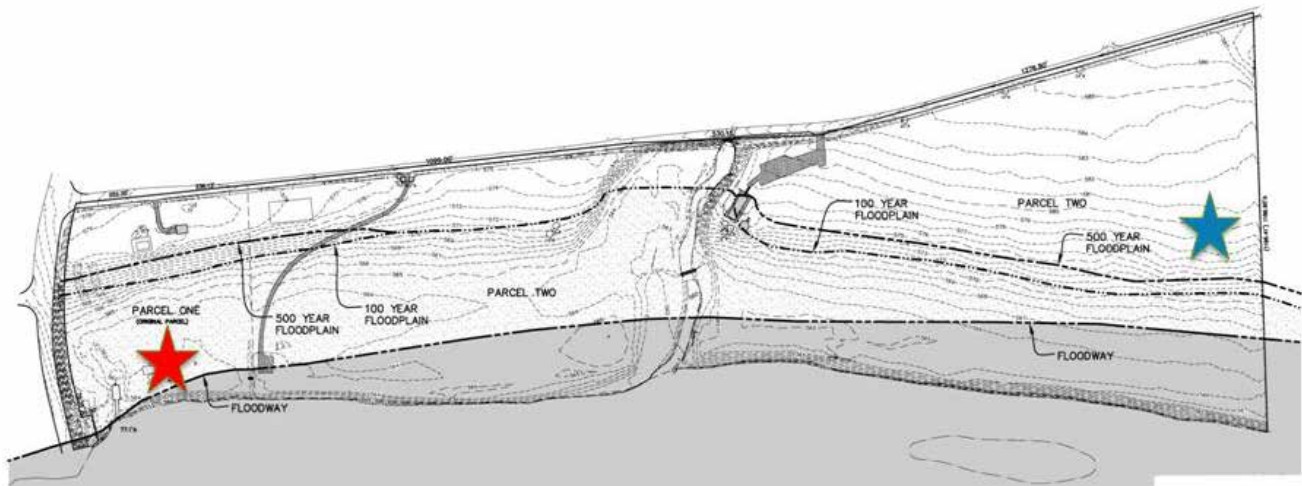


Figure 9: Blue star indicates farm field site vicinity. Courtesy of EEI, 2014

Cultural Landscape Report and Preservation Plan

The latest research is being gathered into a cultural landscape report and preservation plan for the building and site. Lanning Roper's files have been discovered and the Trust has conducted an extensive interview with Lord Palumbo to help better understand the integrity and significance of the site during 1951-1971 (Farnsworth ownership) and from 1971-2003 (Palumbo ownership). At the Metropolitan Museum of Art, the Trust recently discovered the shop drawings, as-built drawings, specifications, product literature and construction notes created by Mies's firm, which acted as the general contractor for the project. The members of the research team have been engaged at Farnsworth House for over a decade.

Discussions with the National Park Service

The Trust wants to ensure that the National Park Service (NPS) was in agreement that any proposed solution meets the Secretary of the Interior's Standards and does not endanger the National Historic Landmark Status. At meetings with senior staff at the National Park Service (Dr. Stephanie Toothman, Brian Goeken and Paul Loether) the options under consideration were discussed, as well as the application of the standards and NHL designation. The NPS guidance was very pragmatic in nature and reflected their experience in dealing with properties that have been impacted by natural forces. Here are some of the highlights of those conversations:

- NPS staff agreed that doing nothing, in the face of the documented threat of flooding, was not an acceptable long-term stewardship option.
- The addition of large amounts of fill was seen as highly problematic, as it destroys too much of the site.
- The hydraulic solution could meet the Standards, depending on the planning and implementation and it could be a model for other properties that can't be relocated. It is the only option that maintains the relationship between the house and the river.
- Relocating down the shoreline in the farm field is preferred to adding fill. If the house is moved, an appropriate and compatible setting will be created, not necessarily a recreated landscape.

Conclusion

There is no solution yet. The Trust has been working intensely with Landmark Illinois which holds an easement on Farnsworth House and will need to approve the proposed changes. At this point, there are two serious options that can be finessed to create the desired results of protecting Farnsworth. Moving the house to the farm field site is the more passive solution and it allows an opportunity to interpret both landscapes. An appropriate setting could be created for the house in the field and also interpret the Lanning Roper/Palumbo landscape and the flood history at the old site. A viewing platform or ghost house could be created at the old house, so the visitor can experience the view and understand the flood problems. As Lord Palumbo and the NPS pointed out, this country has many precedents of moving properties to save them; relocation is part of our nation's stewardship history.

The hydraulic scheme, on the other hand, mitigates the threat of flooding to the house without compromising the site-specific qualities of the landscape as originally designed by Mies and later enhanced by Lanning Roper. Although there have been objections that the scheme is too complex and too dependent on technology, exactly similar components are used every day in movable bridges, in exotic rides at amusement parks, in all types of vehicular and airline transportation and are proven, reliable and safe. The Hydraulic Scheme can also serve as a model for other sensitive, high value buildings that are located in zones of potential flooding, a rapidly escalating problem worldwide.

RESTORATION AND REPLICATION OF STEEL ELEMENTS AT FRANK LLOYD WRIGHT'S FALLINGWATER AND SOLOMON R. GUGGENHEIM MUSEUM

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Abstract

Frank Lloyd Wright used steel windows and doors in innovative ways. At Fallingwater, a weekend home designed for the Kaufmann family of Pittsburgh, Wright incorporated Hope's steel casement and fixed windows to create a dramatic effect, often without corner mullions or directly into the stone walls with no frame. For the Solomon R. Guggenheim Museum, Wright employed Hope's window-walls on the Thannhauser Pavilion.

WASA Studio served as preservation architect for both structures. In the case of Fallingwater (1936-39), cantilevered over a stream, the steel elements were found to be significantly corroded and had to be stripped to bare metal. Fixed windows in the main house had no drip edge at the head; this was corrected subsequently for the guesthouse addition. Both the heads and sills lack waterproofing, and deformation of the concrete roofs and terraces left enlarged gaps that promoted moisture penetration. This was further exacerbated by the curved profile of roof edges, which also do not include a drip. In several units, areas of deteriorated steel had to be cut out and new sections welded on. The hatch over the stairs to the stream, an iconic element within the living room, was so severely corroded that it had not worked in years. A specialty steel window contractor, Seekircher Steel Window Corp. of Scarsdale, NY, executed the work. In addition, the mild-steel straps from which the stairs to the stream were hung had caused the ongoing deterioration of the cast-in-place concrete treads; these were replaced with stainless steel when the stairs were reconstructed. WASA Studio's Preservation Group specified the industrial paint system for all exterior steel elements, which in the case of the stairs to the stream, had to also withstand partial submersion.

By contrast, at the Solomon R. Guggenheim Museum (1959), the original steel window-walls were in excellent condition. However, the high relative humidity in the museum's interior environment, favorable to the artwork on display, resulted in extreme condensation at the single-glazed window-walls, rendering the Thannhauser Pavilion unusable during the winter months. In this case, with the assistance of William B. Rose Associates, a building-envelope sub-consultant, we undertook a thorough investigation into the efficacy of retrofitting the existing frames, including evaluation of the aesthetic impact (the building is also a NYC-designated interior), as well as performance. It was concluded that the window-walls could not be reliably upgraded, nor could the introduction of storm windows guarantee the resolution of the condensation issues. Therefore, we specified steel-framed replicas that were thermally-broken and double-glazed, unprecedented in the US at the time, which were custom-fabricated by Torrance Steel Window Co. out of Torrance, CA. The extreme condensation at the single-glazed steel skylights, concealed above the lay-lights that follow the spiral of the rotunda, coupled with gaps in the insulation that had been remedially installed in 1992 at the interior of the shotcrete walls and where the ramp soffits are exposed to the exterior, produced little rivulets of water that ran down the ramps. The skylights, which are not visible from the interior or exterior, were replaced with aluminum units with thermal breaks and double-glazing.

Although in both cases, Frank Lloyd Wright relied on single-glazed steel-frame windows and doors, our philosophical approach to Fallingwater was completely different from that of the Solomon R. Guggenheim Museum. Fallingwater is a house museum, and the house is interpreted and presented in the way the Kaufmanns lived in it. As such, the windows and doors are open during the months of good weather. Despite the fact that there is important artwork from the Kaufmann's per-

sonal collection displayed in the main house and guesthouse, these are intentionally not kept in a museum environment. This condition is reversed at the Solomon R. Guggenheim Museum, where authenticity of use—that of a world-class museum—had to take precedence over authenticity of fabric.

Introduction

From 1989 through 2005, WASA Studio's Preservation Group¹ was involved in the study, prototype-conservation treatments, conditions assessment, development of the preservation master plan, and design and administration of the restoration of the National Historic Landmark Fallingwater, the weekend home and guesthouse of the Kaufmann family. Considered one of Frank Lloyd Wright's masterpieces, the house was designed in 1935, and along with the guesthouse, built between 1936–39. Located in rural Pennsylvania in Mill Run, approximately 60 miles to the southeast of Pittsburgh, it remained in the family's possession until 1963, when it was deeded along with 1,700 acres to the Western Pennsylvania Conservancy.² It currently operates as a house museum, open from March through November, with an annual visitation rate of about 160,000.

From 2004–2008, WASA Studio's Preservation Group led the multi-disciplinary team that designed and administered the exterior restoration and enhancement of the Solomon R. Guggenheim Museum. Also designed by Frank Lloyd Wright, this National Historic Landmark located on Fifth Avenue of New York City was completed in 1959. The building still maintains its original function, housing Mr. Guggenheim's collection of modern art, as well as temporary exhibitions.³ With over 1.1 million visitors annually, the Solomon R. Guggenheim Museum is purported to be the second-most visited landmark in NYC after the Statue of Liberty.

Both buildings are currently on the US Tentative List for potential World Heritage site designation, as part of a serial nomination of ten buildings known as the *Key Works of Modern Architecture by Frank Lloyd Wright*. The nomination is scheduled to be reviewed by the World Heritage Committee during the summer of 2016 session.⁴ As such, the treatment these buildings underwent during restoration, as well as over time, will come under scrutiny by an expert mission of ICOMOS (International Council on Monuments and Sites) in the fall of 2015 as part of the review of meeting the criteria proposed for World Heritage status. The mission will also evaluate their State of Conservation (SOC).

Construction Materials

Both Fallingwater and the Solomon R. Guggenheim Museum are considered important concrete buildings of the Modernist style. Fallingwater, with its striking cantilevers projecting over the waterfall of the stream, Bear Run, is not just a stucco-covered cast-in-place concrete building. The structure includes load-bearing walls of random stone ashlar. The guesthouse, built a few years after the main house, is actually steel framed with stucco on metal lath.⁵ In the case of the Guggenheim, the interior ramp and its web walls are cast-in-place concrete, whereas the rotunda walls are shotcrete, the soffits are stucco on metal lath, and the frieze on the Thannhauser Pavilion is pre-cast concrete.

Windows and doors are treated in a similar way at both buildings. For Fallingwater, single-glazed Hope's Windows of Jamestown, NY were used.⁶ Wright stated, "Steel sash came within reach also for the first time,"⁷ and he utilized it with dramatic effect, particularly at corners where there are no mullions (Figure 1). The windows and doors consist of rolled-steel Z- or T-shaped sections. The windows are both casement and fixed. Some of the fixed windows disappear into the stone walls without a frame. Integral steel drip edges were incorporated into the operable units at the main house. For the guesthouse, the drips are present above both operable and inoperable windows. As a house museum, Fallingwater is displayed and interpreted the way the family lived in it; therefore, windows and doors remain open during good weather, despite the Kaufmann's notable collection of artwork, which includes works by Diego Rivera and Picasso.



Figure 1: Fallingwater exemplifies Frank Lloyd Wright's bold use of steel windows in a residential context.
(All photos by author unless otherwise noted.)

Steel was used for other elements as well at Fallingwater, for instance to support the stepped canopy to the guesthouse. There is also an operable steel glazed hatch in the living room, which leads to the stairs to the stream. The stairs to the stream were hung from the underside of the living-room slab with mild steel straps. This design detail is repeated for the stairs leading from the east living-room terrace up to the pottery terrace.⁸

Similarly, at the Guggenheim, the window-walls of the Thannhauser Pavilion were single-glazed, manufactured by Henry Hope and Sons out of the UK. At the third floor, the floor-to-ceiling window-wall had a complex configuration, consisting of fixed and casement doors leading to a perimeter balcony, with half-round operable windows at the top. At the fourth floor, the window-wall had a simpler rectangular configuration, and also leads to a balcony. The monitor, as the Thannhauser Pavilion was originally known, was intended by Wright to be a space for museum personnel, and to entertain patrons. It exemplifies transparency, unlike the rotunda, and embodies Wright's principles of connecting the indoors with the outdoors. The amount of window-wall was reduced by the erection of the 1989 Gwathmey Siegel & Associates addition to the building.⁹

Existing Conditions

The existing condition of the windows and doors at Fallingwater, prior to the 2001-2005 restoration, was fair-to-poor. The hatch over the stairs to the stream, which was so corroded that it was inoperable, had already been refurbished in 1992 by the specialty contractor, Seekircher Steel Window Corp., along with the adjacent living-room corner windows (Figure 2). The main issue was severe corrosion, along with deflection of slab edges and lack of flashing at heads and sills. As noted, not all windows at the main house had drips, but even where drips existed, they were ineffective. This has to do with the design of the roof-slab edges, which are half-rounds (roof rolls). The soffit of the roof rolls has no drip, thereby leading water directly into the head of the windows and doors. Where there are steel drips at the heads, these direct water to fall to the sill, saturating the bottom of the sash. As a result, the horizontal mullions at top and bottom were often in poor condition.¹⁰

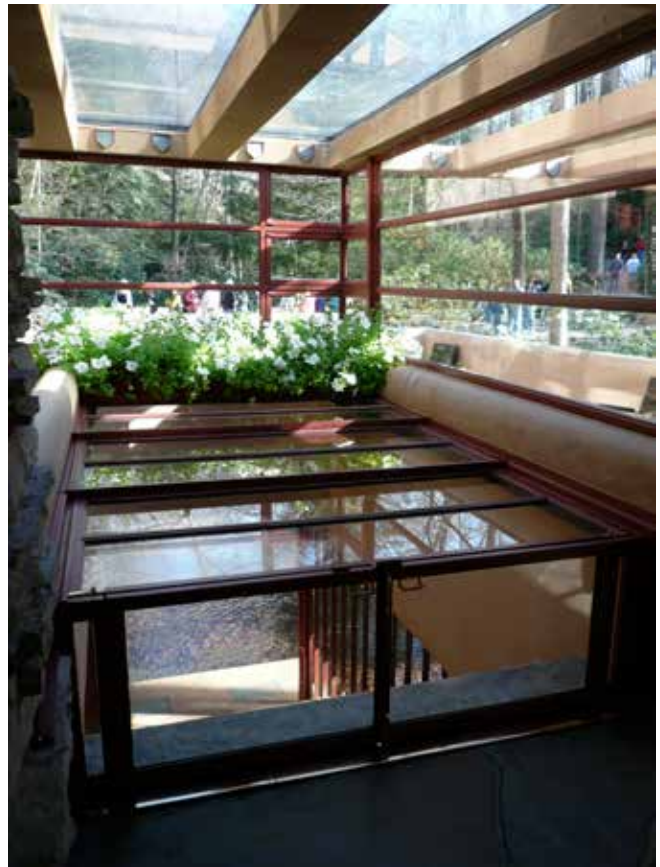


Figure 2: The restored living-room hatch over the stairs to the stream at Fallingwater

As stated, the stairs to the stream were hung on steel straps. Frank Lloyd Wright's design has each strap pene-

trate the cast-in-place concrete treads twice. Since the area is directly above the stream, the stairs are on occasion partially submerged; therefore, corrosion was inevitable. Despite cleaning the steel to bright metal and repainting, WASA Studio's attempts at trowel-applied patches, as well as cast-in-place patches, failed due to corrosion (Figure 3).¹¹



Figure 3: Failed patches at the stairs to the stream

At the Guggenheim, the window-walls were in an excellent state of preservation, and the skylights were in relatively good condition. However, unlike Fallingwater, in the case of the Guggenheim, the building is kept at 70° F and 50-55% relative-humidity level, producing severe condensation along the window-walls (Figure 4), making two floors of the Pavilion unusable during the colder months, and to a lesser degree, in the summer. During extreme cold weather, icicles formed at the interior steel mullions. The condensation on the window-walls at its worst obscured the view of Central Park entirely, thereby negating the building's connection to nature, one of the tenants of Frank Lloyd Wright's organic architecture. In addition, although the main skylight of the rotunda had been replicated in 1992 with a thermally-broken double-glazed unit, the original perimeter skylights were still in place and were problematic in terms of condensation within the cavity of the skylights. For a world-class art museum that exhibits priceless artwork, this was an unacceptable situation.¹²



Figure 4: Extreme condensation on the window-walls of the Guggenheim's Thannhauser Pavilion obscured the connection of the building to Central Park. (Photo by Angel Ayón.)

Philosophical Approach

As preservationists, we are taught that authenticity of materials is paramount. It could be said that this concept is at the root of an ethical approach to conservation of the built heritage, as exemplified by the international doctrine, the *Venice Charter*,¹³ which still guides our decision-making in the treatment of cultural heritage to this day. However, for ephemeral building materials, like wood, this dogma is more difficult to sustain, and is now recognized as a Euro-centric approach that applies to monumental architecture built of more permanent materials, such as stone or brick.¹⁴ This materials-based significance did not appear to be controversial when the first World Heritage sites were designated in 1977 for the World Heritage Convention of 1972¹⁵ in accordance with the earliest version of UNESCO's *Operational Guidelines*,¹⁶ which embraced the *Venice Charter*. But without a clear definition of authenticity in the *Venice Charter*, this gradually became problematic, as State Parties to the Convention began to propose other types of properties for consideration.

In order for a site to be inscribed on the World Heritage List, the site must possess Outstanding Universal Value (OUV) by meeting one or more of ten criteria set forth in the *Operational Guidelines*, of which (i) through (vi) apply to cultural sites and (vii) through (x) apply to natural sites. "Outstanding Universal Value means cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity" (Art. 49). In addition to authenticity, there is also the requirement of integrity for inscription onto the World Heritage List. In order for a site to have integrity, it

must include "all of the elements necessary to express its Outstanding Universal Value" (Art. 88.a). It must be large enough to ensure complete representation of the OUV-bearing features.¹⁷

The issue of authenticity of materials was brought to the forefront as nations whose built heritage was constructed of wood became concerned that the sites they wished to nominate to the World Heritage List would not "meet the test of authenticity in design, materials, workmanship, and setting" (Art. 9).¹⁸ In Japan, for instance, ancient wood temples are periodically and ritualistically disassembled and reassembled, with their rotted wood parts removed and replaced. However, the techniques used to replace deteriorated wood, as well as the method of reconstruction, utilizes the exact same technology as the original. Was this not a form of social-cultural authenticity of tradition, an intangible heritage? At the request of the World Heritage Committee, the definition of authenticity was explored, resulting in the *Nara Document on Authenticity*,²⁰ a seminal doctrine that broadened our perception and understanding of authenticity.²¹

For Fallingwater, there was no question that the single-glazed windows and doors could remain, despite their poor condition. Fallingwater survives with its original design intent intact; with the exception of the sensitive conversion of the carport into a lounge for visitors, all alterations to the building site, including the addition of the guesthouse, were designed by Frank Lloyd Wright. The visitors' center, designed by Edgar Kauffman jr's [sic] companion, Paul Mayén, and constructed in 1979-81,²² is set at a respectful distance and completely concealed from the main house and guesthouse. Even though Fallingwater has lost its original function as a weekend home, it possesses great integrity.

The Guggenheim, however, has undergone a series of transformations in the form of additions and alterations. These include the first addition designed by Wright's son-in-law Wesley Peters and completed in 1968; the 1975 Donald Freed-designed gift shop that enclosed the driveway that once connected East 89th Street to Fifth Avenue; Richard Meier's 1978 conversion of the Architectural Archives into the Aye Simon Reading Room; the 1992 addition by Gwathmey Siegel & Associates that replaced the earlier addition;²³ the 1992 expansion of basement-level space under the Fifth Avenue sidewalk; the temporary canopy by Frank Gehry dating to 2001 and removed in 2005; and most recently, the re-design of the ground-floor café by Andre Kikoski in 2010. Therefore, the Guggenheim must be examined under the light of progressive authenticity, wherein significant changes to a site are considered the physical manifestation of its history. "Due recognition should be given to "progressive authenticity", that is to say, to buildings and constructions, in which, although having been modified throughout time, some of the original intention still were [sic] retained."²⁴ The most visible impact is arguably the limestone-clad Gwathmey Siegel addition, but in reality,

it more closely resembles Wright's own rendering depicting a future addition, than the one designed by Wesley Peters.

One of the tasks of the recent restoration was to give serious consideration to the enhancement of the Guggenheim's exterior envelope to improve its performance. This meant that the original single-glazed window-walls and skylights were extensively studied by WASA Studio in collaboration with William B. Rose Associates, the building-envelope sub-consultant. Additionally, all of the proposed interventions of the team underwent two-day peer reviews on two separate occasions, and thereby were vetted by professional colleagues. Decisions were not taken lightly nor made in a vacuum. For the WASA Studio team, the replacement of the original fabric of the window-walls and skylights represented a necessary evolution of the building, dictated by its continuing to function as an art museum.

At Fallingwater, material authenticity when it came to windows and doors was possible, whereas, for the Guggenheim, authenticity of function took precedence over authenticity of materials.²⁵ And in the case of Fallingwater's stairs to the stream, the impossible reality of the situation, coupled with the fact that the stairs themselves were no longer original, having been reconstructed in the 1950s after debris carried by the stream as a result of a storm knocked most of them away, guided our intervention.²⁶

Conservation vs. Upgrade

The poor condition of Fallingwater's steel windows and doors meant that a specialty contractor was required. Seekircher Steel Window Corp. was again retained to perform the restoration of the remaining glazed enclosures. The steel was stripped to bright metal, and sections corroded beyond repair were cut out and replaced with new matching sections welded in place. Rather than attempt to remove the windows and reinstall them, the work was performed in situ and completed in 2003. New aluminum glazing stops were installed, along with new glazing putty.²⁷ An industrial paint finish in Wright's signature Cherokee red was applied.²⁸ This finish has held up remarkably well, with some touch-up occurring in 2010.²⁹

For the flat steel straps that supported the stairs to the stream, our previous attempts at cleaning the metal and patching the concrete treads had failed. In addition, we were not dealing with authentic material. Therefore, working with Robert Silman Associates, structural engineers, new stainless-steel straps were installed and the treads recast and stuccoed (Figure 5). Stainless steel is notoriously difficult to paint and have the coating adhere. In this case, we specified immersion³⁰ and non-im-

mersion³¹ industrial paints. The replacement of the steel straps was not necessary for the similarly designed stairs between the east living-room terrace and pottery terrace, which were not reconstructed and remain original fabric.



Figure 5: Fallingwater's reconstructed stairs to the stream. The stairs between the east living-room terrace and pottery terrace are also visible

A more difficult decision was the intervention to the window-walls at the Thannhauser Pavilion. Various concepts were explored, including whether or not the existing sash could be upgraded with double-glazing. Thermal-protective coatings, insulating blankets and heated glass were also considered. Interior or exterior storm windows were another option. However, the modification to the appearance of a designated interior and exterior landmark, as well as the unpredictability of performance, led us to conclude that the best upgrade option was replication despite the excellent condition of the original fabric. The same applied for the perimeter skylights. In this case, the social-functional integrity of the Guggenheim took precedence. Working with William B. Rose and Associates, we specified thermally-broken double-glazed steel replicas that were manufactured by Torrance Steel Window Co. out of Torrance, CA (Figure 6); these were unprecedented in the US at the time.³² The perimeter skylights, invisible from both the exterior and interior, were replaced with aluminum, as the replication of the mullion profiles was not as important.



Figure 6: The third-floor window-wall of the Thannhauser Pavilion of the Solomon R. Guggenheim Museum following replication. (Photo by Angel Ayón.)

Conclusion

Frank Lloyd Wright's use of single-glazed steel windows and doors and other steel elements was an aesthetic choice that could be considered inappropriate in these two examples. On the one hand, because of Fallingwater's location in a constantly damp environment, corrosion was inevitable. On the other hand, the Guggenheim's intended program as an art museum meant that high relative humidity was required to maintain a suitable interior environment for the exhibition of art. Restoration was necessary at Fallingwater to increase the service life of the windows and doors. Reconstruction resolved the perennial issues affecting the stairs to the stream. And replication and replacement was the only way to reliably upgrade the performance of the building envelope at the Guggenheim.

What these two case studies clearly illustrate is that there are compromises that occur when intervening in cultural heritage, which can impact authenticity. However, if a values-based approach is taken, then a logical sequence of priorities is possible.³³ The *Burra Charter* teaches us to understand cultural significance through identification of values, including historic, aesthetic, scientific, social and spiritual.³⁴ Values, however, can be in conflict, as seen in the Guggenheim, where material authenticity (historic and aesthetic) compromised the resource's ability to function as an appropriate environment for the display of priceless artwork (social). But values can also change over time. Decisions need to be carefully considered in light of their potential impact on authenticity and integrity, which may affect cultural significance in the long term.

The criteria under which the *Key Works of Modern Architecture by Frank Lloyd Wright* are proposed for inscription are (i) "represents a masterpiece of human creative genius," and (ii) "exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design." Concepts of "symbolic forms expressing function," "dynamic space and form," and "organic expression" are cited in the nomination dossier under criterion (i). "Adaptation to modern requirements" and "organic influence" are noted under criterion (ii).³⁵ Fallingwater is considered to be an embodiment of Frank Lloyd Wright's organic architecture, perched over a waterfall in the middle of a forest. The Guggenheim also exemplifies this theory, both in the organic shape of the rotunda, inspired by a nautilus shell,³⁶ and in the window-walls, which connect the building to Central Park across the street. Both are considered iconic structures of the Modernist period.

For these two structures, our interventions must also be reviewed from the perspective of whether or not the sites maintain the ability to convey Outstanding Universal Value in the context of the World Heritage Conven-

tion. The evaluation of OUV for built cultural heritage is the responsibility of one of the three statutory advisory bodies to the Convention, ICOMOS. It will be interesting to see if they agree with our approach to restoration and enhancement of these two buildings, and find that our work has had minimal impact on the OUV of the sites.

Endnotes

- 1 Now Architectural Preservation Studio, PC.
- 2 Weiss N, Jerome P, and Gottlieb S, Fallingwater Part 1: Materials-Conservation Efforts at Frank Lloyd Wright's Masterpiece, *APT Bulletin*. 2001, 32, 44-55.
- 3 Jerome P, Conserving Frank Lloyd Wright's Solomon R. Guggenheim Museum, *Historic Environment*. 2013, 45, 62-70.
- 4 Department of Interior, Secretary Jewell Announces Nomination of 10 Buildings by Frank Lloyd Wright to the World Heritage List, Jan 30, 2015, <http://www.doi.gov/news/pressreleases/secretary-jewell-announces-nomination-of-10-buildings-by-frank-lloyd-wright-to-the-world-heritage-list.cfm>, (accessed March 16, 2015).
- 5 Wright F L, 1867-1959. Frank Lloyd Wright architectural drawings and papers, circa 1880-1959, (accessed at Avery Library, May 1994).
- 6 Weiss N, Jerome P, and Gottlieb S. 2001.
- 7 Wright F L, Fallingwater, *The Architectural Forum*. Jan 1938, 36.
- 8 Weiss N, Jerome P, and Gottlieb S. 2001.
- 9 Ayón A and Rose W, Reglazing Frank Lloyd Wright's Solomon R. Guggenheim Museum in New York City, *APT Bulletin*. 2011, 42, 59-66.
- 10 Weiss N, Jerome P, and Gottlieb S. 2001.
- 11 Jerome P, Weiss N, and Ephron H, Fallingwater Part 2: Materials-Conservation Efforts at Frank Lloyd Wright's Masterpiece, *APT Bulletin*. 2006, 37, 3-11.
- 12 Ayón A and Rose W. 2011.
- 13 ICOMOS, The International Charter for the Conservation and Restoration of Monuments and Sites. 1964, http://www.icomos.org/charters/venice_e.pdf, (accessed March 21, 2015).
- 14 Jerome P, An Introduction to Authenticity in Preservation, *APT Bulletin*. 2008, 39, 3-7.
- 15 UNESCO, Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972, http://portal.unesco.org/en/ev.php-URL_ID=13055&URL_DO=DO_TOPIC&URL_SECTION=201.html, (accessed March 21, 2015).
- 16 UNESCO, The Operational Guidelines for the Implementation of the World Heritage Convention. 1977, <http://whc.unesco.org/archive/out/opgu77.htm>, (accessed March 21, 2015).
- 17 UNESCO, The Operational Guidelines for the Implementation of the World Heritage Convention. 2013, <http://whc.unesco.org/archive/opguide13-en.pdf>, (accessed March 29, 2014).

- 18 UNESCO, The Operational Guidelines for the Implementation of the World Heritage Convention. 1977, <http://whc.unesco.org/archive/out/opgu77.htm>, (accessed March 29, 2015).
- 19 Stovel H, Origins and Influence of the Nara Document on Authenticity, APT Bulletin. 2008, 39, 9-17.
- 20 ICOMOS, Nara Document on Authenticity. 1994, <http://www.icomos.org/charters/nara-e.pdf>, (accessed March 21, 2014).
- 21 Jerome P. 2008.
- 22 <http://www.amnesta.net/other/fallingwater/>, (accessed March 30, 2015).
- 23 Jerome P. 2013.
- 24 Von Droste B and Bertilsson U, Authenticity and World Heritage, Larsen K E, Ed. Nara Conference on Authenticity in Relation to the World Heritage Convention, Tokyo, 1995, 3-15.
- 25 Ayón A, Jerome P, et al, The Guggenheim at Fifty. Notes on Recent Preservation, Docomomo. September 2009, 41, 74-79.
- 26 Jerome P, Weiss N, and Ephron H. 2006.
- 27 The glazing putty used was Vulkem 116 as manufactured by Mameco/Tremco. Jerome P, Weiss N, and Ephron H. 2006.
- 28 The primer was Tnemec Poly-Ura-Prime 50-330, top of which was applied two coats of Endura-Shield Series 73. Jerome P, Weiss N, and Ephron H. 2006.
- 29 Conversation with John Seekircher on February 26, 2015.
- 30 The straps were shop-primed with Tnemec 66 Hi-Build Epoxoline; an additional coat of the primer was applied in the field. The finish coat was 290 CRU. Jerome P, Weiss N, and Ephron H. 2006.
- 31 Once shop-primed with Tnemec 66 Hi-Build Epoxoline, the field primer was 1975 Endura-Shield II, and the finish coat was 1070 Fluronar. Jerome P, Weiss N, and Ephron H. 2006.
- 32 Ayón A, Jerome P, et al. September 2009.
- 33 Jerome P, The Values-Based Approach to Cultural Heritage Preservation, APT Bulletin. 2014, 45, 3-8.
- 34 Australia ICOMOS, The Burra Charter. The Australia ICOMOS Charter for Places of Cultural Significance. 2013, <http://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf>, (accessed March 29, 2015).
- 35 <https://savewright.files.wordpress.com/2015/01/section-3.pdf>, (accessed March 30, 2015).
- 36 <http://www.guggenheim.org/new-york/education/school-educator-programs/teacher-resources/arts-curriculum-online?view=item&catid=730&id=122>, (accessed March 30, 2015).

THE KNAPP'S CENTRE: 1930S ART MODERNE ICON REINVENTED

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Abstract

The Knapp's Centre is a five-story Art Moderne building near the center of downtown Lansing, Michigan. The building was constructed in 1938 as the flagship downtown Knapp's department store. The building expanded ten years later, with the exterior designed to match the original design. Designed as a department store, the building reveals functional design characteristics: large expansive floor plates provided ample space for merchandise displays; natural light was brought into the building via ribbon glass block windows along the north and east elevations; on the first floor, large pieces of glass provided the storefront for showcase windows at street elevation.

The building remained a department store until 1980 when the Knapp's doors closed for the last time. In 1983 the building reopened as overflow office space for the State of Michigan. While the exterior remained untouched, the interior was divided into several different departments and offices. The state moved out in 2003 and the building has since sat vacant.

What made this building unique, especially to Lansing, was the exterior streamline design and materials. The exterior envelope on the north and east elevation was constructed mostly of a series of Maul Macotta panels and prismatic glass block. A series of four vertical pylons, also constructed of Maul Macotta panels, denote the four main entrances into the building. The Maul Macotta panels were finished using four colors, the field as bold yellow and the vertical pylons as dark and light blue. Horizontal accent banding was done with a dark blue. The fifth floor is set back from the main north and east elevation, and finished with a pale yellow Macotta panel.



Figure 1: 1948 image of knapps

When it was completed in 1939, the building was hailed in the contemporary press as "the most modern building in the Midwest."¹ Today, it is considered to be one of the finest intact examples of Streamline Art Moderne commercial buildings in the Midwest, notable for its size, clarity of design and brilliant colors.² [Figure 1]

The Maul Macotta System

The Maul Macotta panel was a proprietary system by the Maul Macotta Company. This panel system was constructed of three different components including a concrete backing, a metal panel with a porcelain enamel exterior finish and an aluminum trim. The panels were then hung from a series of steel girts attached to the building structure. As the building was constructed in two phases, ten years apart, the second phase did not use steel as the support structure for the panels. In lieu of the steel framing, a clay tile system was constructed and used as the backup system to the Maul Macotta panels. The panels were then cemented in place with the clay tile.

For the 1938 portion of the building, a series of column steel "H" sections wrapped the north and east elevations, installed every ten feet on center, anchored to the

concrete floor slabs. Then a series of horizontal steel angles spanned between each H steel column, providing the framing for the concrete. This steel framing also was used as the support for the prismatic glass block ribbon windows that wrapped the north and east elevations. [Figure 2]



Figure 2: existing steel girt framing system

The concrete was poured into a shape that allowed for the concrete to sit on an upturned steel angle framing member. The top of the concrete panel was held into place with a steel clip anchored to the concrete and braced against a downturned steel angle, all while maintaining a flush exterior finish. Embedded in the concrete was steel wire mesh reinforcement. [Figure 3]



Figure 3: cross section of concrete panel

From the exterior of the building, the concrete backing of the panels is not visible. The finish for the Maul Macotta panels was porcelain enameled steel. The metal panel was anchored to the concrete by a dozen or so small copper clips that were welded to the back of the metal panel. The concrete was then poured on top of

the metal panel, using the panel as a side to the form-work, and allowing the copper clips to be embedded into the concrete.

The exterior finish to the metal panels was a porcelain enamel finish, which provided the exterior durability and sleek appearance of the panels. Enamel is an extremely durable finish providing a high level of protection to the steel and, in this case, the exterior envelope of the building. Used for building cladding, the enamel finish can withstand extreme temperatures and is non-flammable, UV-, climate- and corrosion-resistant. Additionally, it is easily to clean and maintain.³

The final element to the Maul Macotta panel was the aluminum trim. Banding the perimeter of the panel, the trim provided a finished edge to the metal panel and a transition to the concrete. Shaped similarly to a corner bead, the trim slipped over the edge of the metal panel. The side was then cast into the concrete, securing the trim in place. The trim also provided the framework on the edges, allowing the Maul Macotta panels to be squared, and to be placed adjacent to each other with tight fittings. [Figure 4]

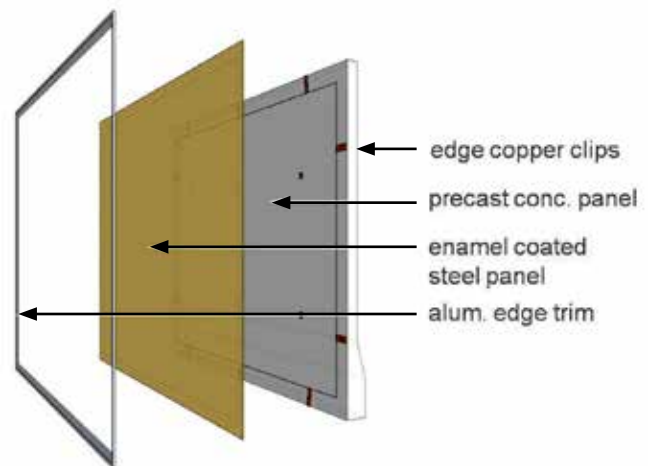


Figure 4: exploded diagram of the maul macotta panel

All of these elements comprised the panel system that was then supported from the steel framing system. Through the design of the steel framing structure supported off the concrete floors, and the design of the panels to mount to the steel, this system was the beginning of an early curtain wall system. As this system of construction was experimental, seventy-five years later we are reviewing the conditions of the system and trying to understand why elements have failed, as well as the ways to restore and/or correct the system.

The first objective of the restoration of the exterior envelope was to understand the Maul Macotta system and its failures. The panels showed three different signs of deterioration and failure. First, there was evidence of

rusting through the porcelain enamel on the exterior of the metal panels. Second, there were panels where the metal panel had completely sheared off from the concrete backing, exposing the concrete. Third, as viewed from the interior, the concrete had begun to deteriorate, exposing the embedded metal lath which had begun to rust.

All indications led to moisture being trapped in the exterior skin. At some point in time, as a method to mitigate water infiltration, all of the joints between the concrete panels were caulked. While this treatment helped to prevent the moisture from entering the system, it also prevented the moisture from exiting. Therefore, moisture was trapped in the wall, with the concrete acting like a sponge. The original system, though it allowed moisture into the system, also allowed the moisture to evaporate out.

The visible rusting on the exterior was mostly noted around the perimeter of the panels. These markings appear to be areas where the exterior porcelain finish was damaged, allowing moisture to access the steel from the exterior. [Figure 5]



Figure 5: rusted metal panel

The second objective was to determine the explanation of panels sheering off from the concrete. By looking at the concrete, we could tell the clips were made of copper and that the clips were either still in place, or broken off at the face of the concrete. By looking at the back side of the metal panels, rusting was visible where the copper clips were anchored to the metal panels. While the copper did not rust, the connection between the two metals did, resulting in the metal panels becoming disengaged from the concrete. As the concrete retained moisture, the copper clips and their connection were in constant contact with the moist concrete and, therefore, the weakest connection of the system. Over time, the moisture continued to erode away, eventually causing joint failure between the copper and the metal panel. [Figure 6]



Figure 6: Panels where the metal panel has sheared away from the concrete

A portion of the interior wall was removed where, from the exterior, the concrete panels were severely deteriorated and or missing. On the backside of the concrete, enough concrete has spalled, exposing the steel reinforcement cast into the concrete. [Figure 7] As expected, the exposed reinforcement was rusting. Like the condition above, the concrete acted as a sponge and absorbed the moisture. The concrete constantly keeping moist allowed for the reinforcement in the concrete to rust, placing pressure on the concrete, causing it to separate from the steel and break apart.



Figure 7: back side of concrete panels as viewed from the interior

All three of these conditions pointed to moisture in the wall. Originally, the system was not caulked, allowing the moisture to escape through the exterior assembly. With the addition of caulking to all the joints, moisture was being contained in the wall. In addition, the interior wall did not contain a moisture barrier. Therefore, warm moist interior air was able to migrate into the exterior wall

system, again with the concrete absorbing the moisture. This allowed the exterior wall to constantly contain moisture, without a way for the moisture to escape, causing the level of deterioration observed in the Maul Macotta panel system.

In addition to the failure of the Maul Macotta panels, moisture was getting into the exterior skin through other failures, including deterioration of exterior masonry backup walls at the parapets, and through failure of the glass block system which will be discussed later. All of these conditions combined allowed for deterioration of the Maul Macotta panel system.

Understanding the failures of the system informed the potential solutions. The first goal was to understand the method of installing a proper moisture barrier. This would require building a new interior wall with sheathing. The second goal was to understand the ability to reuse the historic porcelain enamel metal panels.

Based upon the amount of moisture being contained within the existing exterior skin, it was assumed the existing steel structure used to support the concrete panels was also in poor condition. The steel structure was comprised of a series of angles welded together. Based upon assumptions, the original plan was to remove the existing steel structure used to support the panels. Therefore, a new structural cold-metal stud framed wall was designed to span from concrete floor slab to floor slab. The moisture barrier would then be applied to this new framing.

The next challenge was to determine the ability to reuse the historic porcelain enamel metal panels. The use of the existing panels with the concrete backing was not viable, so being able to attach the existing metal panels to a new system became the focus. Through much investigation, there were three issues that suggested that reusing the metal panels would not be the best approach.

The first step was to attach the panels to a new system. Originally the copper clips were welded to the back of the panel, and the concrete casted onto the panel. However, welding anything to the back of the metal panels would damage the porcelain enamel finish. Another option for anchoring would be to use mechanical fasteners. However, these would be visible from the face of the panels, thus creating a different appearance from the exterior. To use the existing metal panels, adhesive became the favorable approach as it would be a way to attach the panel without damaging the porcelain finish or altering the exterior view. However, adhesive is not a favorable building construction method, especially when referring to several hundred large metal panels weighing fifteen pounds each, mounted five stories above grade. This research led to the path of the necessity for full metal panel replacement.

The second issue was the replication of the metal edge band. Each panel was trimmed with an aluminum edge trim. The trim was applied to wrap the edge of the metal panel and cast into the concrete backup. While the trim has been caulked over for the past forty years, the edge trim is a character-defining feature of the metal panels.

Companies are available to create new porcelain metal panel systems. However, the inclusion of the metal edge trim proved to be tricky. The sequencing of the preparation and installation of the trim required the involvement of multiple companies. This scenario created a situation in which coordination and final responsibility of a finished product could not be guaranteed.

These two factors—the ability to reuse the existing metal panels, and the installation of the aluminum trim on a new panel—created the third issue of a warrantee. Under both conditions, the exterior skin could not be placed under a warrantee. This issue was not only important to the owner of the building, but also to the architects, pursuing a path in which the final result as planned would be a new exterior system to mimic the historic elements of the Maul Macotta system, while also providing a quality system designed to last.

Those three challenges brought the design of the exterior skin around to being constructed using a new modern day rain screen system. [Figure 8] Since the design of the Maul Macotta system, rain screens have evolved, now allowing moisture to enter the system and properly drain while preventing moisture and air from infiltrating into the building.

The design intent was to remove the existing steel structure that was used to support the Maul Macotta panels. A new structural metal framed wall was to be built bearing on the existing concrete floor slabs. Once the Maul Macotta panels were removed, the existing steel structure appeared to be in better condition than expected. Structural analysis determined the steel was still in good enough condition and could bear the support of the new rain screen system. The steel was then left in place, prepared and painted to prevent any future deterioration. The metal framing system was then relocated from bearing on the existing concrete floor slabs to bearing on the existing steel framing.

The porcelain enamel is an extremely durable finish which provided a bit of a shine to the building. The porcelain enamel was applied over a metal panel. This new rain screen system would not be constructed using metal and porcelain; therefore, replication of the finish was critical to the overall exterior appearance of the new system. The new system was designed using an aluminum composite material. The panels were comprised of two sheets of aluminum thermally bonded to a polyethylene core. This system allowed for the flexibility of the custom shapes necessary for the radius at the corner of

the building, along with custom fluted pieces in each of the vertical pylons.

The composite panels were then coated with a finish to provide the appearance and durability of the porcelain enamel. This finish is comprised of a specialty plastic material in the fluoropolymer family known as polyvinylidene fluoride (PVDF). As a fine powder, PVDF is used as the principal ingredient of high-end paints for metals such as Kynar. These PVDF paints have extremely good gloss and color retention. This also allowed for custom colors to match the four historic colors on the building.

The final step needed to replicate the historic Maul Macotta system was the ability to install an aluminum trim edge around each panel. While a challenge for a new porcelain enamel panel, installation of the trim piece on the composite panel was no issue at all. The composite panel system was designed to have a gap between each panel, mostly for installation and movement of the panels. A custom extrusion was created to mount to the return leg of each side of the composite panel, with a



Figure 9: sample of new composite panel with trim

small flat piece along the edge of the panel to create the same look as the historic aluminum trim. [Figure 9] This trim was then also used as a way to reduce the "gap"

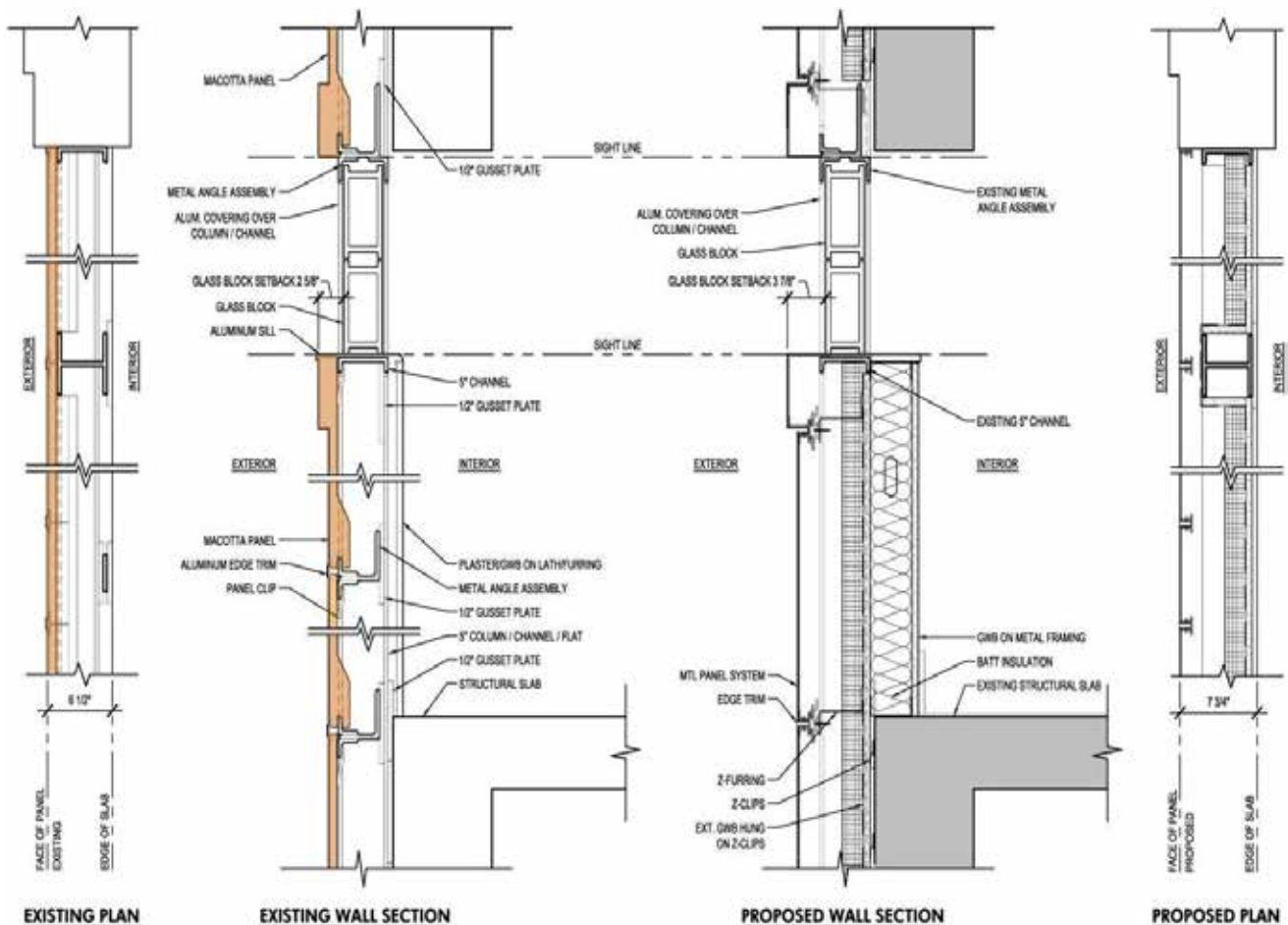


Figure 8: existing and proposed wall section and plan views

between the composite panels, to more closely resemble the narrow gap between the historic metal panels.

Overall, this new composite panel was able to meet all the character-defining elements of the historic Maul Macotta system, including the shape, sizes, color, reflectivity and appearance, while providing a state of the art modern day rain screen system. The full replacement of the system allowed for a uniform look across the north and east elevations, while providing a warranted system.

The Prismatic Glass Block

The second major component to the exterior wall were the prismatic glass block ribbon windows that stretched across the entire north and east elevations for four levels. The prismatic glass blocks allowed the natural light to enter into the building while limiting views to the exterior, thus keeping with the needs of the department store for which the original design was made.

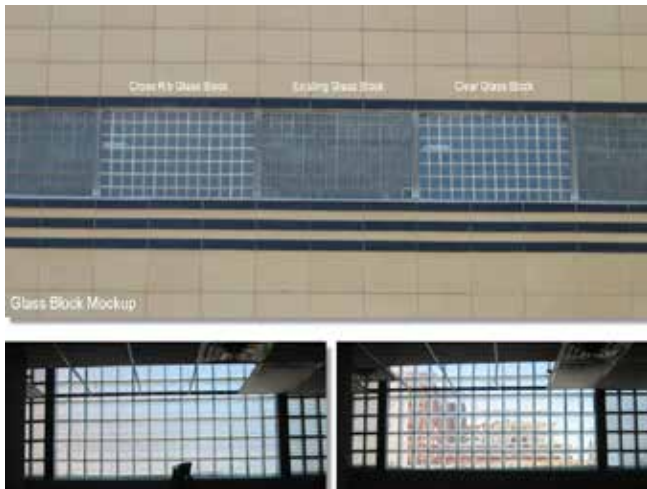


Figure 10: mockup of glass block, view from exterior and interior

Over time, individual glass blocks failed or broke, requiring select replacement. This created a patch work of original glass block, damaged original glass block, and replacement glass block. The design pattern of the original prismatic glass block is not a standard pattern manufactured today. In order to use a standard manufactured glass block today, a ribbed pattern is a replacement for the prismatic glass block. With the existing condition of the glass block, along with the available manufactured products today, full replacement of the glass block became the best solution.

The question became one of what to use as a replacement for the historic prismatic glass block. Though it was

originally designed as a department store, this portion of the building was slated for new use as Class A office space. The ability to see through a window and understand the exterior conditions was critical to providing a desirable office space. The desired preference was to replace the prismatic glass block with a clear glass block. This change would be in keeping with the style of the historic glass block, while updating it to meet the needs of the new tenants.

Mockups were completed to better understand the impact this change would have on both the visual appearance between the interior looking out, and the exterior looking inward. A mockup was done using currently manufactured cross rib glass block and clear glass block, with a section of existing prismatic glass block between. [Figure 10]

From the interior, the view between the cross rib and the clear blocks was significantly different. Though a bit distorted, the clear glass block allowed the user to visually connect to and understand the general surroundings of the exterior, such as shapes of buildings and weather conditions. The cross rib glass block did not allow for any visual connection to the exterior beyond the basic outlines of surrounding buildings. From the exterior, however, the difference between the cross rib and the clear block was not much different. One could clearly see a light fixture hanging behind each window. However, the prismatic glass block clearly obscured the view into the building.

Unexpectedly, what the mockups greatly demonstrated from the exterior was the difference in the mortar joint appearance between the historic glass block and modern day manufactured glass block. While gray mortar was used in the mockup, it appeared almost white when compared to the historic mortar. Being able to more closely match the appearance of the mortar from the exterior became a greater issue than expected.

The historic glass blocks were manufactured in two halves, fused together with a lead joint. [Figure 11] This lead joint created a darker appearance around the edge of the glass block. Modern day manufacturing of glass block fuses the two halves together with melted glass. This manufacturing technique created a much different visual appearance than the lead in the historic glass block. In addition, modern day manufacturing provides a white paint coating around all four sides of the glass block. This is done for better adhesion of the mortar to the glass. However, this white coating also reflects the light, allowing the edges of the glass block to appear whiter. These differences created a drastic difference in appearance from the exterior, regardless of the mortar color or style of glass block.

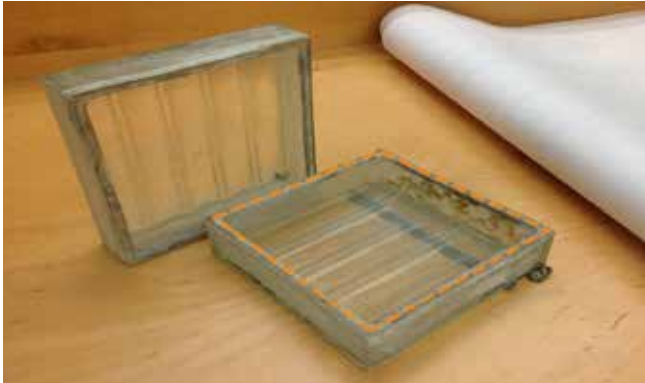


Figure 11: Historic prismatic glass block

The solution was to use a darker color instead of painting the perimeter of the glass block in white. This custom paint solution would not allow as much light to reflect, and would effectively darken the perimeter of the glass block, resembling more closely the darkness of the lead band around the historic glass block. [Figure 12] Once installed with the gray mortar, the appearance around the perimeter of the glass block was much closer to that of the historic glass block.



Figure 12: mockup of glass block with custom paint edging

The argument for support of the glass block change to clear was that, although it was an appearance change from the exterior, the style and rhythm of the ribbon glass block bands was consistent. The overall composition of the panels and glass block would remain, keeping in character with the design of the building regardless of the style of glass block used. In the end, the clear glass block was approved as an appropriate substitute, with the provision that the perimeter be painted the custom color.

Conclusion

Overall, the Maul Macotta system was an experimental early rain screen system. While modifications to the building in later years may have accelerated the system's deterioration, the system had its flaws that would eventually lead to the full removal of the system. Modern day rain screen systems have developed greatly over the past decades, allowing more opportunity and flexibility to accurately replicate historic design intentions while providing a contemporary solution. Without the ingenuity, creativity, and participation of all parties involved, chances are that this iconic building in downtown Lansing would have been lost or, if not, then modified so greatly that the beauty of its past would have been lost.

Endnotes

1. Lansing City Pulse. July 3, 2002.
2. J.W. Knapp Company Building, Michigan State Housing Development Authority, Historic Preservation Office.
3. Vitreous and porcelain enamels—Characteristics of enamel coatings applied to steel panels intended for architecture. Standards Policy and Strategy Committee. 2008.



Figure 13: november 2012



Figure 14: august 2014

MATERIAL CHANGE: ATTENUATION TO SIGNIFICANCE

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Abstract

Paul Rudolph (1918-1997) accepted the position of chair of the Department of Architecture at Yale University in 1958 after spending over fifteen years practicing architecture on the west coast of Florida. The well-published work from his Sarasota residency established Rudolph as the leader in the development of American regional modernism. This presentation will analyze the evolution of Paul Rudolph's output, from the relative lightness of his finely-tuned wood frame construction implemented after graduation from the Harvard University Graduate School of Design under Walter Gropius, to later Florida works engineered in concrete and steel. The advancement of monumentality and evolving material performance in Rudolph's design methodology will be tracked through his teaching at Yale University and evaluated in relation to the outcomes of student work from a new generation of architects.

Direct access to the Paul Rudolph archive at the Library of Congress (Prints and Photographs Division) and the Judith Chafee archive at the University of Arizona (Arizona Architectural Archive) provides the primary source material for this investigation, along with entree to the remaining architectural work.

Light Construction

Before consolidating his architecture office in New Haven, Connecticut in the early 1960s, Paul Rudolph practiced architecture in the southeastern United States, primarily on the west coast of Florida. He completed over seventy projects and built works in partnership with Ralph Twitchell and later in private practice. During this first phase of Rudolph's career, he utilized wood frame construction, thin steel profiles and recently developed cast-in-place concrete systems for residential construction. Projects were reduced to minimum material economy; an ethic of attenuation can be seen across the work. The efficiency of his naval yard experience is evident throughout Rudolph's early residential work in Florida, where finely-tuned buildings were linked carefully to local site conditions and material was employed deftly with a carpenter's logic. Local colleagues would often speak of the "Rudolphian" qualities of seemingly impossible material thinness and infinite strength—a tongue-in-cheek compliment delivered with a touch of envy.

In fact, Paul Rudolph would study each project thoroughly via drawing, as he had been taught at Harvard. This can be seen in the didactic spatial and construction technology drawings created during his partnership with Twitchell. These precise illustrations are evidence of a young architect attempting to study the component parts and constructive logic of a project before the full resolution is exhibited in perspective renderings and built work.

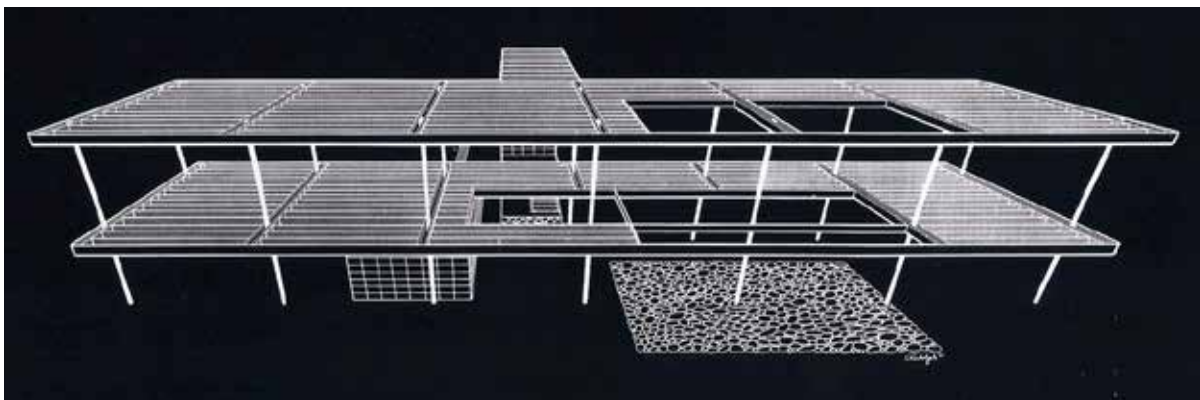


Figure 1: Leavengood Residence, Twitchell + Rudolph Architects, 1950-51
Image: The Library of Congress, Prints and Photographs Division

The systematic study of the building process in Rudolph's education can be traced to the pedagogy established by Walter Gropius and overseen by key faculty members at Harvard, including Marcel Breuer and Sigfried Giedion. In this context, students were tutored in professional studies, field practice and principles derived from historical precedent.¹ Both professional studies and field practice included the investigation of building process from the ground up. What were seen as typical or ubiquitous American construction systems, such as wood platform framing, were systematically explored and understood in relation to other building components and systems. The structural steel frame, linked to the strength of American industrialization, was also studied with equal vigor. Most importantly, students were encouraged to relate design intent to realities of materials and techniques; solutions were to be built upon the very real conditions of site analysis and client need. It was Gropius' interest in the "science of design" that defined the character of the advanced professional studies at Harvard.

Concurrent with Rudolph's master-level studies, Gropius published an article titled "Design Topics," which delved more explicitly into his scientific method understood in relation to the human condition: "I consider the psychological problems, in fact, as basic and primary, whereas the technical components of design are our intellectual auxiliaries to realize the intangible through the tangible."² There is little evidence of how the psychological was explored in the curriculum, but ample artifacts exist from the investigation of horizontal framing, steel columns, vertical circulation, height-cost ratio and wind bracing, among other topics. A portfolio of construction analysis drawings and a selection of Gropius' pedagogical writings were also published in the February 1950 edition of *L'Architecture d'Aujourd'hui*, edited by Paul Rudolph during his Wheelwright Fellowship from Harvard. In this publication, Gropius and the architecture faculty praise IM Pei's thesis project, "A Museum for Shanghai," because they felt that, "A modern architectural expression on a monumental level was reached."³

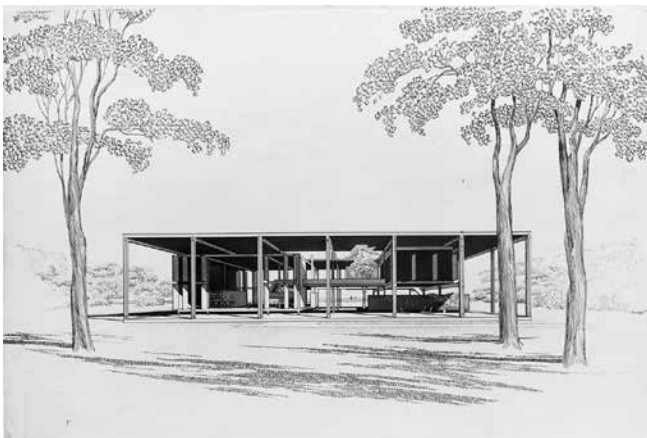


Figure 2: Burgess Residence, Paul Rudolph Architect, 1953
Image: The Library of Congress, Prints and Photographs Division

Professor Sigfried Giedion also had a strong influence on the intellectual development of the curriculum at Harvard during the periods directly before and after World War II. His articles "Nine Points on Monumentality" (1943, with JL Sert, F. Léger) and "The Need for a New Monumentality" (1944) influenced the development of work that began in the Bauhaus and was now taking root in the United States.⁴ These essays were, in part, a call for the re-establishment of symbolic expression in western culture, but in the hands of a new generation of architects dedicated to structural integrity and material logic. Monumentality took a new form and an ethical imperative. Giedion later taught at Massachusetts Institute of Technology (MIT) in the early 1950s with Rudolph, who was teaching as a visiting studio critic at the same school. In time, Giedion became a significant influence on Rudolph's intellectual development.

The organization of a new generation of architects in *L'Architecture d'Aujourd'hui* offered Rudolph a leadership role in the profession that strengthened his professional and academic reputation. Through travel, he gained access to major examples of European modernism and witnessed, first hand, the need for Giedion's provocations as Europe began to rebuild after World War II. Individual buildings were rebuilt within the existing urban fabric and entire towns were under redevelopment. Through organizations such as the *Congrès Internationaux d'Architecture Moderne*, and its well-circulated proceedings, an increased focus on urban planning strategies began to extend Rudolph's thinking beyond the single-family house. Large public buildings and groupings of buildings within a defined urban context influenced his residential architecture and paved the way to a new phase of work. The Charles Burgess Residence on Little Bokeelia Island, south of Sarasota, exhibits his early foray into monumental expression through the overarching classical frame of the canopy that organizes a group of interconnected pavilions underneath. Within the residential program, Rudolph began to layer a new set of issues that widened his scope and priorities.

During his partnership with Twitchell and the early years of Rudolph's private practice, starting in 1952, invitations as a guest lecturer and visiting design critic increased at schools such as MIT, the University of Pennsylvania and Yale University. Rudolph would often assign design problems based on commissions in his office. During the early 1950s, a residential program along a coastal setting was an ideal student offering. This strategy was logical due to the fact that his teaching invitation was often based on the strength and ingenuity of residential work completed along the west coast of Florida and the reasonable assumption that students would confront similar programs upon graduation.

"Paul Rudolph was a great teaching personality. None of his students could resist his insistent train of thought, nor indeed did they want to. Discussions with him were always of the utmost intensity. Our fascination with him lay in the credibility and the

captivating aura of his personality. Our days together at MIT began at eight o'clock in the morning. During the strenuous phase toward the end of the project when we worked day and night on our designs, it was not uncommon for him to take us away from our drawing boards, over which we had fallen asleep during the night, and we would end up in one of the pubs on Harvard Square. As far as our work was concerned, he was unrelenting; but he made up for this with his inimitable ability to motivate his students to outstanding achievements. In spite of all our cheerful toils, my memory of Paul Rudolph is of an inspired and gifted teacher.

My design for a beach house at Cape Cod gained his appreciation. He thought the question of scale and the relationship of the house to the location had been properly resolved. He expressed doubts about the use of stone rubble to the end walls. On the other hand, my drawings received his unreserved approval."⁵

- Hans Busso von Busse

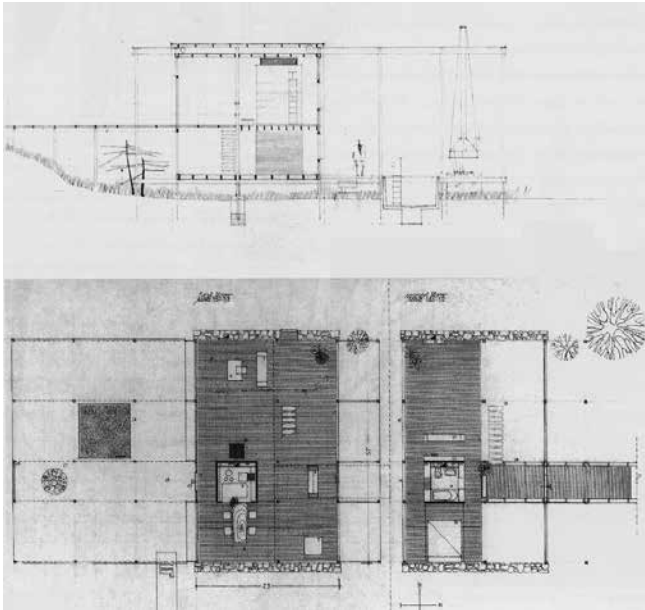


Figure 3: Cape Cod Beach House Project, Hans Busso von Busse, 1954

Paul Rudolph, Design Critic

Image: Hans Busso von Busse Architekten

Along with his published renderings, Rudolph often shared lessons from practice with students, including the time-tested strategy that, "Architecture is a process of finding out what you need to know."⁶ For Rudolph, the key to this search was drawing and redrawing. Defining a discipline based on the search for, and resolution of, the unknown offers enhanced opportunity compared with limiting expertise to what is already known. This heuristic, research-based methodology quickly moved into vetting multiple options and, finally, iterative project development.

Rudolph was in his mid-thirties at the inception of his private practice, but he already had a significant body of work to display, along with some valuable counsel from Gropius and Breuer and the technical skill honed in part-

nership with Ralph Twitchell. The young architect also developed a deep respect for regional adaptation in vernacular building that was encouraged by his teacher E. Walter Burkhardt, a professor at Alabama Polytechnic Institute.⁷ Burkhardt, an emigre from Germany and the first District Administrator for the Historic American Building Survey (HABS) in Alabama, introduced Rudolph and a generation of students at Alabama Polytechnic Institute to the value and function of buildings that surrounded their daily routines. Administration of the HABS program came organically to Professor Burkhardt, for he was known to require students to complete measured drawings of historic structures as an integral component of an architectural education. In fact, it was Professor Burkhardt that supported Rudolph's application to Harvard in order to complete his formal education.

Florida to New Haven

In the mid-1950s, Paul Rudolph was a peripatetic university lecturer and kept two small offices engaged with his expanding number of commissions. Work developed in Rudolph's Cambridge, Massachusetts office assisted with the expansion to other locales. The completed projects display a broader range of material conditions along with an increase in scope and ambition.

"I first met Paul Rudolph in 1956 when I became an apprentice draftsman in his Cambridge office. I worked on drawings for the Jewett Arts Center, the Blue Cross-Blue Shield Building in Boston, the United States Embassy in Amman, and many other projects both large and small. I was constantly amazed by his extraordinary imagination and seemingly boundless creativity. His uncompromising pursuit of excellence attracted the attention of many talented students of architecture and design, and inspired his contemporary practitioners as well.

During the three decades since I first met Paul Rudolph, his distinguished professional achievements have multiplied. His years at the Yale School of Architecture opened a refreshing new chapter in architectural education. His completed works today are found in many areas of the United States and in a number of foreign countries; these form the basis of his well deserved international reputation for excellence in architecture.

Very few practitioners have had greater influence on the architecture of their times than Paul Rudolph has had on his."⁸

- William Morgan

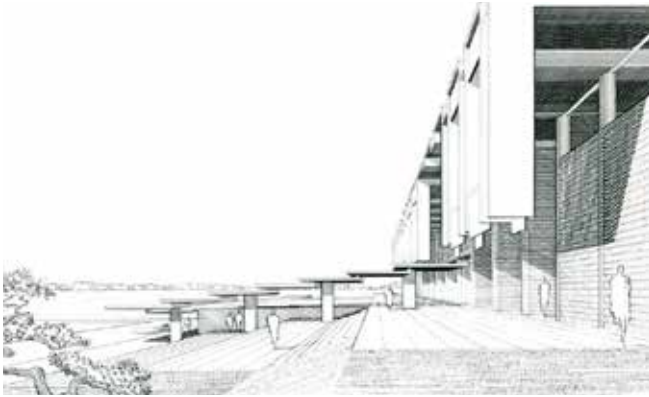


**Figure 4: Sarasota High School Expansion,
Paul Rudolph Architect, 1958-60**

Image: The Library of Congress, Prints and Photographs Division

Projects for the Jewett Arts Center (1955-58) at Wellesley College and the Sarasota High School expansion (1958-60) were both administered out of the Cambridge office and display an awareness of linkages to existing building fabric. Rudolph's direct engagement with building precedent of the distant and recent past is clear in the architect's decisions in the works, including the expansion of a collegiate gothic quadrangle at Wellesley and respectful references to the current work of Le Corbusier with his employed palette of massive materials such as cast-in-place concrete and stacked stone.

A Beautiful Education: Yale 1960

Paul Rudolph began his first full-time academic position at Yale in the fall of 1958. To his advantage, he took leadership of a program in which he was already a visiting design critic and was highly respected by the students.

"I was a student of Mr. Rudolph in the spring of 1957, his first semester of teaching in the graduate school at Yale. It was my final semester, working on my thesis project. Mr. Rudolph as a critic was a wonderful influence, open to all avenues of thought. There was a lot of give and take, a continuous exchange of ideas. I particularly appreciated my visits to his newly opened office in Cambridge for critiques. That fall, he became chairman of the architecture department at Yale.

A number of years later, I returned to Yale as a visiting critic on the faculty. As chairman, Mr. Rudolph surrounded himself with a faculty of very diverse persuasions, providing the school with the rich pluralism that continues to be the strength of Yale

today. Choosing his faculty carefully, he never interfered with those teaching in the studio.

During his teaching tenure at Yale, he was, of course, working on the designs of several extraordinary additions to the campus. Here we had a giant of a practitioner and a giant of a teacher at the same time, a rare feat for any institution."⁹

- Harold Roth

Rudolph assumed command from acting chair Henry Pfisterer, a professor of architectural engineering, who was able to rescue the professional reputation at the School of Architecture from previous leadership and return a level of skillful competence to a program that had become known for its faculty discord. When Rudolph arrived, the program was on strong footing and he was able to reorganize the visiting faculty roster and reinvigorate the design studio curriculum. The early transition phase offered what some students viewed as the ideal dual-natured architectural education in the hands of two skilled educators: Louis Kahn and Paul Rudolph.

"Kahn was a poet, he was a metaphysicist, he spoke about architecture as if it were a religion. He was interested in meaning, in the symbolic content and impact of architecture. Rarely could you get him to talk specifically about how he was trying to implement. It was very broad, and almost had a kind of personalized morality to it that was very stimulating but also very frustrating for students because as any student I wanted to know how he did it. I wanted the key. Rudolph, on the other hand, I considered and still do consider to be the absolute genius of architectural tactics and architectural techniques—I am talking about design techniques."¹¹

- David Niland, M.Arch, '60

The School of Architecture studios were located on the top floor of the University Art Museum, which had been completed by Kahn in 1953. From the students' perspective, the location was ideal. Studios were open and spacious with a provocative triangulated roof, lofted above the desks, that personified Kahn's evolving language of geometry and material precision. Paul Rudolph's Arts and Architecture building site was well within view of the floor-to-ceiling glazed walls to the northeast. The matriculating 1960 baccalaureate class were fortunate to have Rudolph directing their thesis projects and Louis Kahn offering a masters class in the space adjacent to their first-year studio. Overhearing Kahn's class at the beginning of the program was, for some, an education in itself.¹² This bookend training—with Kahn lecturing about essential conditions of architecture at the outset and Rudolph coordinating design techniques and urban planning in the final months—provided a rich and varied intellectual scaffolding for this graduating class. During third year, James Stirling directed a Hotel for New Haven project and Mies van der Rohe led a two-week sketch problem at Yale for a small office building in an urban context.

Many advanced students in the School of Architecture would also work in Paul Rudolph's office during the night and evening hours as deadlines increased for Rudolph's rapidly expanding practice. These students included Judith Chafee, James McNeely and Stanley Tigerman. This experience would allow the students to pull the curtain back and understand more about Rudolph's personal definition of architectural practice and how the life and work of an architect like Rudolph was intertwined.



**Figure 5: J. Chafee Portrait, Yale School of Architecture
University Art Gallery, Top Floor Baccalaureate Studio
Image: Arizona Architectural Archive**

It was in the work of this matriculating cohort that Rudolph's skill as an educator and a leader of the program became evident. For the first time during Rudolph's tenure at Yale he personally managed the direction of the undergraduate thesis studio. Students in the class of 1960 were encouraged by this individual attention and enlivened by the prospect of developing their own site and program for the final project, which included a United States Embassy for Afghanistan (J. McNeely), a Shakespearean theater for Central Park, New York (T. Prentice), an arts building for Bennington College (J. Chafee) and an apartment tower in Chicago (S. Tigerman). Students could expect at least one formal desk critique each week during the development phase of the project.

"I had my first [thesis] crit from Rudolph and was bowled over by the eloquence, the understanding, the perspicacity of the man. He set my head spinning over the ground he could cover in a few minutes. Most important of all, he taught me a methodology for studying the problem—listing all possible alternatives in plan and section at the tiniest scale (but not inaccurately) and checking off various ones for various advantages. Obviously, in this way he gets through the entire conceptual stage of the problem very quickly. It seems very important not to bog down at this point—to try everything very quickly. Why do I move along so slowly on my own? Now I must begin the quest for detailed knowledge of (1) soil moving and retaining walls, (2) pre-cast concrete details, (3) plans of Middle Eastern compounds, i.e., Khorsabad, Persepolis, Pataliputra."¹³

- James McNeely

The final semester review was a major event in the school and was well-attended by students and an elite group of guest critics—formidable practitioners from Boston, New York and London. Because of his reputation, Rudolph was able to attract a strong group of students and a small, but dedicated, cohort of full-time faculty. The remainder of the curriculum was taught by a roster of guest critics including: Jean Paul Carlhian, John Johansen, Paul Mitarachi, Ladislav Rado, James Stirling, Harry Weese and King-lui Wu.

In a photo of Judith Chafee's undergraduate thesis review, Paul Rudolph and Philip Johnson are at the center. On the far left is Jean Paul Carlhian, Principal at Shepley, Bulfinch, Richardson and Abbott. Carlhian was a regular guest critic at Yale and students spoke highly of him as a teacher and practitioner. The juror behind Chafee is Henry Pfisterer, former program chair and Rudolph's structural engineer on many of his large projects during the early 1960s.



**Figure 6: J. Chafee Undergraduate Thesis Jury, 1960
Image: Arizona Architectural Archive**

"...a great architect, educator, philosopher, artist and practitioner. Totally dedicated to the exercise of his profession, over a lifetime, he has been a source of inspiration to a whole generation.

He has taught us all a respect for the site, its configuration and context (re: the Jewett Arts Center, the Boston Service Center). Deeply concerned with the nature of materials, their assembly, articulation and expression whether it be the sheen of steel (57th Street Townhouse) or the roughness of concrete (the Tuskegee Chapel), he has proven to be a patient searcher as well as an innovative achiever...

His tenure as chairman of the Department of Architecture at Yale, on which I was privileged to serve, inspired its diversified faculty and its inquisitive student body to the brightest degree of achievement by developing intellectual curiosity and fostering debate.

Steeped in personal convictions, his philosophy, expressed in countless articles, lectures and interviews, never failed to stimulate new thoughts if sometimes controversial.

Paul Rudolph remains a creative artist of the highest order. His talent as a delineator finds its expression in an array of beautiful drawings not only royal in size but imperial in conveying the scope of his unique vision.

The large volume of executed work is a testimony to the richness of his inventive abilities."¹⁴

- Jean Paul Carlhian

Stanley Tigerman's final baccalaureate project cut a strong profile in the room with a model topping out at over six feet. The base level and apartments were organized in a dynamic pinwheel configuration with alternating projections and subtractions. An ensemble of solid and void defines interior and exterior zones of privacy for each resident along with uninterrupted prospect to the surrounding city or lake. Massive walls rise out of the ground and provide a solid foundation for the individual dwelling units that project a modular singularity, which could be efficiently produced in cast concrete.

"There is no doubt that Paul Rudolph was the single best teacher (in whatever subject and at whatever academic level) that I ever had in my entire life. He was the most rigorous, lucid and articulate man to down the architectural academic pike, since his own mentor Walter Gropius (I have always secretly felt he was actually better than Gropius, though, of course I cannot substantiate that claim). He managed to cajole, demand, extract and finally get a level of work from the students at the Yale of that epoch that none of us thought possible."¹⁵

- Stanley Tigerman

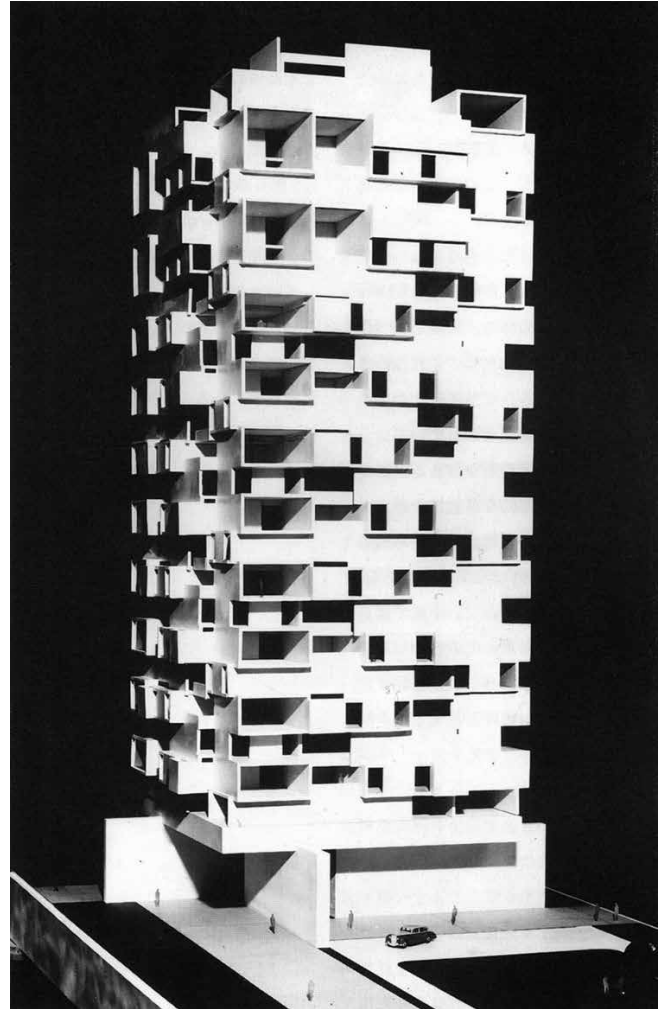


Figure 7: S. Tigerman Undergraduate Thesis Project Model, 1960
Image: Tigerman McCurry Architects

"If I had to single out one teacher to whom I was most indebted it would, without question, be Paul Rudolph. I was privileged to be in his masters class at Yale in 1962 and I know that a generation of architects who likewise came under his influence both from the United States and elsewhere around the world [and] who share my sentiments. But Rudolph challenged through his buildings, as well as his teachings, and they always reward the pilgrimage to them."¹⁶

- Norman Foster

Judith Chafee continued after graduation in the office of Paul Rudolph in order to assist with the development and completion of the Arts and Architecture Building, Married Student Housing for Yale University and a residence in Baltimore, Maryland. Before concluding her ten-year internship in the northeast, Chafee worked with some of the most revered architects practicing in the 1960s: The Architects Collaborative (Walter Gropius/Sarah Harkness/Benjamin Thompson), Eero Saarinen + Associates (Kevin Roche), and Edward Larrabee Barnes.

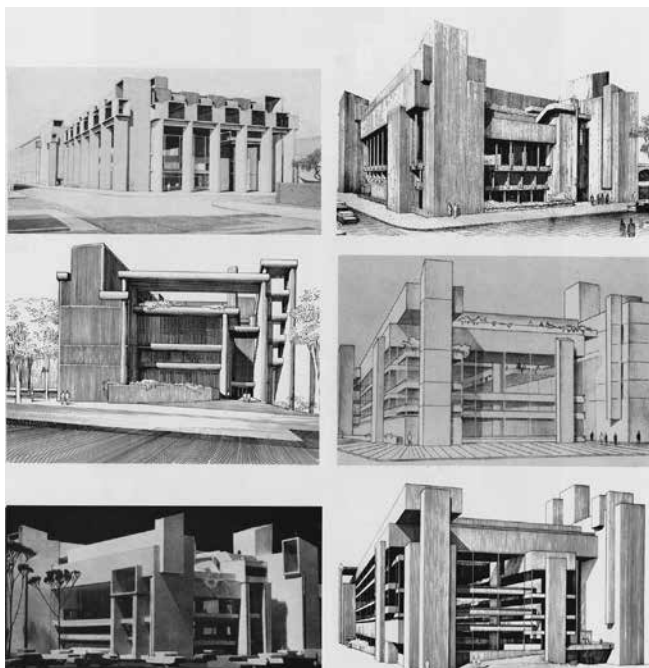


Figure 9: Yale University Art + Architecture Building Design Drawings

Paul Rudolph Architect 1958-63

Image: The Architecture of Paul Rudolph, Praeger

Both in the office and the Yale School of Architecture, Rudolph would bring an intense level of dedication to each task. Much as was the case in discussions during desk critiques with students about the proper resolution of a design problem, Rudolph would study a building commission through the lens of iterative development. This is evident in the progression of the Art and Architecture building over time, as he moved from the thin planes of precast and cast-in-place concrete, similar to his strategy for Sarasota High School, to the relatively massive iterations that followed and the ultimate striated concrete building that we know today at the intersection of Chapel and York Streets in New Haven. The move from site-sensitive environmental tuning of his work in Florida to urban composition and programmatic choreography is physically evident in the monumental expression developing on campus at Yale. James McNeely wrote this remembrance in a diary entry during his tenure in the Rudolph office:

"A hi-fi set played Bach, the sun shines in a [36-foot long] wall of glass, tea comes twice a day, and conversations flow in the conversation pit. I have been placed [at the desk] in front of Rudolph's – quite the best place from my point of view. No one else seems to want it anyway. He has not really spoken to me yet, only nodded when I first walked in. I have overheard all his letters, speeches and reports being dictated, and have seen conferences on the Art and Architecture Building including with the Yale provost, the engineers (all kinds), the contractor (Macomber), and the architect and job captain, Ulli Scharnberg. I have heard more in three days than in a year..."¹⁷

- James McNeely



Figure 10: Yale University Married Student Housing

Paul Rudolph Architect, 1960-61

Image: The Library of Congress, Prints and Photographs Division

The renewed focus on massive materials and the expression of their unadorned qualities certainly appealed to Judith Chafee when she returned to Tucson, Arizona in order to begin her private practice in a connected series of adobe and brick residential structures located in Tucson's historic core (a neighborhood now known as El Presidio). Much like Rudolph's New Haven architecture office, Judith Chafee developed an adaptive reuse project that respected the historic form of the existing urban context but expanded the interior to graciously allow for an architect's studio and residence to coexist in close proximity.

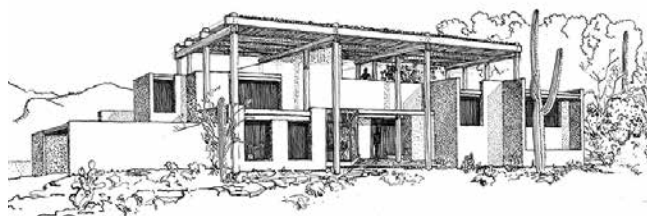


Figure 11: Ramada House, Judith Chafee Architect

Tucson, Arizona, 1973-75

Image: Arizona Architectural Archive

Judith Chafee's later design for the Ramada House substitutes traditional adobe for concrete slump-block finished with a mortarwash. The walls appear to rise out of the Sonoran Desert floor. [Figure 11] A roof deck and large glass openings in the walls are protected from above by a sheltering roof canopy that Chafee relates to a Papago ramada, or vernacular shade structure.¹⁸ Paul Rudolph's embrace of the later work of Le Corbusier finds its way to southern Arizona through the work of Chafee's office.

Stanley Tigerman's Saint Benedict's Abbey, developed a decade after Yale graduation, is nestled into the ground with 68-foot square earth-sheltered cast-in-place concrete walls with a heavy timber sheltering roof.¹⁹ The interior is lit from above through glazed subtractions in the planar roof system. The continuous interior sanctuary walls of unadorned concrete and exposed form ties are only broken by deep-set openings defined by shadow. This massive structure, rooted in the earth, provides a stable frame for spiritual exercise and intimate retreat with the divine. [Figure 12]

Other students in the class of 1960 continued to work with Rudolph on his major projects for the Boston Government Service Center or the associated architect Desmond and Lord.

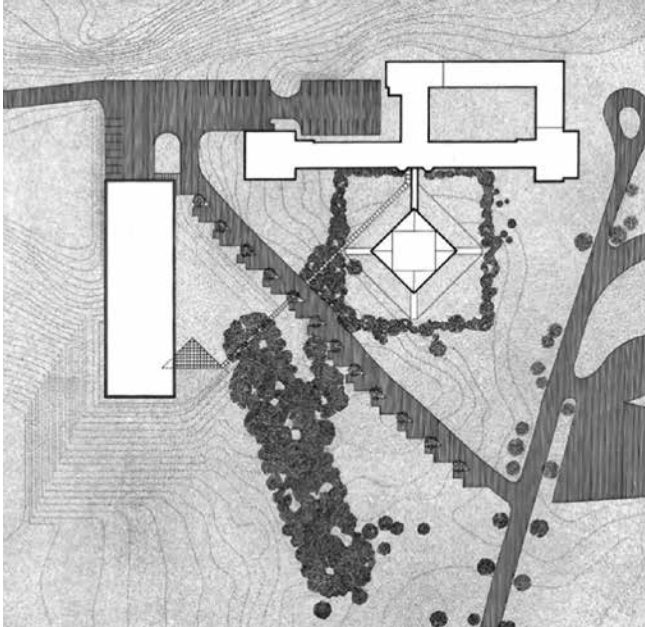


Figure 12: Saint Benedict's Abbey, Site Plan
Stanley Tigerman + Associates
Benet Lake, Wisconsin, 1969-1972
Image: Tigerman McCurry Architects

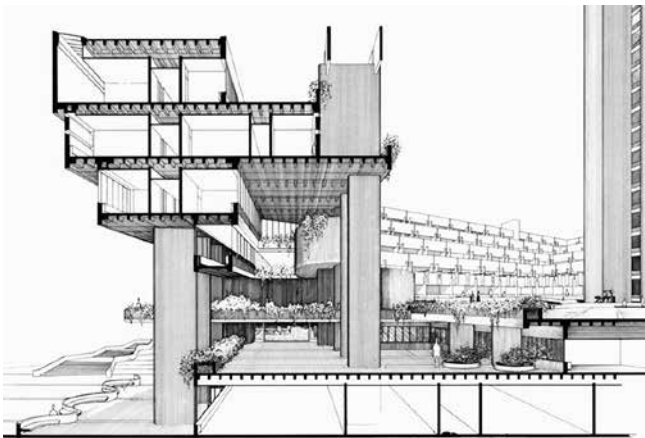


Figure 13: Boston Government Service Center, Section Perspective
Paul Rudolph Architect, 1962-71
Image: The Library of Congress, Prints and Photographs Division

Even though public taste for Rudolph's monumental public buildings inevitably fell out of favor, his massive corrugated concrete buildings and ethical integrity inspired a generation of architects to begin their own practices based on lessons learned in the Yale architecture studios and Rudolph's influential office at 31 High Street in New Haven.

The permanence and virtuosity of Rudolph's large public projects, such as the Art and Architecture Building at Yale University, the Southern Massachusetts Technological Institute and the Tuskegee University Chapel, inspired sincere dedication in his students. As his brightest apprentices transitioned into private practice, they would summon Rudolph's energy, seemingly boundless imagination and originality as they laid the foundation for a new generation of work that respected the significance of materials coupled with the correlated magnitude of sustained professional practice.

Endnotes

1. Gropius W, *Scope of Total Architecture*, Collier Books, 1962 (first published as "Training the Architect," 1939), 54.
2. Gropius W, *Scope of Total Architecture*, Collier Books, 1962 (first published as "Design Topics," 1947), 30.
3. Gropius, W, In: *L'Architecture d'aujourd'hui* 20, Rudolph P Ed., February 1950, 76-77.
4. Giedion, S, *Architecture, You and Me: The Diary of a Development*, Harvard University Press, 1958, 25-51.
5. von Busse H B, Hans Busso von Busse on Paul Rudolph, In: *Architects on Architects*, Gray S Ed., McGraw Hill, New York, 2001, 198.
6. Sudjic D, quoted from Norman Foster: *A Life in Architecture*, The Overlook Press, New York, 71-72.
7. Houghton, M, E. Walter Burkhardt, FAIA, In: *Pioneers in Preservation: Biographical Sketches of Architects Prominent in the Field Before World War II*, Daniels, B Ed., AIA Pamphlet, February, 1990.
8. Morgan W, from Letter in support of Paul Rudolph AIA Gold Medal Application, Collection of Carl Abbott, 1986.
9. Roth H, from Letter in support of Paul Rudolph AIA Gold Medal Application, Collection of Carl Abbott, 1986.
10. Stern, S, Yale 1950-65, In: *Oppositions* #4, October 1974, 43-44.
11. Niland, D, Interview with David Niland, In: *GA Houses* 13, March 1983, 70-71.
12. Molloy, JJ, Interview with C Domin, March 13, 2015.
13. McNeely, J, from unpublished diary entry (digital version), Collection of James McNeely, Feb, 15 1960.
14. Carhian J P, from Letter in support of Paul Rudolph AIA Gold Medal Application, Collection of Carl Abbott, 1986.
15. Tigerman S, from Letter in support of Paul Rudolph AIA Gold Medal Application, Collection of Carl Abbott, 1986.
16. Foster N, from Letter in support of Paul Rudolph AIA Gold Medal Application, Collection of Carl Abbott, 1986.
17. McNeely, J, from unpublished diary entry (digital version), Collection of James McNeely, Nov 1, 1961.
18. Naim, J, *Desert House Revives its Regions Traditional Forms*, *Architectural Record*, February 1979, 107-110.
19. Schmetz, M, *Interior of St. Benedict's Abbey*, *Architectural Record*, January 1973.

SEPARATING BABY FROM BATHWATER: CONFLICT RESOLUTION IN MID-CENTURY MODERN MATERIALS, SYSTEMS & FORMS

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Abstract

Religious architecture is a dominant expression of Mid-Century Modernism in St Louis and throughout much of the Heartland. The embrace of Modernism nourished spiritual exploration in the confluence of building and environment, and encouraged experimentation in the interplay of form, light and space. In context — following World War II — these structures represent a period of national expansion, space discovery, cheap energy and a palette of new building materials and systems that brought Eisenhower's famed "military-industrial complex" to the doorstep of historic city centers and nascent suburbs alike. In its zeal to break with tradition, Modernist aims led to some unlikely marriages of material and form, many of these now seen as Modernism's Achilles' heel and the origin of specific pathologies of deterioration.

For preservation professionals, Modernist religious structures provide a potent laboratory for illuminating issues relating to authenticity, maintenance, resiliency, code compliance, material science and sustainability. They challenge us to reflect on, expand and even reinterpret precepts of preservation including the time-honored *Secretary of Interior's Standards* and Venice Charter, each now celebrating its 50-year milestone. In order to specify appropriate treatments, preservation professionals must be able to ascertain both why modern building systems fail as well as the contribution each system brings to the whole. Cast-in-place concrete, exposed & embedded metals, roofing membranes, glazing and HVAC systems often are targets for wholesale replacement because of inadvertent biases built into computer modeling and building codes. As such, they are flash points for those seeking a more refined approach that would maintain technological authenticity while keeping the building functional, durable, comfortable, efficient and healthy. It is critical that the often-brilliant innovations of Modernism not be discarded simply because they are misunderstood, untested or incorporate components that have failed but are readily renewed.

Tools for testing and analysis do not discriminate based on architectural style or age. Processes that have proven successful in measuring critical levels of performance at traditional historic sites are easily adapted to special conditions and materials represented in Modernist buildings. Performance data — based on true conditions, not computer models — are the underpinning of holistic preservation decision-making. Evaluations need not be costly, and have proven invaluable in pinpointing issues to be addressed: what to keep, what to change. Using case studies of St Louis Mid-Century Modern religious structures, this paper illustrates approaches and concepts of analysis that is at once different from, yet similar to, that which preservation professionals have been employing at traditional heritage sites for years. Its intent is, foremost, to establish a clear paradigm for critical field evaluation of space-age materials, systems and assemblies — to see their value as timeless and irreplaceable, not something to be "upgraded." Unbiased analysis and hard data are keys to establishing and deepening awareness of the superlative performance these vintage buildings already possess, in part and in whole. Lessons offered through diagnosing religious structures have far-reaching applicability to the vast landscape of Modernist buildings, both prodigious and mundane.

Prologue

What a paradox that Mid-Century Modern buildings are becoming historic along with the National Historic Preservation Act of 1966 — and *Secretary of Interior's Standards* — which was enacted in large part to protect heritage buildings against an onslaught of urban renewal and the threat of displacement, or ruin, by Modernism. Once polar opposites, they both now would benefit from an introspective look in the mirror, as their validity increasingly depends upon one another. The *Secretary's Standards* have been updated recently to address pressures placed on traditional buildings by newly adopted and far-reaching energy conservation codes, which

are becoming increasingly stringent, and acknowledge many of the inherent sustainable attributes of heritage buildings brought to light in seminal publications over the last decade.¹ The trouble is, unlike traditional heritage sites, Mid-Century Modernism was born during the Era of Cheap Oil; consequently, little consideration was given to energy conservation.

In that light, the well-worn mantra of sustainable preservation² should be qualified:

"The Greenest Building is the One Already Built...Before 1950"

But that wouldn't represent the whole truth. In fact, despite common attitudes, many Modernist buildings were exemplary — far ahead of their time — in acknowledging issues of environmental concern and stewardship, incorporating some very inventive, even traditional, forms of "green" building. Some of these are highlighted throughout this paper.

Of all the challenges facing Mid-Century Modernism and applicability of the *Secretary's Standards*, foremost must be the rigidity and immutable nature of evolving energy conservation codes. For example, the 2015 International Energy Conservation Code (IECC) eliminates a prior blanket exemption for historic buildings, now instead requiring submission of a report detailing why any code provision would be detrimental to the historic character of a building. As such, the final decision relative to meeting an applied code relies on the unequivocal strength of support offered via the *Secretary's Standards* of the purported significance of the site, in a clear enough voice that a building official may concur. For Mid-Century Modernist buildings this is a formidable hurdle since public perception of the significance of this genre — especially as valuable historic resources — often was, and remains, negative.

"Modern Buildings Need Not Be Ugly"

This quote — the headline of a 1959 St Louis Globe-Democrat newspaper article³ — summarizes one of the most significant challenges facing the preservation community: from the beginning, people have had a hard time warming up to Modernist architecture⁴. Even Richard Neutra, the celebrated modernist who taught at Washington University in St Louis, commented (also in 1959), "most [modernist churches] look as though they've been designed by atheists."⁵ This rather indelicate reference is a useful point of departure: claims like these made by contemporary insiders and practitioners reflect a still-widely-held distaste of Modern architecture by the public, including members of the architectural, planning and preservation communities.⁶ In our decision-making — particularly about the removal and upgrade of original elements of design — we need to be mindful not to inflict deeply entrenched biases, nor rely on old modes of specifying remedies to perceived degradation and shortcomings. Innovative architecture deserves — and demands — innovative approaches to its care and stewardship.

To illustrate this point, eight St Louis area religious properties⁷ representing a palette of styles within the Mid-Century Modern movement (1940s – 1960s) were selected and analyzed to highlight problems and opportunities that are often discovered hidden beneath layers of misunderstanding and misguided change. These signature buildings embody a wide range of the era's prominent forms, materials and technologies; they are instructive in guiding and highlighting informed approaches to preservation, restoration and refinement.

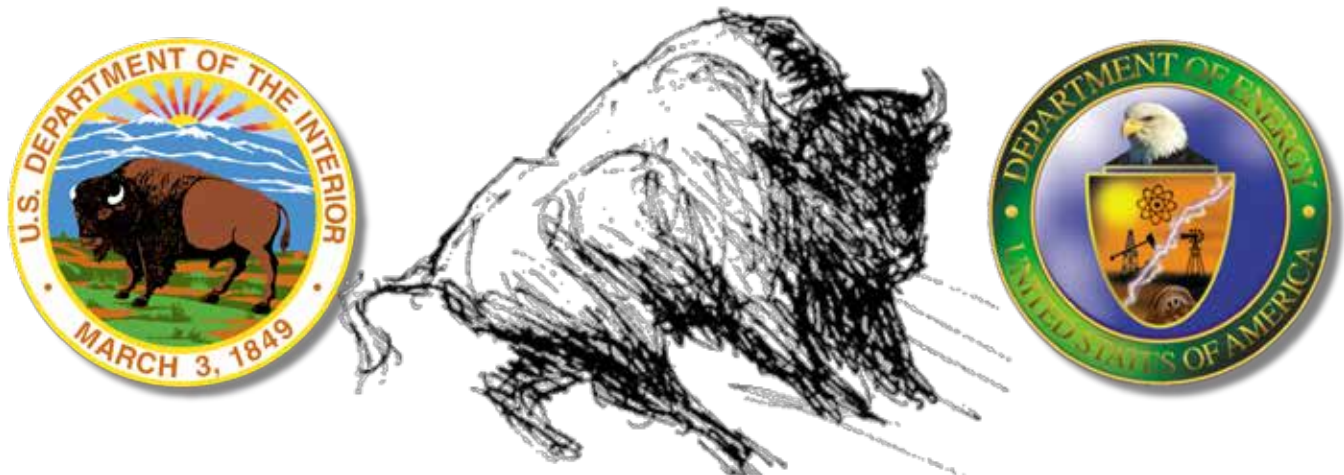


Figure 1: Potential conflicts between the guidance of DOI and the stringency of DOE regulations will test the applicability of the *Secretary's Standards* as increasing numbers of Modernist buildings become historic sites

An Anomaly of Intent: Preserving Short Lifespans

The author's architectural firm has in recent years witnessed a steady rise in requests for 75-year and longer stewardship plans, encompassing a variety of traditional building types and sites. For traditional buildings, with systems refined over millennia, this horizon is not unusual, since they have the capacity to remain vital for centuries to come. On the other hand, the appeal of Mid-Century Modernism was its freshness and, with it, an ephemeral nature that suggests lifespans of 25-30 years, not 25-30 generations.

In 2010, Docomomo declared to an international audience of professionals and public:

*"The very essence of the modern movement deeply challenges the possibilities of its restoration: **not only was the intended lifespan of modern buildings often abridged by the technical limitations of new materials and construction methods, but modernity's call for progress made the durability of buildings a relative concept altogether.** Therefore, conservation approaches must deal with the physical deterioration of modern buildings while assessing the extent to which replacement materials may adopt or retain the symbolic qualities originally associated to these buildings."⁸ (emphasis by author)*

Numerous paradoxes distinguish modern from traditional in issues facing the preservation community. For instance, traditional buildings' structural systems have multiple pathologies of deterioration (eccentric or excessive loading, water migration, freeze-thaw, insects, fungus, deformation, crumbling binders, corroding steel). Modernist structural systems — with iconic and boundary-pushing innovation (thin shell arches, tensile structures, exotic materials) — is often found to be remarkably free of defects, intact and serviceable. Regarding sustainable features (longevity, adaptability, energy conservation), Mid-Century Modernism seems to be more sustainable the smaller the building, while the opposite may be said for traditional heritage buildings, principally due to the benefit of large scale passive systems.

Conflict & Adaptability: The Secretary of Interior's Standards in Modern Times

Setting aside structure as an initial overriding concern, predominant challenges facing ecclesiastical Mid-Cen-

tury Modernism tend to revolve around innovations in form, material and technology. These three elements, and the breadth of their respective citations from the latest edition of the Secretary's Standards,⁹ form the central question the preservation community needs to ask: How well do the Standards protect our Modern heritage, and do they encourage innovation in understanding, measuring performance and retaining its defining features?

For example, consider the following:

"Historic building construction methods and materials often maximized natural sources of heating, lighting and ventilation to respond to local climatic conditions. The key to a successful rehabilitation project is to identify and understand any lost original and existing energy-efficient aspects of the historic building, as well as to identify and understand its character-defining features to ensure they are preserved."

While Mid-Century Modernist buildings did incorporate energy conserving features, they tend to be subtle or easily overlooked elements related more to building-specific forms than to local climatic conditions. On the contrary Modernism by nature eschewed local in favor of global. The above statement has an apparent bias toward traditional forms and methods of responding to local climatic conditions; that could lead to establishing precedent that is out of character with underlying concepts of Modernism. Similarly, the following paragraph suggests applying "new measures" (insulation, sealants, vapor barriers?) intended to improve energy efficiency. In practice, many potential "new measures" have been shown to cause irreparable harm to the underlying building form, or to elements that are so expressive of the era (trading black roofs for white, as one example):

"Whether a historic building is rehabilitated for a new or a continuing use, it is important to utilize the building's inherently sustainable qualities as they were intended. It is equally important that they function effectively together with any new measures undertaken to further improve energy efficiency."

Clearly these are meant for interpretation and application on a case-by-case basis. The question is whether they are clear enough to establish beneficial paths toward attaining preservation goals, especially with new codes requiring a narrative demonstrating why reusing original elements and systems is so vital and appropriate. The eve of the Secretary's Standards' 50th birthday seems a particularly poignant time to reassess and recalibrate, to ensure protection continues for our traditional buildings as well as those that intended to turn tradition on its head.

Form, Material & Technology Meet Preservation, Sustainability & Stewardship

Modernist form is striking, dynamic, fresh and varied... dictated by well-defined, broadly encompassing principles:

- Collaboration: "Artist, engineer and technician must be brought together to work in mutual respect and understanding..."
- Universalism: "Every manmade thing should follow nature's rules and derive its form from the demands of its function and the character of its materials..."
- Authenticity: "Construction is expressed openly and with relish, provided it is new construction characteristic of an industrialized era..."
- Emancipation: "Modern architecture attacks old rules of historical styles. It attacks the old rules of composition, proportion, symmetry; it attacks ornament. Ornament — symbol of the old — is the first thing that must be torn down by the new."¹⁰

Unfortunately, "ornament" also represents elements of lasting value that have provided critical watershed functions for generations, including cornices, scuppers, leaders and boots. Pristine lines and forms of Mid-Century Modernism — devoid of ornament — allow little room to add elements that enhance these buildings' self-preserving capabilities, from managing rainwater to modulating interior humidity. This is a controlling issue that needs to be addressed and resolved early on in the process of building analysis and project planning.

Homage to Tradition: Sustainability & Mid-Century Modernism

In examining preservation challenges related to form, material and technology, it is instructive to explore examples of sustainability — many sublime — that demonstrate a desire to infuse Mid-Century Modern buildings with elements that benefit energy use, communion with nature and longevity, three pillars of sustainability. Modernist buildings cited herein include sublime examples of sustainability, drivers of the design of The Abbey at Priory (Gyo Obata with Pier Luigi Nervi, 1962), St Andrew Church (1959, Harris Armstrong) and Ethical Society (1964, Harris Armstrong). These latter two — designed by the same prominent St Louis architect — are purposeful-

ly juxtaposed to illustrate that the underlying inspiration drawn from nature, and the desire to form a symbiotic relationship to the environment, exists in sites of disparate form. These principles are deeply embedded. In an era of cheap oil, though, it was nevertheless exceptional to embrace durability, energy conservation and operational efficiency. When early sustainable features are revealed, they should be heralded as impressive artifacts; they are. They deserve to be carefully analyzed, retained and integrated into responsible, comprehensive stewardship programs; as the preservation community is at the threshold of embracing its Modernist heritage, we need to be mindful not to throw out the baby with the bathwater.

This level of reverence is laudable, since many Modernist structures are categorically dismissed as antithetical to sustainability, energy code compliance and resiliency. That is simply not true. The following summarizes some of the principal sustainable elements reflected in just three of the eight sites studied. Myriad other examples exist of similarly inventive systems; many have been corrupted by populist pressures to change or update them, including sealing operable windows,¹¹ adding insulation, removing glazed wall systems and bowing to vicissitudes of style. Even in the select sampling to follow, not all original features remain.

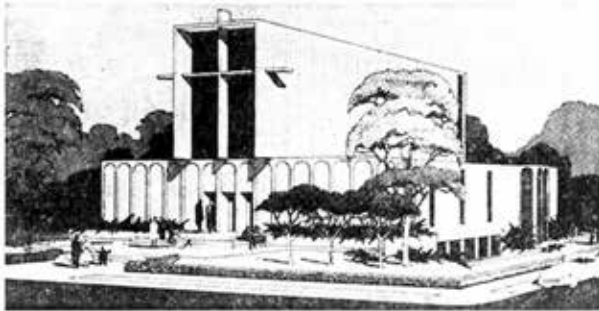


Figure 2: The Abbey at Priory Church St Louis

The Abbey at Priory Church¹²

- Thin shell concrete arches creating soaring interior spaces
- Reflective, high albedo (low emissivity) elastomeric roof coatings
- Kalwall® insulated fiberglass wall glazing system (renewed after 48 years of service life)
- Stratified interior environment; natural convective currents

- Radiant floor heating; no original cooling system required (nb. a/c added reluctantly)
- Excellent musical acoustics



New Presbyterian Church to Be Built on South Side

Perspective sketch from Haris Armstrong, the architect, of church to be built for St. Andrew Presbyterian congregation at Loughborough and Southland avenues in southeast St. Louis. The Schneiderman Construction Co. has been awarded the general contract.

Contracts Let For New Church

Contracts were let last week for construction of a new St. Andrew Presbyterian Church at Loughborough and Southland avenues in southeast St. Louis. Designed by Haris Armstrong, the church is to be contemporary in style. Construction was budgeted at \$250,000 when the Armstrong architectural group was commissioned to design it. Working with the Rev. William Munkach, minister, and J. E. Kunkel, chairman of the building committee, the architects prepared preliminary estimates and tended them against bids before final plans were drawn.

The accepted bids total \$225,000, covering innovations that will distinguish the church, and leaving a budget margin for furnishings not covered in the contracts.

At the entrance, facing south, a large concrete overhang will project over the roof of the sanctuary. Behind the overhang is to be a stained glass window, designed in mural. Three movable panels, in color complemented, the window will be above the entry doors. Side windows will be in soft colors and non-representational designs. Small pews are to do the stained glass work.

Exterior materials are to include salmon pink brick on first floor and lower level. The high walls spanning the nave, as well as the roof, will be of architectural concrete protected by sprayed plastic. Landscaping of the grounds is to complement the extensive use of plastic materials which will grow from planting pockets along the walls.

The sanctuary has been designed to seat 250 persons. Interior walls are to be of soft gray plaster, pink brick and walnut wood finishes. The sanctuary is to be decorated with wood and glass. The sanctuary is to be decorated with an interrupted view of the chancel. Though granite columns are to support a partially vaulted ceiling. The wall behind the chancel will be white pumice-plaster, against which ivy and similar plants will grow. A concealed window will direct daylight across the plants.

Lighting fixtures will direct light both up and down. They are to be suspended from the high ceiling on diagonal ribs that will form a geometric pattern. The lighting system is to be equipped with a dimmer. Fluorescent fixtures in the roof are to provide day lighting.

The Armstrong group designed many of the fittings for the church, including all of the chancel furniture, and the chancel floor which is to be a granite block on a wooden frame, with a silver bowl set into the granite.

The church is also to include seven large educational rooms, a 1500-square foot social room, an all electric kitchen, church offices. Dismissing of the basement rooms is to be achieved through lowering

grade, but entry to the sanctuary is to be arranged with no more than three steps at any level.

The entire area is to be air-conditioned, with a separate unit serving church offices so that the main system need not be used when the church is empty. The cooling tower is to be recessed in a sink above the heating plant.

The congregation of St. Andrew was organized as a branch Sunday school of Southhampton Presbyterian Church 10 years ago, and the Loughborough site was chosen there for a new church. However, the site was not immediately available, and the church bought a lot at 4923 Hampton avenue, and erected a building for temporary use. This building was designed to convert economically to permanent use.

This property, in which the congregation presently worships, forms part of the foundation for the new church. Additional funds are being contributed or lent directly to the church. General contractor for the new St. Andrew Church is Schneiderman Construction Co. Mechanical and electrical engineers are Bell and Glavin, and Leslie J. Berginger is structural engineer.

- Diffuse daylighting, including level changes to increase amount
- Direct-indirect interior lighting with manual dimming
- Infusion of plant materials both interior and exterior to buffer climate
- Convective currents and intended cross ventilation
- Separate infrastructure for heavy (office) and periodic (sanctuary) spaces
- Concealed mechanical equipment to maintain exterior form and lines



Figure 4: Ethical Culture Society.
Note reflecting pools serving multiple duty

Ethical Society St Louis

- Reflecting pools at entrance serve as heat exchanger for air conditioning system
- Reflecting pools also are sited to increase the incidence of natural daylighting
- Stratified heating and cooling in central auditorium
- Cylindrical ventilators allowing for fine-grained control of office windows

Regarding this confluence of modernism and tradition, Right Reverend Columb Cary-Elwes OSB, first Prior of the Abbey, summed it up from his vantage: "Tradition is not just sticking to the letter of the law. Even in theology, tradition is transposing the idea into a modern language, into the idiom of the day...not just repeating over and over again, but having the idea and putting it into the ingenuity of the day."¹⁴



Figure 3: St Andrew Presbyterian Church St Louis

St Andrew Church¹³

- Architectural concrete protected by "sprayed plastic"

Challenges Relating to Roofing, Drainage & Stormwater Management

While sculptural expression, dialogue with nature and exquisite colored glass features abound in Mid-Century Modern sacred sites, it is often the roof that most alluringly signals a sweeping break with precedent and context. Modernist roofs, masterpieces of engineering innovation and the subtle hand of experienced craftsmanship, tend to be the predominant feature of many post-war religious buildings.

Unlike traditional roofs, they rarely are composed of shingles. Rather, both formed and flat roofs tend to employ large sheets of either flexible membrane (e.g., rubber) or sheet metal, often copper. Curvilinear and folded plate geometries of formed roofs focus rainwater, snow and ice into confluences that often are hard to resolve, leading to leaks and damage to walls and foundations below; clearly, the lack of “ornament” also contributes to difficulties managing stormwater. For flat roofs, there often are issues with pitch and inadequate drains — in size, number and location. Both types of roof forms seem to conspire against simple drainage solutions. That said, the wide range of appropriate roofing technologies now available provide multiple approaches for remediating drainage-related issues, without corrupting underlying design features or the wellbeing of collateral building elements. Successful approaches include increasing the size and number of drain outlets while re-pitching to better compartmentalize and direct rainwater away from vulnerable edges and intersections. Advancements in fluid-applied membrane roofs (polymethyl methacrylate, or PMMA) as well as a variety of sheet roof systems (EPDM: ethylene propylene diene terpolymer and APP: atactic polypropylene) have proven performance. Energy codes notwithstanding, be vigilant in avoiding high albedo roofing (white) if the original roof was intended to be black as a deliberate contrasting design element.

While formed, sloped roof systems can take advantage of the same membrane roofing technology, effectively discharging increasingly high levels¹⁵ of concentrated rainwater remains a controlling issue. The nature of these roofs and the philosophical dictates against “ornament” preclude prescribing retrofits of scuppers, conductor heads or leaders. Instead, there is ample opportunity to fine-tune flashing detailing at eaves and valleys to help move water away from more susceptible building elements, which in turn may be coupled with efficient water collection and dispersal systems closer to the base of the building. These include permeable swales, xeriscape landscaping, rainwater basins and attenuators — all elements with existing ties to Mid-Century Modernism. It is notable that stylistic elements themselves (e.g., arches) provide for effective groundwater dispersion, as does the use of slabs-on-grade (precluding subsurface foundation walls) and the tendency to position buildings on flat or high elevations.

Challenges Relating to Window Walls & What is Lost in the Name of Energy Conservation

Among the greatest threats to Mid-Century Modernism is the unnecessary degradation and loss of rich, varied historic fabric through wholesale replacement of authentic window walls, glass facades, clerestories & glazing systems. It is especially egregious when executed in the name of energy conservation. To illustrate why, consider the following:

- Glass & glazing systems, generally composed of aluminum and steel framing members, represent the highest levels of embodied energy. Most of this energy is a reflection of the high cost of manufacturing, along with extracting and transporting raw materials. It is fallacious to cite energy conservation as justification to discard of these materials and systems, when their replacements comprise equivalent — or even higher — levels of embodied energy. To verify, first perform an accurate Life Cycle Cost Analysis.
- Early glazing systems are marvels of their time. They represent advancements (and failures) in applied technologies, just like traditional buildings, in methods of framing, creating an envelope, machine-age craftsmanship and passive environmental systems. Each time original historic fabric is discarded in favor of modern replacements (insulated glass, thermally broken frames, anodized coatings, et al.), another authentic building artifact — a record of the original technology — is lost, forever.
- Heritage buildings in general, and Mid-Century Modern buildings in particular, suffer from a dearth of field testing that could verify whole building performance, especially under the lens of current and universally rewritten applied codes. These codes often allow for trade-offs relating to whole building performance that, in turn, allows a more measured approach to best preserve, restore and refine these glazing systems.
- The three principal culprits robbing these systems of optimal energy performance — infiltration, conduction, condensation — may be addressed on an individual basis, producing solutions that can optimize one or more conditions and result in a markedly better performing assembly overall. These vintage glazing systems generally made use of single glazing in metal frames that relied on sealants, both wet and dry. First it is critical to assess the quality and condition of the sealants: wet seals, which in practice have short performance lives (6-8 years), are readily renewed while multiple suppliers

of custom dry seals already exist nationwide. Managing conduction, or “thermal bridging” through metal frames, while difficult, also has been cited as overrated in whole building analysis,¹⁶ so long as condensation resulting from conduction is concurrently managed. This may be accomplished very effectively by combining passive (architectonic) and active (mechanical) systems. Many methods exist for overcoming condensation, and are often part of the original building design: providing a steady stream of warm air to absorb excess moisture and modulate dew point, installing storm windows (interior or exterior), isothermally resetting leaded glass systems¹⁷ and replacing single glazing with low-e laminated glass set into the original framing system. While heritage glazed wall systems are not likely to produce the U-value of a thermally broken insulated glass unit, major projects, such as the recent restoration of Louis Kahn’s Richards Building (1965) at the University of Pennsylvania in Philadelphia, have already demonstrated the validity of this approach in meeting the goals of current codes and stringent programming, while retaining the original artifact, balancing embodied energy, extending performance life and — most significantly — changing attitudes.¹⁸

Challenges Relating to Insulation, Transpiration & Moisture Management

Approaches to insulating Mid-Century Modern buildings benefit by keeping in mind two interrelated premises: 1) in order to be effective, building insulation must be installed as a whole balanced system, and 2) insulation should not abridge the natural flow of moisture through building components and spaces. Both are significant, with demonstrable disastrous side effects when unheeded. Aside from the visual damage wrought by overzealous programs that can lead to over-insulating¹⁹ (e.g., defacing quintessential elements, including thin shell arches, folded plates and horizontal bands) changing pre-existing patterns of heat transfer and moisture migration can have severe unintended consequences affecting dew point, inviting corrosion or increasing the potential for condensation to form. Again, because these buildings were built during a time when energy wasn’t the concern it is today, they are often uninsulated and reliant on thin, fragile buffers to modulate year-round climatic change. In St Louis, these changes are extreme and often accompanied by relatively high levels of humidity.

First, assess heat transfer issues, accounting for the entirety of composite systems that make up the exterior envelope: interior wood paneling, air spaces, convective currents (both within walls and within the space), high albedo coatings and air stratification. Thermal mass, often lacking from the envelope, may be found within floor systems, coupled with radiant heating (in the

floor or exposed). Radiant systems have the capacity to remain fully serviceable well after fifty years, but they also are prone to failure for a variety of reasons often related to fundamental misunderstandings of how the systems work. Common reasons for radiant heat system failure include poor initial installation, inappropriate maintenance, untreated water, excessive makeup and — in the case of embedded floor systems — corrosive cementitious environments surrounding radiant tubing. While replacing a deteriorated radiant floor system is complex and logistically difficult to, repairing original atmospheric or vacuum radiant systems is highly effective and relatively easy to accomplish, offering a far superior solution than replacement with lightweight fin tube or, worse, forced air systems that often are not well suited to spaces originally intended for radiant heat.

Modernist buildings tend to rely more on natural ventilation and convective currents to provide fresh air and circulate moisture, elements that are virtually excluded from current codes. Like the robust discussions in the late 1970s regarding retrofitting insulation and vapor barriers into traditional heritage buildings — with notably disastrous results — unintended consequences that threaten the underlying resource await the injudicious installation of insulation. Here again, codes allow for modeling and tradeoffs that can enlighten a more measured approach to managing heat transfer while retaining the salient authentic features of the original resource.

Epilogue

Historic preservation benefits from taking a long, sometimes infinite, perspective. Alongside that horizon, the wisdom of the National Register’s 50-year rule reveals its potency, since it is now illuminating in a very favorable light the Modernist buildings it had originally protected us against. At the same time, building stewards must deal with a mix of intensive energy codes that run contrary to the historical setting in which Mid-Century Modernism was born. Given this, it is more critical than ever to be creative and circumspect — not so quick to jump to conclusions — regarding the merit, management and care of preservation’s distinctive and newly-coined oxymoron: “Modern Heritage.”

Endnotes

- 1 Sedovic, Walter. "History's Green Genes." Paper presented at the Greenbuild International Conference & Expo, Pittsburgh, Pennsylvania, November 12-14, 2003.
- 2 Elefante, Carl. "The Greenest Building Is..." Paper presented at the Association for Preservation Technology International Annual Meeting, Symposium of the Technical Committee on Sustainable Preservation, Halifax, Nova Scotia, September 21-26, 2005.
- 3 Orthwein, Walter. "Modern Buildings Need Not Be Ugly," *St Louis Globe-Democrat*, February 15, 1959.
- 4 Crowell, William. "A Church Should Look Like," *St Louis Globe-Democrat*, February 8, 1959.
- 5 Orthwein, Walter. "Modern Architecture Draws Fire from Many Sides," *St Louis Globe-Democrat*, February 8, 1959.
- 6 Chusid, Jeffrey. Introduction to CRP Spring 2015 Colloquium, Cornell University, Ithaca, New York, March 20, 2015.
- 7 (1) Center of Creative Arts (COCA) née B'Nai Amoona Synagogue; 524 Trinity Avenue; University City;
Eric Mendelsohn & Bernard Bloom; 1950
(2) Kirkwood Methodist Church; 201 W Adams Avenue; Kirkwood; Schmidt, Perlsee & Black; 1964
(3) St Andrew Presbyterian Church; 5905 Loughborough; South City; Harris Armstrong; 1960
(4) Christ the King United Church of Christ (UCC) née Independent Congregational Church; 11370 Old Halls Ferry Road; North County; Manske & Dieckmann; 1959
(5) Ethical Society Meeting House; 9001 Clayton Road; Richmond Heights; Harris Armstrong; 1964
(6) Church of the Immacolata; 8910 Clayton Road; Richmond Heights; Bernard McMahon; 1967
(7) Priory Chapel of the Abbey of St Mary & St Louis; 500 S Mason Road; Creve Coeur; Gyo Obata | Hellmuth Obata & Kassabaum (HOK); 1962
(8) St Martin de Porres; 615 Dunn Road; Hazelwood; John C McEwen with Robert F Rodriguez; 1962
- 8 Docomomo, Call for Papers, 11th International Conference, Mexico City, 2010
- 9 Grimmer, Anne E., et al. Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings. US Department of Interior, National Park Service, Technical Preservation Services, Washington, DC, 2011.
- 10 Boyd, Robin. *The Puzzle of Architecture*. Carlton, Australia: Melbourne University Press, 1965
- 11 In the United States, following the 1973 Arab Oil Embargo, legions of historic sites were widely and, arguably, indiscriminately outfitted with a variety of perceived energy-saving devices (e.g., polycarbonate glazing over windows, insulation and polyethylene vapor barriers), causing serious deterioration.
- 12 Author's conversations with Benedictine monks currently in residence at the Priory St Louis Abbey.
- 13 Steward, John. "Protestants Plan 101 New Churches," *St Louis Post Dispatch*, December 31, 1955.
- 14 Except of interview with the Rt Rev Columb Cary-Elwes, OSB, Founding Prior (1955-1967) in "Saint Louis Abbey 1964." Documentary produced by ABC News, 1964.
- 15 "Hurricanes and Climate Change: Exploring the Potential Causes of Increased Storm Intensity," Union of Concerned Scientists, <http://www.ucsusa.org>.
- 16 "The Effects of Thermal Bridging at Interface Conditions." Totten, Paul E, et al., National Institute of Building Sciences, http://c.ymcdn.com/sites/www.nibs.org/resource/resmgr/BEST/BEST1_034.pdf
- 17 Femenella, Arthur & Walter Sedovic. "Preserving Our Stained Glass Heritage While Meeting New Energy Code Requirements." Paper presented at Preserving the Metropolis, Annual Meeting of the Association for Preservation Technology International, New York, New York, October 11-15, 2013.
- 18 Fixler, David & Matthew Chalifoux. "No Thermal Break, No Problem: Upgrading Kahn's Stainless Steel Windows in the Richards Building." Paper presented at the Mid-Century Modern Structures: Materials and Preservation Symposium, National Center for Preservation Technology and Training (NCPTT), St Louis, Missouri, April 14-16, 2015.
- 19 "Deep Energy Retrofits: Just Chasing Rainbows?" Michael Anschel, <http://www.remodeling.hw.net/business/design/the-fall-of-deep-energy-retrofits>.

PRESERVING THE UNLOVED MODERN: THE ESTES KEFAUVER AND CORDELL HULL BUILDINGS IN NASHVILLE

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Abstract

The circa 1882 High Victorian Gothic Customs House on Broadway in Nashville is easily recognized as an important architectural statement. The cut stonework, lancet and Tudor arched windows, large arched entrance, and imposing tower denote that this is an architectural style to be reckoned with. Designed by US Treasury architect William Appleton Potter and originally known as the Federal Office Building, construction of the building symbolized the end of Reconstruction, yet showed continued Federal presence in the city.



Figure 1: 1882 Customs House on Broadway in Nashville

Fifty years later, the New Deal's building program resulted in the Nashville architectural firm of Marr and Holman designing the US Post office a block away from the Customs House. Much simpler in detail, the post office was designed in the Stripped Classicism style, also called Starved Classicism or PWA Modern, popular in the 1930s. Art Deco details embellish the interior and exterior of the building. The squat rectangular form of the post office makes the building less striking at first glance; its low relief details in stone and metal need to be seen up close to be appreciated. Yet like the Customs House, the post

office shows the Federal presence in Nashville and it reflects the idea of permanence and stability so lacking during the Great Depression. The former post office is now the Frist Center for the Arts and is often appreciated more for the art exhibits shown in the building than for its architecture.

Less than twenty years later, in 1949, work began on another Federal Building and Courthouse in Nashville. Located on Broadway between the two earlier Federal buildings, it was also designed by Marr and Holman. Later renamed the Estes Kefauver Federal Building, this building takes the Stripped Classicism style of the post office and strips down details even further. The Kefauver building retains the symmetrical form of classical designs but removes embellishments. The building is sheathed in two colors of granite and limestone on the exterior, giving the building a columnar appearance.



Figure 2: Estes Kefauver Federal Building, designed by Marr and Holman and constructed in 1949



Figure 3: Entrance to the Kefauver Building

Looking at the post office and Kefauver building, which were both designed by Marr and Holman, indicates the change in architectural styles preferred for public buildings from the Depression era to the post-World War II era. Unlike classical designs, including Stripped Classicism, there are no decorative details on the Kefauver building. After World War II the Federal government's focus was building quickly, and efficiently, usually resulting in conservative styles. Function was more important than form. Whether they were designed by notable architects and used quality materials or not, these apparently "plain" buildings are difficult for many people to see as good examples of modern Federal architecture.

Thomas Marr was born in Nashville, attended Galludet College and MIT, and returned to Nashville to practice architecture. He opened his own office in 1897 and hired Joseph Holman as an office boy and later draftsman. In 1913 the firm of Marr and Holman was incorporated with Marr doing most of the designing and Holman doing most of the marketing. They designed prolifically throughout the southeast and kept busy working on New Deal projects. Marr died in 1936 and Holman died in 1952. The firm passed to Holman's sons and finally ceased business in 1963.

Work began on Nashville's Estes Kefauver Federal Building in 1949, the same year the General Services Administration (GSA) was created. While the design principals and materials used in the building appear to follow GSA's precepts, the planning and design of the Kefauver building predates the GSA and its standardization of building materials and designs. Prior to the mid-nineteenth century there was minimal effort by the Federal government to design and construct buildings that were easily recognizable as Federal buildings – something that showed the importance of having a Federal presence in a city. In 1852 the Office of Construction and the Office of the Supervising Architect were established as part of the Treasury Department. This helped standardize designs and helped to streamline the building

process as the nation was growing. After the devastation of the Civil War, it became prestigious to have new government buildings, especially for legislators trying to impress voters. New technologies and improved transportation made construction easier and faster. However, there were complaints that government buildings were not "innovative, efficient, or of a high quality, so the AIA promoted the Tarnsey Act in 1893."¹ This act allowed outside architects/non-government architects to be used for Federal buildings. Today it is difficult for us to think of a building like the 1882 Customs House as being in this non-innovative category.

Congress repealed the Tarnsey Act in 1912 and a year later created the Public Buildings Commission to oversee construction of Federal buildings. The Public Building Act supplanted the Commission in 1926 and soon after, the New Deal programs changed the focus from constructing buildings where they were needed, to constructing buildings to pump up the economy. The modern style of this era, Stripped Classicism, is seen in Nashville's post office. With more and more buildings being designed and built, the government's focus now changed from looking at maintaining "high design standards through the employment of *talented* architects," to "the encouragement of such standards through the careful development of building requirements and the selection of capable architects."²

In the post-World War II boom, the Federal government changed from concentrating on war-related construction to commercial and industrial construction and, more importantly, promoting residential construction. Costs for public buildings were still high and, unlike during the Depression era, there was no mass of funding for public buildings. At this same time, the number of Federal employees had increased from one-half million in the pre-war era to about two million in the post-war era.³ In an effort to become more efficient and improve services, the GSA was one of the new agencies created to manage space and materials for the government.

The GSA was charged with standardizing design, production, and purchasing and the result for buildings was "...achieved by using clean, unornamented lines and developing standard details for all types of fixtures and equipment. Elements thought to be superfluous, such as monumental exterior stairs and custom-made features, were quickly abandoned."⁴ Nashville's new Federal Building and Courthouse was built during this era, although before the government codified the design principles of GSA.

In October 1946, the site for the new Federal Building and Courthouse was chosen to be on Broadway between the two existing Federal buildings. W.E. Reynolds, the Commissioner of Public Buildings, stated that this was "...an 'ideal' place for the new building because it is between the post office and the old courthouse, as well as close to the railroad and bus stations."⁵ Construction of

the building would consolidate scattered Federal offices in Nashville. The firm of Marr and Holman was chosen to design the new building, with Joseph Holman as the lead designer.

Floor plans for the new courthouse and Federal building were unveiled in early 1949. The building would have a similar boxy shape and narrow setback from the street as the post office that Marr and Holman had designed, but it was a much larger building. Existing buildings on the site were demolished and the city issued a building permit for the estimated \$6 million building – the costliest building in the city at that time.

The estimated cost of the building rose to \$7.2 million by the time the exterior was finished in May 1951. A shortage of steel – and strikes by steelworkers – resulted in a delay in finishing the 310,000 square feet of interior floor space. Modern features of the new building included air conditioning and fluorescent lights. As late as June of 1951, the *Nashville Banner* newspaper wrote that the agency overseeing the construction of the Federal building was the Public Service Agency. In September of that year, the *Nashville Tennessean* newspaper mentions the GSA. GSA's function was explained as being responsible for the specifications of items like office spaces. The GSA was also responsible for direct purchases and making standard details for fixtures and equipment, in an effort to keep costs down. Considered ready for occupancy in April 1952, twenty-one federal agencies occupied the building and the first court was held on June 17, 1952.

Nashville's Federal Building and Courthouse is a transitional building. Begun before the creation of GSA, it was finished under the supervision of the agency. It does not represent some of the more creative modern designs seen in later GSA buildings, but it is an archetypical post WWII design found in many Federal buildings. Not until the late 1950s did GSA encourage modern innovative designs. Basic designs with little embellishment, high quality materials in public spaces, and making the Federal presence known were the primary features of this era of public building.

Marble and granite are used extensively on the interior and exterior of the building. Dark granite separates the main public story from the limestone sheathed upper seven stories. The profile of the repetitive pattern of aluminum windows on the building is the most distinctive feature of the exterior of the building. Terrazzo floors and marble walls are found in the entrances and hallways of the building. The overall design is simple and the quality of materials used is high.

The Nashville architectural firm of Taylor and Crabtree designed an annex to the Kefauver Building that was begun in 1968 and completed in 1974. The GSA made National Register of Historic Places eligibility assessments of many of its holdings, including the Kefauver building

and annex, which they looked at as two separate buildings. Even before GSA completed its modernism studies, the Tennessee SHPO and regional GSA office considered the Kefauver building to be eligible for listing in the National Register for its local significance. The consulting firm who prepared a draft nomination for the Kefauver building had to be convinced by the SHPO and GSA that the building was significant. A study and building inventory prepared by another consulting firm stated that the annex was not eligible now nor would it be eligible when it became fifty years old. Our office The Tennessee SHPO believed that the annex did not have exceptional significance as defined by the National Register at this time, but we had questions about assessing the annex as not eligible in the future. In many cases we would just look at this as one building, but because the connection between the two parts of the building was minimal, we could look at this as two buildings. At first glance, the assessment of eligible or not may not seem important to anyone but a historian or architectural historian, but it has consequences. The type of treatment used for changes – using the Secretary of the Interior's Standards or not – depends on its eligibility assessment.

In 1979, the building was renamed the Estes Kefauver Federal Building and United States Courthouse. Kefauver served in the U.S. house and senate from 1949 until his death in 1963. He ran on the Democratic presidential ticket with Adlai Stevenson in 1956. Kefauver received national attention as the chair of the Special Committee on Organized Crime in Interstate Commerce.



Figure 4: The Cordell Hull Building, designed by the Nashville architectural firm of Hart and McBryde, opened in 1954

The state of Tennessee was responsible for the Cordell Hull Building. It was designed by the Nashville architectural firm of Hart and McBryde (Joseph Hart and James Bolton McBryde) in 1952 and opened in 1954 to house the offices of Tennessee's post-war growing state government. Hart and McBryde's partnership did not last long, with McBryde moving to Florida and Hart remaining in Nashville. The building sits at the foot of Capitol Hill, below the antebellum Tennessee State Capitol, and next to the New Deal-Era John Sevier State Office Building – both acknowledged as historic. Like the Kefauver building, vertical elements and masonry construction combine in this building to strip the Stripped Classicism style of the preceding era even further. Sheathed in

limestone, interior corridors feature wall panels of book-matched pink Tennessee marble. With over 350,000 square feet of office space, the Cordell Hull Building was among the largest of Tennessee's state office buildings at the time of its construction. Nashville architect and architectural historian Charles Warterfield has commented that the Cordell Hull Building "is an attempt to retain classical dignity in an essentially modern building."⁶ A statement in the National Register nomination for the Kefauver building also applies to Cordell Hull: "It was built at a time when architects abandoned ornate designs common in earlier federal buildings and embraced more modest plans that were appropriate for a modern country that had recently endured the Great Depression and World War II."⁷

The building was named for Cordell Hull of Byrdstown, Tennessee, who was Secretary of State under President Franklin D. Roosevelt from 1933 to 1944. Hull holds the distinction of being the longest-serving U.S. Secretary of State, helping guide the country through World War II. He won the Nobel Peace Prize in 1945 for helping to establish the United Nations.

Architect McBryde commissioned Tennessee sculptor Puryear Mims to create sculptures as an essential part of the architectural design of the new state office building. Four groups of bronze statues at the west and north elevations depict Tennesseans at home, on the farm, in industry, and at war. Mims studied at the Academie Julian in Paris and the Art Students League in New York. In 1934 he worked on the Mount Rushmore project as an assistant to Gutzon Borglum. He went on to teach art at Vanderbilt University, his alma mater, and eventually became sculptor-in-residence at the university.



Figure 5: Tennessee sculptor Puryear Mims created four groups of sculpture for the Hull building, an example is seen here

With limited space on Capitol Hill, in the 1970s the administration constructed the Central Services Building, most of it below ground, to connect the Hull and Sevier buildings. A concrete plaza sits atop the Central Services Building.



Figure 6: An alternate view of the Hull building showing the top of the Central Services Building

Jones Lang LaSalle (JLL), a private company, manages the state's buildings and in 2011 the company was asked to assess the viability of continuing to use the Cordell Hull and Central Services Buildings. The company looked at the buildings as one project and determined that it was not practical to continue using the buildings. Deferred maintenance was a major problem for both buildings. JLL also determined that the buildings did not fit into the state's new "Transforming Tennessee for Tomorrow" (T3) program, which changed the way office space was planned. The focus of the T3 program is "Creating a more enduring, effective and efficient workspace."⁸ The reality is that worker spaces are smaller, there is more open space so employees can collaborate easily, and fewer partitions or closed offices in state owned or leased buildings. In 2013, the administration of Tennessee Governor Bill Haslam announced plans to demolish the Cordell Hull and Central Services Buildings, claiming both water damage in the basement and inefficiency in office space dated the building and made it unworkable for the new T3 program.



Figure 7: Interior view of the Hull building showing size of hallways

Preservationists, the general public, and the state legislature did not agree with the administration's assessment of the Cordell Hull Building. In July 2013, a state official noted that "Because of the interest in this building and because of the importance of its location, again its perceived historical nature, we think it's probably wise to have yet another set of eyes on this again."⁹ An investigative reporter for Nashville's News Channel 5 ran several stories with headlines such as "Outsourcing a piece of Tennessee history?"¹⁰ Allegations of impropriety by JLL – who were paid for each building lease they obtained – and questions of the administration's association with JLL were also mentioned.

As a result, a Nashville architectural firm was hired by the state to prepare another report and to assess the JLL report; Cordell Hull and the Central Service Buildings would be assessed together and separately. In August 2014, the commissioner of the state's Department of General Services reported to the State Building Commission that the most expensive option would be to demolish both buildings and construct a new building, which would cost between \$151 million for standard space to \$191 million for high quality space. Demolishing both buildings and using rented buildings for state workers would cost \$121 million. Renovating and using both buildings would cost \$109 million. Finally, renovating Cordell Hull and building a much-needed parking garage on the Central Services site would cost \$95 million.¹¹ The report mentioned that there were serious but not unsurmountable problems with Cordell Hull. The General Services department recommended that the Cordell Hull Building could be renovated and used to house workers – to hotel them – while other office buildings were renovated. This would eliminate the need to find leased space when much needed upgrades occurred in other state buildings. At this time, workers are being moved out from the Cordell Hull and Central Services Buildings. A larger plan for the Capitol Hill area will result in the Legislature moving permanently into Cordell Hull.

Summing up, there are two quotes that apply to both of these buildings. In a 2009 article in an issue of the National Park Service's publication *Common Ground*, the director for GSA's Center for Historic Buildings was quoted on Denver's Byron G. Rogers Federal Building and Courthouse. The statement holds true for the Kefauver and Cordell Hull buildings and other buildings of its era. "The implications were significant....What was noteworthy, and what was not? With some of the structures already in dire need, how to balance maintenance and historic integrity? What does the future hold for these buildings, so synonymous with the era of America's rise to global leadership."¹² A 2013 article in a Nashville weekly publication stated "Cordell Hull, on the other hand, is Truman-era. This no-nonsense, plainspoken president is gradually getting his due, but the buildings of Truman's time, which speak an architectural language equally spare, get less respect. Nevertheless, the stripped style

of mid-century modernism expresses the 'us' of that time. It says: We're lean and mean – ready for any war you throw at us, hot or cold."¹³

Sources

1. *Banner* (Nashville). June 21, 1951 and July 14, 1949.
2. Centric Architecture, Phase II-JLL Report Review Building Evaluation of Cordell Hull and Central Services Office Buildings, July 8, 2013.
3. Centric Architecture, Building Evaluation of Cordell Hull and Central Services Office Buildings, March 25, 2014.
4. Craig L A, *The Federal Presence: Architecture, Politics, and National Design*, MIT Press, Cambridge, MA, 1984.
5. Entorf A, *When Eligibility Opinions Collide*. Case Study: Estes Kefauver Building, Nashville, TN Presentation at GSA Regional Historic Preservation Officer meeting in Nashville, October 2009.
6. Foell S, *Estes Kefauver Federal Building*, Draft National Register nomination, 2009.
7. General Services Administration. *Growth Efficiency and Modernism: GSA Buildings of the 1950s 60s and 70s*, US General Services Administration, Washington, DC, September 2003.
8. Hogan M, *The Future of Modern: Federal Architecture in an Era of Change*, *Common Ground* (Spring 2009): 26-37.
9. Kreyling C, *In architecture, as plans to tear down the Cordell Hull building show, the recent past gets no respect: Hull and Void*, *Nashville Scene*, April 18, 2013.
10. Lee A J, *Architects to the Nation: The Rise and Decline of the Supervising Architect's Office*, Oxford University Press, NY, 2000.
11. Mielnik T M, Presentation on Cordell Hull at the Southeast Society of Architectural Historians 2013 conference.
12. Orr F, White E, and Waterfield C A (eds.), *Notable Nashville Architecture 1930-1980*, Taylor Publishing Company, Dallas, 1989.
13. Reed M B, Price D, and Sullivan P, *GSA Modern-Era Buildings: Region 4 Inventory and Assessment*, Draft technical report submitted to the General Services Administration, August 6, 2010.
14. *Tennessean*. Oct 18, 1946 and September 15, 1951.

Endnotes

1. General Services Administration. *Growth Efficiency and Modernism: GSA Buildings of the 1950s 60s and 70s*. (Washington DC: US General Services Administration September 2003), 22.
2. Antoinette J. Lee. *Architects to the Nation: The Rise and Decline of the Supervising Architect's Office*. (NY: Oxford University Press, 2000), 279.

3. Lois A. Craig. *The Federal Presence: Architecture, Politics, and National Design*. (Cambridge MA: MIT Press, 1984), 438.
4. General Services Administration. 29.
5. *Tennessean* Oct 18, 1946. Reynolds remained Commissioner of Public Buildings in the new GSA.
6. Frank Orr, Elbridge White, and Charles A. Warterfield (eds.). *Notable Nashville Architecture 1930-1980*. (Dallas: Taylor Publishing Company, 1989), 72.
7. National Register of Historic Places, "Estes Kefauver Federal Building," Nashville, Davidson County, Tennessee. Draft nomination.
8. http://tn.gov/generalserv/psm/project_t3.shtml (Accessed March 12, 2015.)
9. "Future of Cordell Hull again uncertain while administration re-evaluates options," *The City Paper*, June 16, 2013.
10. News Channel 5, June 17, 2013
11. Getahn Ward, "Aging Cordell Hull May Get Second Wind," *The Tennessean*. July 5, 2014 and Centric Architecture, "Phase II-JLL Report Review", July 8, 2014.
12. Meghan Hogan "The Future of Modern: Federal Architecture in an Era of Change," *Common Ground* (Spring 2009), 27.
13. Christine Kreyling, "In architecture, as plans to tear down the Cordell Hull building show, the recent past gets no respect: Hull and Void," *Nashville Scene*, April 18, 2013.

GATEWAY ARCH STAIN INVESTIGATION: UNCOMMON STRUCTURE

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Abstract

The Gateway Arch is quite possibly the most fascinating and important stainless steel structure ever constructed. Commemorating westward expansion and designed by Eero Saarinen, the Arch was constructed between 1963 and 1965 and has a basic shape of a modified inverted catenary curve with the Arch legs equilateral triangular in cross section. Both the height and the span are 630-feet. This paper explores the unique technical history of construction of the Gateway Arch which includes the one-of-a-kind fabrication and erection methods that were used. The authors have been involved in lead roles with a comprehensive Arch staining study since 2005 up to the present.

Introduction

The Gateway Arch is obviously an elegant sculptural monument of world-renowned significance. While the intent of the design may have been to erect a soaring structure celebrating westward expansion that would survive a millennium, the designers and builders may not have considered future mundane tasks such as cyclical inspections and routine maintenance in their design. While stainless steel is perceived as a material that remains bright and shiny over a long period of time, the Arch designers may not have understood the effect of construction methods and St. Louis' environment on the long-term appearance of the exterior surface. This paper explores construction history, and defines construction materials and methods on the Gateway Arch exterior.



Figure 1: St. Louis riverfront during 1930s demolition on present-day Gateway Arch grounds' Jefferson National Expansion Memorial (JEFF) Archives, image V106-501a

Planning

In response to a decaying riverfront and Depression-era economic hardship, St. Louis' civic and business leaders initiated a process during the 1930s that, it was hoped, would revitalize the area. Even before a memorial design was conceived a large area along the riverfront was demolished in anticipation of a construction project (Figure 1).

Following World War II funds were allocated to execute a national design competition that was to provide for a memorial design "transcending in spiritual and aesthetic values" according to the competition requirements. By September 1947 172 architects and engineers had submitted designs for consideration. Entry No. 144, Eero Saarinen's submission, was given much praise as a beautiful and inspiring design during the first review. Review of second stage competition entries produced a unanimous vote in favor of Saarinen's design, with the winning selection announced in February 1948.

Design

The structural concept for the Gateway Arch was a collaborative effort between Eero Saarinen and his partner, John Dinkeloo and the office of Severud Elstad Krueger Associates of New York. Hannskarl Bandel, Fred Severud's chief engineer, modified the inverted catenary shape for Eero Saarinen's Gateway Arch project.¹ During the design competition, Saarinen indicated the Arch would be a steel structure filled with concrete. Severud introduced new orthotropic design principles, a concept that had only been previously used on military vessels and bridge decks. Following these principles, the Arch structure was designed to be supported by its skin. A carbon steel inner shell and stainless steel outer shell were set at slightly different weighted catenary curves and connected through stiffener plates (Figure 2). The interstitial space between these shells was filled with post-tensioned concrete² at the lower half of the Arch. The two interconnected skins thus helped support each other.

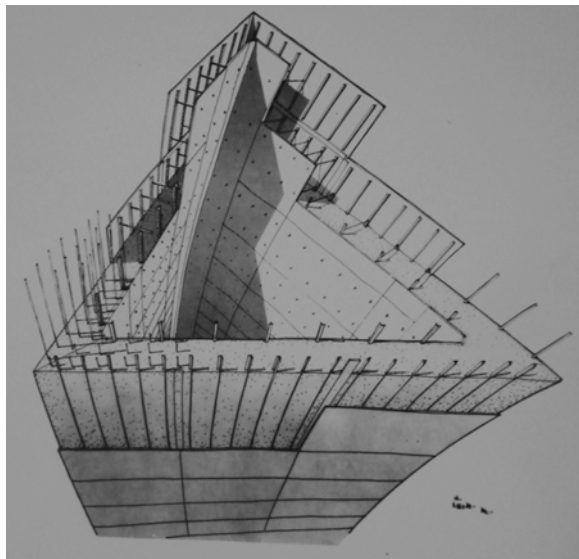


Figure 2. Equilateral cross-section of the Arch with inner and outer skin and post-tensioned concrete core, Yale University Archives, Eero Saarinen Collection

Pittsburgh-Des Moines Steel Company helped with developing the construction sequencing during the design phase. Because of the difficulty inherent in constructing an arched structure without centering,³ the legs of the Arch had to be designed to act as two cantilever structures. Eventually, the legs would be joined at the top, upon which the overall strength of the Arch would be substantially increased. The design had to consider the loadings, stresses, and structural action at the various stages, while also addressing the practicalities of construction. Finally, since the Arch was too tall for conventional cranes, the cantilevered legs had to be designed to support climbing cranes which would ride on rails attached to the outside face of the Arch legs. Therefore the Arch legs needed to rely on either large tieback ca-

bles or another mechanism to hold the inward deflection to within the specified engineering tolerances until they were joined at the top. Instead of tieback cables, the legs were designed as composite members consisting of pre-stressed concrete along with the inner and outer skins to resist the gravity loads causing inward deflection of the Arch legs and the overturning moment.

Another measure was designed to provide stability against the inward acting bending moments on the cantilevered Arch legs once the legs reached the height of 530-feet. A large stabilizing strut was to be installed between the legs. This additional measure of construction stability was deemed necessary by the contractor to ensure the stability of the cantilever legs, while simultaneously limiting the stresses on the post-tensioned concrete.

Fabrication

Pittsburgh-Des Moines Steel Company fabricated the Arch stations in their Pittsburgh and Warren, Pennsylvania plants. The stations were designed with ¼-inch thick Type 304 polished stainless steel plate for the exterior skin. Nine hundred tons of stainless steel in panels ranging in size from 6-feet by 18-feet to 6-feet by 5½-feet was used. For the interior skin ¾-inch thick ASTM A-7 carbon steel plate was used except at the corners where the steel is 1¼-inch thick (Figure 3).

The following procedures describe what would have been standard practice. The stainless steel panels were fabricated through a rolling process.⁴ They would then have been annealed⁵ and pickled.⁶ Annealing dissolved chromium carbides that form in the grain boundaries. Pickling austenitic stainless required strong oxidizing agents such as diluted mixtures of hydrofluoric and nitric acids. After the panel edges were trimmed, they would have been subjected to a series of cold-rolling processes to produce sheets that would be accurate in thickness and with a smooth surface. Stresses developed in the cold rolling process required additional annealing and pickling. Following the final cold-rolling operation the sheet would have been degreased. The stainless steel plates of the Gateway Arch were specified to have a No. 3 finish. This mechanically-applied finish was created by successive passes of polishing wheels or belts across the surface.



Figure 3: Shop assembly of the Arch stations, showing internal temporary framing for placement and installation, JEFF Archives, image V106-35946

Gas-metal arc welding⁷ was used in the shop to butt weld both the stainless and carbon steel panels together. The fabricator built two house-sized welding fixtures, the larger for butt welding the stainless steel plates and the smaller for butt welding the carbon steel plates and filleting angles to them. All of the shop welds on the stainless steel were reportedly completed as single pass welds to create a smooth and uniform appearance. The shielding mixture of 75-percent argon and 25-percent carbon dioxide was reportedly used. Nondestructive testing with spot x-rays was used to check the welds.

For stations below the 300-foot level rows of 5/16-inch stainless-steel studs were welded to the back of the stainless steel plates and then Z-bars were fastened to the studs with carbon-steel nuts tightened to 22½-foot-pounds with a torque wrench. High-strength steel bolts were attached to the Z-bars that passed through holes in the inner skin of carbon steel and were held in place by nuts that applied a squeezing force to the concrete core thus creating a friction bond.

Above Station 45, the inner and outer skins were to be connected together using a series of carbon steel stiffener angles, diaphragms, ½-inch diameter bars, and bent steel plates in a cellular type of construction, similar to aircraft design. The steel stiffener angles were spaced based on a ratio of the panel and tube width. The stiffener angles (2-inches by 2-inches by ¼-inch) were stitch welded to the back side of the exterior stainless plates with fillet welds. Spot welding was chosen to eliminate the warping that would be caused by heat if arc welding were used. A welded built-up stiffener angle, fabricated from a 2-inch by ½-inch steel plate and a ¼-inch steel plate of width equal to the space between interior and exterior skins, was bolted to the interior carbon steel plates. The interior and exterior skins were further tied together with diagonal rod braces.



Figure 4: The north leg foundation nears completion, December 3, 1962, JEFF archives, image V106-3938

Erection

Excavation for the Arch foundations required creating a pit for each leg at least 75-feet by 90-feet wide that extended to bedrock, approximately 44-feet below grade. Construction of the Arch began on June 27, 1962. The foundation was constructed in five foot increments each of which demanded a continuous monolithic pour that took up to twenty-three hours and required 1,700 cubic yards of concrete. As the foundations reached ten feet high, post-tensioning bars were installed. A second group of post-tensioning bars were started when the foundation reached twenty feet. In total, 252 vertical post-tension bars were set into each foundation to stabilize the Arch during construction (Figure 4). The Arch foundation was completed by February 1963.

The Pittsburgh-Des Moines Steel Company (PDM) was responsible for the assembly and erection of the steel stations of the Arch. Station sections were transported from PDM's shop by rail, and delivered adjacent to the job site (Figure 5). The larger stations, at the concrete-filled lower half of the Arch, were fabricated as three double-wall flat panels and were assembled on site by installing a continuous vertical weld at each of the three corners. All stations above the concrete-filled portion (above the 300-foot level) were fabricated as three L-shaped pieces. Field welds for the upper stations were made on the

faces of the panels, not at the corners. Pick points were welded at the inside intrados corners to accommodate the creeper crane lift cables. Once the stations were assembled, they were lifted into place using the cranes.⁸



Figure 5: Arch station L-shaped sections transported by railcar to the job site, JEFF archives, image VREF-08677

The first station was placed at the base of the south leg on February 12, 1963 (Figure 6). Placement of the first steel stations introduced some minor difficulties to the project. The position of the foundation and post-tensioning bars were not in alignment with the angle of the steel station. To rectify the situation, the post-tensioning bars were slightly adjusted and bent to fit within the station and additional reinforcing was added to compensate for the subsequent reduction in strength.⁹ On April 9, concrete was poured into the first above-ground station.

The contractors established a systematic method and process of construction. The north and south legs of the Arch were erected simultaneously. Stations were assembled, hoisted into place, welded to the station below, filled with concrete and then post-tensioned.¹⁰ After the stations were hoisted into place and aligned, both the interior and exterior skins were tack welded into place and allowed to sit overnight while the survey team verified the height and location.¹¹ In the following days, the station was secured with a continuous weld.

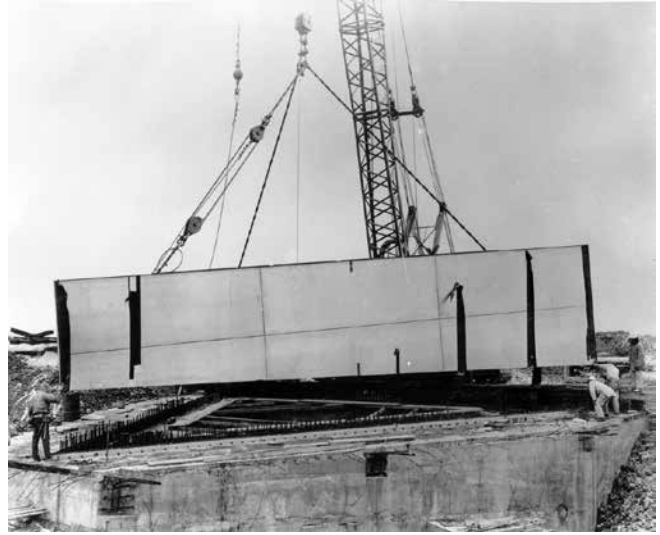


Figure 6: Placement of the first station, February 12, 1963, at the south leg, JEFF archives, image V106-3962

Shielded-metal arc welding¹² was used in a semi-automatic process to join the stainless steel joints between stations in the field. Deformation of the panels initially occurred due to heat shrinkage of the welds. The triangular stations above the 300-foot level where the concrete was no longer placed were cambered about 1½-inches in 35-feet in order to accommodate weld shrinkage. This welding technique with low hydrogen electrodes was also used to weld the inter station joints of the carbon steel. Nondestructive testing with spot x-ray was used to check the field welds.

The field welds were not as neatly done as the shop welds. Because welding was done on a vertical surface with access from only one side, numerous weld passes and grindings were required to guarantee a complete 100-percent weld. Field welds on the exterior were not ground flush as an architectural decision, and helped establish the pattern on the skin of the Arch that was desired by Saarinen. Weld haloes¹³ that occurred due to the field welding of the stainless steel were removed after each station was secured using electrolytic methods.¹⁴ A back up bar was installed on the back side of the steel prior to setting each station to assist in the effectiveness of the welding process. Random samples of the welds were x-rayed to verify quality. The process was labor intensive and demanded skilled welders who would work in the extreme heat and confined environment.¹⁵

From the top of the foundation to the 300-foot level (Station 45), the interstitial three-foot space between the inner and outer skins of both Arch legs was filled with concrete. Once the concrete had adequately cured to 4,000 pounds per square inch strength, the post-tensioning bars were torqued up to 71-tons each (Figure 7).¹⁶ The process of post-tensioning made the concrete more effective at handling tensile stresses applied by the par-

tially completed Arch legs and the creeper crane load. Post-tensioning bars were connected by a threaded sleeve and encased in a hollow steel sleeve to allow for uniform elongation. Post-tensioning bars in each leg continued to the 300-foot level where the reinforced concrete fill terminates.



Figure 7: Applying tensile stress to the post-tensioning bars, 1963, JEFF archives, image V106-3974



Figure 8: The Arch legs under construction with the creeper cranes in place, late summer 1963, JEFF archives, image V106-4034

In July 1963, when the Arch reached 60-feet in height, creeper cranes were erected to complete the construction process (Figure 8). Each leg of the Arch had its own crane that was used for hoisting the stations and putting them in place. Dual tracks were constructed along the face of each Arch leg, and platforms were assembled to support the cranes (Figure 9). As the creeper derricks proceeded up the Arch, the back legs could be adjusted so that the work platforms remained level.

Difficulties at the Midpoint

At Station 45, approximately 300-feet high, plans called for a change in the structural assembly of the Arch. Below Station 45, the cavity between the interior and exterior steel skin was filled with concrete. At this point in the construction process, the legs were designed to lean 49-feet towards each other. Above the concrete-filled cavity, the interior and exterior skins were connected by "L" brackets with the short leg spot welded to the inner skin and the long leg securing the outer skin. Upon installation of north Station 45 on September 27, 1964, it was noted that ripples in the stainless steel skin occurred every two feet in association with the locations of the diaphragm brackets.

Station 45 was removed on October 30, and various attempts were made to resolve the warping. It was reinstalled on November 17, and the wall cavity filled with a lightweight concrete in an effort to stabilize the station. South Station 45 was also filled with concrete to match the north station.¹⁷ Subsequent stations were installed with L-brackets as intended by the original design, and the associated ripples were accepted.

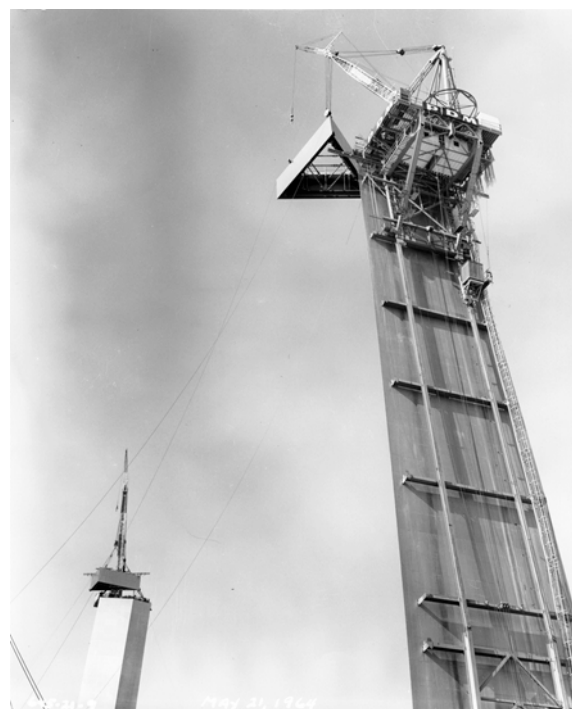


Figure 9: View of initial placement of a station of the Arch completed from the creeper derrick crane, JEFF archives, image V106-4048

Completing the Arch

As the Arch approached 530-feet in height (Stations 22 and 23), a stabilizing strut designed to prevent excessive leaning was installed (Figure 10 and 11). The legs were each leaning 150-feet inwards at this height, and together with the extra load of the creeper cranes additional support against overturning was required as part of the design. The 225-foot-long, bridge-like stabilizing strut structure was assembled on the ground and hoisted into place on the morning of June 17, 1965. Pressure applied to the stabilizing strut forced the legs of the Arch to be jacked outward by about 2-inches.¹⁸



Figure 10: The Arch nears completion with the stabilizing strut in place, September 9, 1965, JEFF archives, image V106-4124



Figure 11: View of the stabilizing strut installed during construction to resist overturning and deflection of the cantilevered Arch legs, JEFF archives, image V106-4119

Discrepancies between the height of the north and south legs were observed during the daylight hours. Throughout the day, the heat of the sun, shining more directly on the south leg, caused that leg to elongate and deflect downward 14-inches below the level of the north leg. For this reason, the Arch project team requested that the final piece be installed at night, when temperatures were consistent and the height of the legs was even. However, this approach was rejected by the City of St. Louis, and the installation of the final station was performed during daylight hours so that a public ceremony could be held at the completion of the Arch structure.

On October 28, 1965, the Arch hosted a “topping out” ceremony when the final 8-foot-wide station was inserted into the Arch (Figure 12). The ceremony was scheduled for the morning before the south leg was heated by the sun. The local fire department sprayed the leg with cold water to keep the Arch cool. With the application of 500 tons¹⁹ of pressure using hydraulic jacks between the creeper cranes, the topmost stations of the north and south legs were pried apart. The final piece had been temporarily retrofitted with five inch pins to help secure a quick fit with the north and south stations. As the station was lowered, the pins were inserted into the north station and pushed into place. The south station was raised approximately five inches²⁰ until it was aligned with the keystone piece, and as the 500 ton pressure was relieved the gap between the south leg and center station disappeared. The legs lined up perfectly.

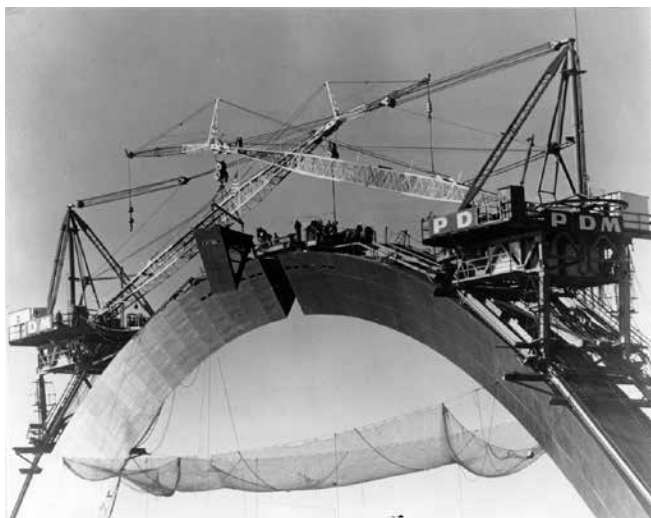


Figure 12: Installing the final station of the Arch, October 28, 1965, at the top of the north leg JEFF archives, image V106-4131

After the Arch keystone station was inserted, final cleaning, repair, and polishing began (Figure 13). The stainless steel panels were washed and polished by hand from the top down using the creeper cranes for access. According to approved shop drawings, grease and dirt was removed with "Oakite #33," a proprietary chemical still used today that contains Phosphoric Acid, Butoxyethanol, and other unnamed chemicals. It is believed that it contained many of the same chemicals when used at the Arch.

Bolt holes in the exterior skin were plugged with stainless steel punches salvaged from the Pittsburgh-Des Moines Steel Company manufacturing plant during fabrication. The stainless steel plugs were welded and ground smooth. The cleaning created some inconsistencies in the finish. Minor abrasions such as those caused by scaffold pads/bolts and suction cup marks were removed using a fine grit impregnated cloth. Hand polishing never seemed to produce the same result as the shop finish, and patched areas remained visible to the discerning eye.



Figure 13: Cleaning the Arch and removing the creeper cranes, February 7, 1966, JEFF archives, image V106-4147



Figure 14: Painting the interior of the Arch legs, August 4, 1966, JEFF archives, image V106-4167

The locations of the stabilization struts required extensive cleaning and polishing in order to have an aesthetically pleasing appearance. The winter weather complicated the cleaning process, as water-based products turned to ice. Final preparations of the stainless steel skin continued as the creeper derricks inched their way down the Arch.²¹ In the fall of 1966, the derricks were disassembled and the cleaning of the Arch was complete. During this time the interior of the legs were also painted (Figure 14).

Conclusion

Topping out and completing the Gateway Arch was successful, but not without encountering a variety of challenges throughout its construction process. Tragically, Saarinen passed away even before Arch foundations were completed. Work progress was affected by day-to-day fabrication, engineering detail and construction issues, developing final finishing methods, air pollutants, and of course St. Louis' fickle weather. These and other issues were factors in the recent condition assessment findings.

Endnotes

1. When Saarinen tried to demonstrate his desired shape with a chain suspended in his hands, he couldn't achieve the slightly elongated, "soaring" effect he wanted; Bandel asked for the chain, came back in a few days, and delighted the architect by producing Saarinen's curve. Bandel had replaced some of the constant-sized links with variable links, thus changing the weight, the distribution of the weight, and the shape. The design of the Arch was then modified so that the legs of the Arch are steeper and larger at the base and the profile tapers down as it reaches the top. http://en.wikipedia.org/wiki/Hannskarl_Bandel
2. Post-tensioned concrete is reinforced concrete in which a tensile force is applied to reinforcing strands after the concrete has cured.
3. Centering is a temporary framework for supporting an arch during construction until it is able to stand by itself.
4. Rolling is the process of shaping metal by passing it between rolls revolving at the same peripheral speed and in opposite directions. Hot planetary rolling of the heated slab under pressurized rolls was probably used.
5. Annealing is heating steel to, and holding the metal at, a suitable temperature followed by relatively slow cooling. The purpose of annealing may be to remove stresses, soften the steel, improve machinability, improve cold working properties, and obtain a desired structure.
6. Pickling chemically removes scale or oxide to obtain a clean surface. The chemicals are cocktails of aggressive acids. After pickling, a washing process takes place followed by immersion in a lime-water bath to neutralize any remaining acid.
7. Gas-metal arc welding utilizes an electrode that is continuously fed from a coil through the electrode holder. The shielding gas is provided from an externally applied source. A mixture of 75% argon and 25% carbon dioxide was typically used. The shielding gas protects the weld from atmospheric conditions.
8. Ken Kolkmeier, interview by Dan Worth of BVH; Stephen Kelley of WJE; Robert Moore, NPS JNEM Historian; Al O'Bright, NPS Historical Architect; and Victoria Dugan of NPS JNEM, January 14, 2009.
9. Don Haake, interview with Ted Rennison, March 24, 1981, 8.
10. Brown S, Administrative History: Jefferson National Expansion Memorial National Historic Site National Park Service, Washington, D.C. June 1984), Chapter 7, 21-22
11. Ken Kolkmeier interview, 4-5.
12. Shielded-Metal Arc Welding (SMAW) is one of the oldest, simplest and most versatile types of welding. The electric arc runs from the coated electrode and the base metals being joined. As the coated electrode is consumed, the electrode wire becomes the filler material in the weld. During the process the coating is converted into a shielding gas, which prevents atmospheric contamination of the molten metal, and slag, which is the residual electrode coating material that blankets the welds to protect it from the environment and slow down the cooling process. A low-hydrogen electrode can be used to obtain superior weld mechanical properties.
13. Haloes are circular or ovoid discolorations that are bluish in color for stainless steel. They are an oxide layer that is formed and can define the perimeter of the heat affected zone of the metal during the welding procedure.
14. Electrolytic cleaning of welds utilizes an electric current applied to an anode wrapped in a chemically damped cloth to serve as a cathode. The surface to be cleaned becomes an anode and the oxides are lifted from the surface.
15. Don Haake, interview with Ted Rennison, 9-10.
16. Ken Kolkmeier to Bob Moore, NPS JNEM Historian, with regard to comments to the Gateway Arch Part 3 Corrosion report, February 20, 2015. According to Ken the rods were tensioned at vertical intervals of 32 to 40 feet.
17. Don Haake, interview with Ted Rennison, 21.
18. Ken Kolkmeier to Bob Moore, February 20, 2015.
19. Ken Kolkmeier to Bob Moore, February 20, 2015. According to Ken 300 tons, and not the documented 500 tons of pressure, was used to separate the legs.
20. Ken Kolkmeier to Bob Moore, February 20, 2015. According to Ken the legs had been aligned within the diameter of a dime on the morning prior to the closing.
21. Don Haake, interview with Ted Rennison, 38.

GATEWAY ARCH STAINS: UNCOMMON INVESTIGATION

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Abstract

The Gateway Arch, constructed with a ¼-inch stainless steel exterior skin and a steel interior skin, is quite possibly the most fascinating and important stainless steel structure ever constructed. Designed by Eero Saarinen to commemorate westward expansion, the Arch was constructed between 1963 and 1965. The Arch reveals the basic shape of an inverted catenary curve, while each leg is an equilateral triangular in cross section. Both the height and the span of the Arch measure 630 feet.

In the past two decades, streaks, stains and discolorations have become apparent on the monument; these were suspected to be corrosion. Additionally, scratched graffiti at the base has captured elements of corrosion. A series of investigative studies, divided into three parts, was performed on the markings in 2006, 2011 and 2014. This paper explores Parts 1 and 2 of the investigation and discusses: the comprehensive archival research that was performed on the Arch and other stainless steel-clad structures worldwide that pre-date or are contemporary with the Arch; the visual inspection of the exterior surfaces of the Arch intrados, which was performed using telephoto photography, field microscopes and a handheld x-ray fluorescence (XRF) device; the creation of inspection openings through the interior carbon steel skin, made to view the space between the structure's two skins and remove samples for laboratory analysis; longterm monitoring of climatic conditions within the legs of the Arch; and the extensive study of various means of access to the upper reaches of the Arch, including scaffolds, cranes and industrial rope access.

The authors have been involved in lead roles with a comprehensive Arch staining study from 2006 through the present.

Introduction

The Gateway Arch, part of the Jefferson National Expansion Memorial, is a world-renowned monument. Although the intent of the design may have been to

present a sparkling and celebratory monument that would survive a millennium, the architect and builders likely could not predict what the structural composition would entail in the future, such as cyclical inspections and routine maintenance. When the Arch was constructed, stainless steel was perceived as a material that would remain bright and shiny over a long period of time; the Arch's designers may not have considered the effects of fabrication and erection methods or the longterm environmental effects on the appearance of the exterior surface.

This paper explores Parts 1 and 2 of the investigation process into the exterior markings on the Arch, which evolved into a sophisticated condition assessment and led to explanations of the environmental and manmade effects on the Gateway Arch exterior. The primary question the authors sought to resolve throughout the investigation was whether the exterior staining on the Arch is detrimental to the conservation of the structure.

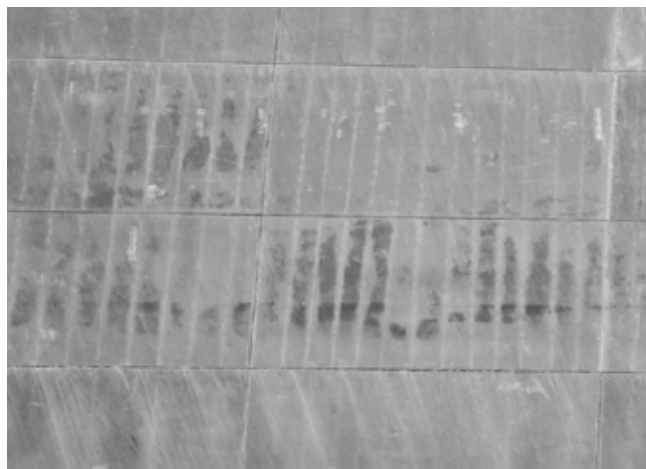


Figure 1: View of the west side of the north leg of the Arch (as it appeared in 2011).

Revelation

The roots of the investigation began to take hold in 1996; National Park Service (NPS) staff had observed curious stains and markings on the structure. The area that most concerned NPS facility manager Dave Bubac and author Al O'Bright—who had been brought in for a preliminary examination of the markings—was the west side of the Arch's north leg, at about the 420-foot level, which exhibited uniformly-spaced, coffee-colored stains that seemed to mimic a pattern of the structure concealed beneath the stainless steel skin, as opposed to rain drainage patterns [Figure 1].

In addition to observing staining on the Arch's exterior, NPS staff noticed water infiltration on the interior; on occasion, it “rained” within the Arch legs, causing park maintenance staff to install wicks and buckets at key points within the intrados of the legs to catch water running down the Arch interior.

At this point, the NPS initiated a project statement to document the stains photographically using a manned helicopter. Although cyclical photo documentation was a good start, it did not explain how the stains and marks originated on the Arch.

In 2000, NPS staff sought to develop a program for a comprehensive condition assessment of the Arch with an emphasis on exterior stains, interior moisture and ideas for mitigating heavy graffiti at the base of the Arch. Over the next several months, O'Bright conducted research into the Saarinen construction drawing set and correspondence in the NPS archives. He also sought advice from metallurgists and a former Arch architect on the potential causes of the stains. What developed was a project statement that initiated a visual and non-invasive investigation with a comprehensive review of archival materials. It was hoped that this initial phase would define the course of additional, more comprehensive investigations. The project statement also postulated preliminary theories of stain causes, including:

- *Modifications made early in construction details of the Arch, namely between the stainless steel and carbon steel skins:* A preliminary investigation of construction files indicated that the steel fabricator had become concerned that the design to weld stiffeners to the internal surface of the stainless steel would result in dimpling and marring of the exposed exterior skin; a series of letters between the contractor and project engineers reveals subsequent revisions to the concealed steel detailing. It was thought that this revised detail may have had a detrimental effect on the stainless steel through galvanic reaction between the carbon and stainless metals.
- *Methods of construction:* During construction, concealed steel plate stiffeners had been added at two points along each Arch leg (just above the 300-foot level and at about the 450-foot level) in order to support the creeper cranes being used for construction. Most of the exterior stain patches observed now appear near these two elevations; a preliminary theory was that a galvanic reaction may be to blame for the stains.
- *Presence of water:* The quantity of concrete placed between the inner and outer skins of the Arch was of concern, specifically in terms of the amount of water contained within the concrete that may not have been allowed to hydrate as the concrete cured and, as a result, may have become sealed between the skins. The space between the skins is hollow above the 300-foot level, with no apparent ventilation; it was surmised that water from the curing concrete may yet be trapped within that cavity. Indeed, the corrosive effects of water flowing from bolt and welding pin holes had been observed within the Arch legs at an interior exposed carbon steel plate. Though those sites are now dry, it was unknown if the presence of water within the cavity was having a detrimental effect on concealed steel surfaces.
- *Air pollution:* Air pollution was also considered as a possible cause for the exterior stains; the Arch grounds have long been exposed to the discharge from nearby industrial mills and coal-fired plants, as well as to vehicle exhaust fumes and road salts applied to the surrounding roads in winters.

Part 1: Corrosion Investigation

The Paper Chase

In 2005, funding was acquired to pursue the initial investigation phase. The firm Bahr Vermeer Haecker Architects was contracted, with Wiss, Janney, Elstner Associates, Inc. as the primary engineering and conservation consultants, in collaboration with the NPS. The investigation included a site visit to the park archives by conservators, historical architects, engineers and metallurgists to research thousands of construction documents. The investigation also included a tour of the Arch legs. Using spotting scopes from various angles from the east and west, Arch stains and markings were categorized and mapped onto elevation drawings.

Early in Part 1 of the investigation, it was concluded that, eventually, up-close inspection and sampling of the stained surfaces at high altitudes would be necessary. In anticipation of future exterior work, a consultant from

the firm Vertical Access LLC of Ithaca, New York, joined the team to preliminarily assess methods of accessing the slick elevations of the Arch without damaging the structure's surfaces.

NPS archivist Jennifer Clark provided thousands of project memoranda and submittals, materials tests and steel weld samples as well as—after a dedicated search—dozens of boxes of folded shop drawing blueprints from the park's comprehensive archives. The shop drawings, which had been in storage since soon after completion of the Arch, reflected all phases of the development of the Arch grounds. Among the found materials is the only known set of shop drawings that exists for the Arch, which became valuable in understanding concealed construction details in the structure.

The report from Part 1 of the investigation offered a compendium of descriptions regarding stainless steel and welding techniques, field findings, preliminary documentary research and assessments by various disciplines. The report also provided recommendations for moving to the next, more invasive, investigative phase.¹ The report recommended:

- Continued research of archived construction documents;
- Installation of an environmental monitoring system within the Arch legs to document microclimatic conditions over the period of one year;
- Selective exposure of interstitial spaces between the stainless and carbon steel faces—which had been enclosed since completion of construction—for inspection;
- Removal of carbon steel and concrete samples for laboratory analysis in order to verify materials quality as indicated in the original project manual;
- Development of alternative methods for accessing the high exterior surfaces of the Arch for inspection and sampling purposes;
- Interviews with the original construction engineers for information related to welding procedures, construction processes and other undocumented information.

Historic Structure Report

In 2007, a Historic Structure Report (HSR) was commissioned as an essential step in the process of continuing with the more invasive investigative work utilizing the same team.² The HSR work included an interview with former Pittsburgh-Des Moines Steel Company engineer Ken Kolkmeier, who provided insight on the challenges

that came with erecting the Arch.³ The HSR work also initiated an extensive search of all files and maintenance facilities within the park, the result of which was more than 3,400 shop drawings. As a component of the HSR project, all drawings were flattened by the St. Louis office of the US Army Corps of Engineers and were transported to a local firm⁴ that provided high resolution scanned files of all drawings. These scans proved critical to project engineers throughout the condition assessment effort and in later work phases, as they helped identify concealed structural members that were to be avoided in investigative cutting.

Part 2: Cutting to the Core

Beginning in late 2010, all recommendations in the Part 1 report were accepted and Part 2 of the project was awarded to essentially the same team as had led Part 1⁵. The second part of the investigation included the following work: a survey of the expanded NPS archives; a contextual survey of other stainless steel-clad structures that pre-date or are contemporary with the Arch; visual inspection using telephoto photography, field microscopes and a handheld x-ray fluorescence (XRF) device; the creation of inspection openings through the interior carbon steel skin in order to view the space between the skins; the removal of samples of carbon steel and concrete between the skins and stainless steel from the archives for testing in the laboratory; longterm climatic monitoring within and between the skins of the Arch; and a comprehensive study on access strategies to perform future close inspection and testing on the upper reaches of the Arch intrados.⁶

Archives

Archival review revealed that continuous discussions regarding issues of stainless steel protection had taken place throughout construction, from fabrication and erection through installation and final cleaning. For example, unacceptable distortions had occurred in the ¼-inch stainless steel plate material during welding tests. Procedures, design, materials and methods were changed to minimize the distortion, yet it was still present in many of the completed stations: the first station on each of the north and south legs without the concrete infill was rejected after installation because of distortions in the stainless steel skin that had been caused by deforming the station during installation. Fixes were prescribed, debated and implemented for the installed north section. As the final stations were fabricated and installed above Station 45, distortion was minimized by improved quality and fabrication techniques.

Contextual Survey of Other Structures

Research into other stainless steel-clad structures centered on three specific time periods: pre-depression; post-World War II; and the present. The pre-depression period signifies the advent of the use of stainless steel in architecture. Structures from this time include the Chrysler Building in New York (William Van Alen, 1929) and the Worker and Collective Farm Girl sculpture, which was created by Russian sculptor Vera Mukhina to adorn the USSR Pavilion (Boris Iofan) at the 1937 World's Fair Expo held in Paris [Figures 2 and 3]. Both structures utilized a thin stainless steel sheet that was soldered and backed up with a carbon steel framework and both provide insight into the cleaning and maintenance of stainless steel material.

Research found that maintenance of the Chrysler Building had included cleaning of the stainless steel in 1961 and 1995. Following an assessment after 2000, the stainless steel of the spire was found to be in fair-to-good condition. Local pitting corrosion was most prevalent at the former boiler flue that discharged the by-products of combustion and hydrocarbon particles. Intergranular corrosion, found on the battens of the standing seam cladding, was presumably caused by the remains of flux material used in the soldering process. The Worker and Collective Farm Girl sculpture had been disassembled and reassembled on two occasions and suffered from excessive galvanic corrosion. It was restored in 2009 and installed atop the Vera Mukhina Museum in Moscow.

The time following World War II marks the advent of the curtain wall in architecture. Notable stainless steel structures constructed during this time include the Socony-Mobil Building in New York (Harrison and Abramowitz Architects, 1954-1956) [Figure 4]. It is an early example of a metal-clad, curtain-walled high-rise, which utilizes 20-gauge, type 302 stainless steel. The skin of the building, composed of approximately 7,000 individual embossed stainless steel panels, is presently in good condition and was cleaned for the first time in 1995 with a mild detergent and degreaser that was scrubbed with cotton cloths.

The Inland Steel Building (SOM, 1958) was the first modern movement skyscraper in downtown Chicago [Figure 5]. The contractor responsible for cleaning the facade in the present day reports that soap and water, with a 3M ultra-fine fiber sponge, are typically used to clean the steel.



Figures 2 and 3: A view of the Chrysler Building (photographer Margaret Bourke-White, 1931) (left); the Worker and Collective Farm Girl sculpture (right), presently on display at the Vera Mukhina Museum at the All-Russia Exhibition Center in Moscow.



Figures 4 and 5: The Socony-Mobil building in New York, undergoing cleaning in 1995 (left); the Inland Steel Building in Chicago (right).

In the present day, stainless steel is used for monuments and building cladding with greater frequency; this is a testament to trust in its longterm durability. Some notable examples of stainless steel in today's architecture include the Korean War Veterans Memorial in Washington, DC (1992); the Spire of Dublin in Ireland (2002); the Atomium in Waterloo, Belgium, reclad in stainless steel (2006); the US Air Force Memorial in Washington, DC (2006); the Genghis Khan Equestrian Statue in Tsonjin Boldog, Mongolia (2008); the Petronas Towers in Kuala Lumpur, Malaysia (1997); the Jin Mao Tower in Shanghai, China (1998); the Jay Pritzker Pavilion in Chicago (2004); and others [Figures 6-9].



Figure 6-9: Unisphere from the 1964 New York World's Fair (top left); US Air Force Memorial, Washington, DC (top right); Atomium, Waterloo, Belgium (bottom right); Jin Mao Tower, Shanghai, China (bottom left).

These contextual studies reveal that stainless steel, if properly installed, weathers well. Historically, the standard treatment for stainless steel-clad buildings has been cleaning with mild solutions. However, the Arch stands apart from the buildings and monuments surveyed during this research because of the extensive use of shop and field welding on the structure performed during construction.

Visual Inspection

Visual documentation of the Arch intrados was performed with a Nikon D5000 Digital Single Lens Reflex camera with a Nikkor autofocus 70-300mm zoom lens. The camera and lens were mounted on a tripod while a remote shutter release was utilized to decrease vibration. The southeast and northeast intrados surfaces were photographed during the early morning hours, while the southwest and northwest intrados surfaces were photographed in the early evening hours; this was done in order to achieve direct sunlight at the areas being photographed. The following was revealed:

- Due to the concrete fill, the lower portion of the Arch remains essentially smooth with minimal warping of the skin; above the concrete-filled portion, oil canning is seen where the skin has warped due to temperature changes [Figure 10].

- Staining that appears as vertical streaks, originating at the welds and more pronounced at the field welds, was observed on the Arch faces [Figure 11]; this staining appears more pronounced above the concrete-filled stations.
- Some streaks are more pronounced than others; these may be due to spills during construction that were not cleaned adequately at the end of the project; they may also attract atmospheric pollutants.
- One of the more obvious discolorations appears above the concrete-filled level and is most noticeable on the west side of the north leg; the darkening occurs between stiffeners and is also present at the southeast and southwest sides of the Arch legs.
- Discolored and darkened spots on the upper areas of the Arch are related to the strut erected to stabilize the north and south legs during construction [Figure 11].

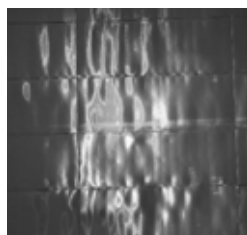


Figure 10: Oil canning of the skin can be seen in the proper lighting.

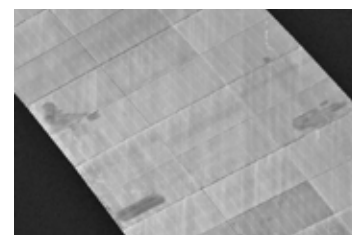


Figure 11: Vertical streaks seen emanating from the welds. The three darkened areas are residue from the strut used during erection.

In investigating the scratched graffiti on the surface, it was revealed with a field microscope that some of the accompanying surface corrosion is a result of the oxidation of ferrous residue left from the tools that had been used to create the graffiti. The stains at this level were found to be well-adhered, as attempts to remove them for laboratory analysis proved unsuccessful.

In order to analyze the chemical stainless steel composition and the surface staining, the surface of the steel was evaluated using a handheld x-ray fluorescence (XRF) device [Figure 12]. In addition, the original mock-up weld submittals located in the archives were analyzed with the XRF. The analysis using the XRF confirmed that the type of steel used at the Arch was ASTM A240, type 304 stainless steel. The stainless steel was characterized by chromium contents between 18% and 20%, and nickel contents between 8% and 10% percent. The average chromium and nickel content at certain red-stained areas of the stainless steel was lower and is possibly a result of the welding process; an increased amount of silicon was measured in these areas and is likely the result of airborne pollutants. It was not possible to identify

differences between stained and unstained areas using the handheld XRF, as these differences were below the detection threshold of the XRF.

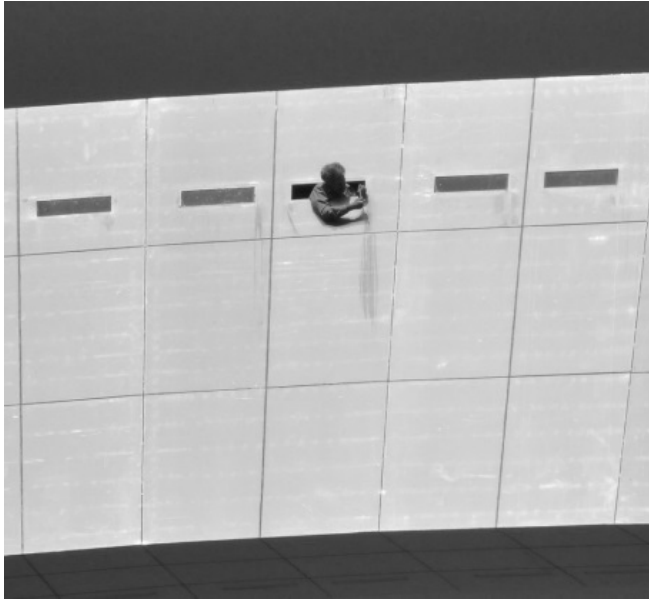


Figure 12: Using the handheld XRF more than 600 feet above the ground.

Inspection Openings and Laboratory Testing

The investigation team developed a proposal to bore inspection holes through the interior carbon steel skin to view interstitial spaces between the skins and install environmental monitoring sensors. Given that this was the first time substantial cutting of the Arch would be performed since its construction, the proposal was placed under review as per Section 106 of the National Historic Preservation Act of 1966 to ensure compliance and receive approval. The inspection openings provided an unprecedented look at the space between the two skins. Three types of inspection openings were made with specific purposes in mind:

- A total of twenty-one 3-inch diameter circular inspection openings were created and immediately sealed with pipe plugs to allow interstitial space to return to the pre-drilled climatic condition.⁷ These openings were located in areas to install climate monitoring devices. Some of these openings allowed for examination using photographic devices and a separate light source [Figure 13].
- Two large hexagonal openings were made in order to permit close examination [Figure 14]. From these openings, a visual inspection of the cavity, as well as that of the top of the final concrete-filled tube space, could be performed.
- Two square inspection openings were created in the lower portion of each leg; these openings permitted the removal of 5-inch diameter concrete cores for laboratory analysis [Figure 15].

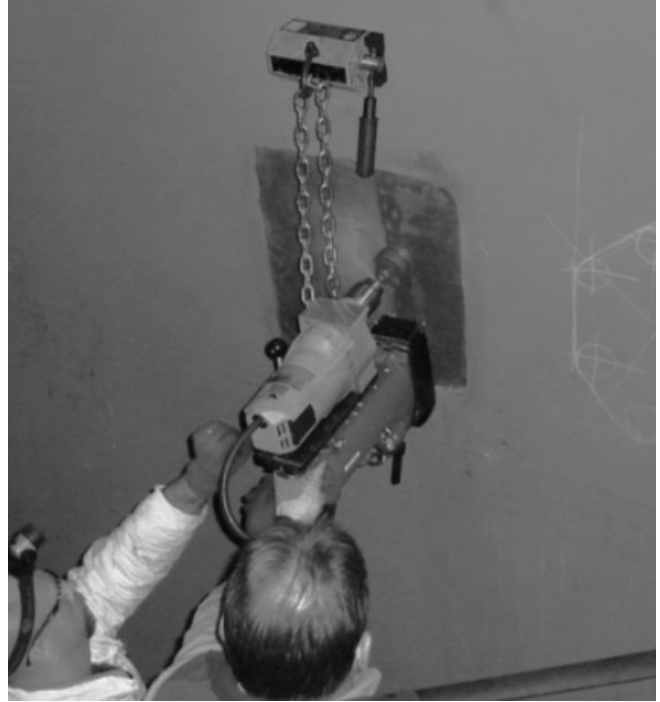


Figure 13: Drilling one of the 3-inch diameter openings in the carbon steel skin.



Figure 14: One of the hexagonal openings in the carbon steel skin.



Figure 15: Removing a 5-inch diameter concrete core from a lower part of one of the legs.

By far, the most difficult aspect of creating these openings was gaining access within the tram shafts to bore the holes. Before the boring could take place, red lead primer paint that had been applied during construction was abated from the marked bore sites for worker safety. The boring work was executed by NPS maintenance staff using an 80-pound magnetic drill with a 3-inch diameter hole saw. As a precaution, the drill was chained to a heavy-duty natural magnet in case power to the magnetic drill was interrupted. Some of the more difficult bore sites required NPS maintenance staff to be harnessed and suspended within the tramway several hundred feet above the basement level.⁸

The following was revealed:

- Both the stainless steel and carbon steel plates within the space had been coated with primer paint.
- There is evidence of moisture streaking within the interstitial space [Figure 16]; these streaks occurred after the segments were installed in the leg, but it was not possible to determine whether the streaking was caused by rainwater during construction or by water leakage or condensation that occurred after the monument was completed.
- It was confirmed that mild steel back-up bars were used to support the interior of the weld when welding the stainless steel butt welds.

- Air movement within the tube was encountered during the creation of the first openings near the top of the Arch, indicating that the interstitial space was not airtight; it was apparent from the air temperature that there are numerous small breaches in the carbon steel skin that allow air infiltration.
- Laboratory testing revealed that the steel complies with ASTM A7 specifications and meets the original specifications; the chemical composition of the stainless steel plate from the NPS archives was found to comply with ASTM A167 and appears to be type 304, which meets the original specifications. Most importantly, testing of the concrete samples revealed that relative moisture levels were in an acceptable range and that the concrete had properly hydrated without leaving excess moisture in the interstitial space.



Figure 16: Image looking upward into the interstitial spaces. The water streak orientation reveals that they were formed after the segment was set in place, but there are no signs of active water leaking.

Longterm Climatic Monitoring

To investigate the tendency for condensation to form on the steel surfaces, the Arch was instrumented so that temperature and humidity conditions within the structure could be monitored and reviewed for conditions that result in condensation. An instrumentation plan was developed to monitor air temperature, surface temperature and relative humidity within the Arch. To determine if condensation can occur on a particular steel surface, the surface temperatures of the steel plate and dew point of the air must be compared. While the steel surfaces can be measured directly, the dew point must be calculated psychometrically from collection of the ambient air temperature and relative humidity.

Surface temperatures were measured on the carbon steel on the interior of the leg (interior skin) and on the

inside face of the stainless steel (exterior skin). Ambient air temperature and relative humidity were measured within the leg and in the interstitial space. This was performed at various heights throughout the legs. Outside temperature and humidity levels were also collected. A wireless-based data acquisition system was installed to monitor the instruments [Figures 17-19]. The system used individual pods installed at each instrumentation station, which relayed data to a modem. The modem in each leg was connected to the Internet so that the current status on each of the instruments could be downloaded and examined from a remote computer in real time.⁹

The monitoring allowed the investigative team to identify periods of time in which there was a tendency for condensation to form in the Arch legs.

- Typically, outside ambient conditions in the spring and fall produce days when conditions exist for condensation to form; these days are likely to be hot and humid with cooler temperatures during the night. However, the number of such days during a single year at the Arch was found to be relatively small and the duration rather short [Figure 20]; based on these findings, the tendency for corrosion due to condensation appeared to be limited.
- The temperature in the Arch legs and interstitial spaces does not closely follow the outside air temperature; this reveals that the interstitial space is affected by the conditioned interior space and also shows that the stainless steel skin is more airtight than the carbon steel skin.
- The dew point temperatures for the outside, the interstitial space and the leg remain relatively close to each other during the same periods.

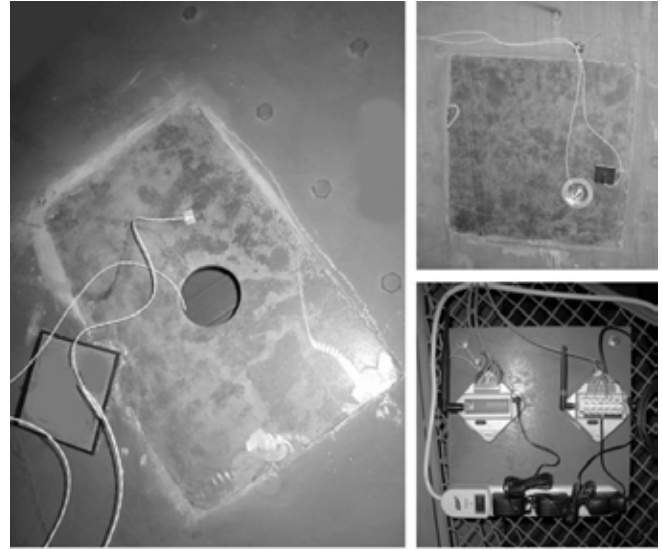


Figure 17-19: Clockwise from left, surface thermistors installed on the skins and ambient temperature and relative humidity devices being installed; wires being run through the plumber's plugs; and one of the pods for gathering data.

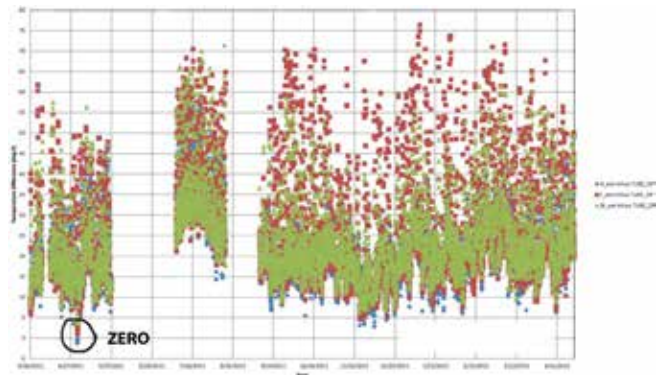


Figure 20: Shows the temperature of the stainless steel surface minus the dew point temperature. If the result is near or below zero, as shown in the lower left hand corner on April 28, 2011, then there is the potential for condensation to form on the skin.

Survey of Access Strategies to the Exterior Skin

Hands-on access to the intrados of either leg at approximately 420 feet was required in order to view the suspect discolorations and to extract surface samples. A wide range of strategies to access the Arch intrados at high locations was considered, including those beginning on the ground (aerial lifts, mobile cranes and tower cranes) and from various industrial rope access (IRA) techniques. Access using helicopter drones was considered but ultimately rejected because of impending Federal Aviation Administration restrictions on the use of drones in proximity to national monuments.

The survey revealed that ground techniques were unsuitable because most would not reach high enough to perform the required sampling and because they would impose too much weight on the structure of the underground museum below the Arch. The only ground access method that would reach high enough was a guyed tower crane [Figure 21]. Like foot scaffolding, this would be a cost-prohibitive approach if used only for investigation.

IRA showed promise but was not without numerous challenges. Various approaches to IRA were considered for sample removal. Ultimately, an IRA approach was recommended; utilizing belts around each leg, the IRA would allow a technician to descend the Arch with stability and to gain access to the intrados [Figure 22].



Figure 21: The access survey revealed that the highest access from the ground would be 344 feet using a guyed crane tower and boom lift.

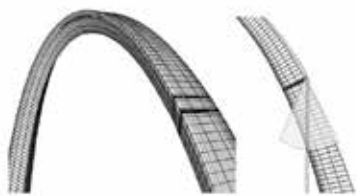


Figure 22: The IRA approach developed by Vertical Access utilized belts along the leg to stay ropes that would allow descent along the extrados and that could be used to swing over the intrados.

Conclusions and Recommendations

- Archival research revealed that stainless steel surfaces on other buildings and monuments have weathered well and have only required a mild cleaning. In addition, stainless steel is still extensively used architecturally in exposed environments. The Gateway Arch stands alone from other buildings and monuments in its extensive use of shop and field welds.
- Many of the discolorations and markings on the surface of the Arch were caused during the erection process, by inadequate cleaning and polishing of the Arch after erection or by atmospheric pollutants.
- The interstitial space between skins was observed to be in good condition; however, there are signs of past moisture. It is not known whether the water streaks observed are from original construction or from condensation. The existing signs of moisture indicate that the amount of water is not substantial.
- The steels were found to meet requirements specified during construction. Review of the concrete mixture characteristics indicated that the concrete is properly hydrated and is not holding excess moisture.
- Climatic conditions in the interstitial space are influenced by the air conditioning in the legs more so than the outside. However, the dew point is similar in the Arch interior, the interstitial space and the exterior. It was found that there were few time periods where the dew point temperature was close to the steel-plate temperatures, making the tendency for condensation low.
- Further investigation and testing is needed to evaluate if there is intergranular corrosion at the welds or contamination of carbon steel at the welds, and their effects on surface staining. This can be done by the removal of small core samples from the exterior and immediate repair performed from a standard personnel lift at lower areas of the Arch.
- An industrial rope access technique utilizing choker-hitched ropes or similar was recommended for access to the upper reaches of the Arch. This access allowed for residue samples to be surveyed and removed for laboratory analysis, for welds to be visually inspected, and for cleaning to be performed on some of the discolorations.

- Stains that emanate from the welds might be cleaned using the gentlest means possible, possibly followed by a passivation treatment.
- At the base of the Arch, where the surface is marked with incised graffiti, more aggressive cleaning treatments can be tested on a trial basis. Clear coatings might be considered after the surface has been passivated to protect against the effects of possible additional incised graffiti.

These recommendations guided Part 3 of the investigation, the corrosion study, which was undertaken in 2014.

Endnotes

- 1 Bahr Vermeer & Haecker Architects, Ltd., Gateway Arch Corrosion Investigation-Part I, Jefferson National Expansion Memorial, National Park Service, Omaha, Nebraska, May 2006. Upon report completion, the issue of security was raised by NPS law enforcement staff in light of restrictions dictated in the post-9/11 era. As a result, the report was only made available to those with security clearance and not to the general public. This decision later posed a challenge with local media, who eventually gained access to the redacted report through the Freedom of Information Act.
- 2 Bahr Vermeer & Haecker Architects, Ltd., National Park Service Jefferson National Expansion Memorial Gateway Arch Historic Structure Report, National Park Service, Omaha, Nebraska, June 2010.
- 3 Ken Kolkmeier, interview by Dan Worth of BVH; Stephen Kelley of WJE; Robert Moore, NPS JNEM Historian; Al O'Bright, NPS Historical Architect; and Victoria Dugan of NPS JNEM, January 14, 2009.
- 4 Digital Preservation used a large format digital camera that did not require the touching or scrolling of drawings through a machine.
- 5 Due to NPS contractual issues, the firm KPB Architects was awarded the general contract, but BVH and WJE continued as consultants.
- 6 Wiss, Janney, Elstner Associates, Inc., Gateway Arch Corrosion Investigation Part 2, National Park Service, Omaha, Nebraska, September 2012.

GATEWAY ARCH STAINLESS STEEL WELD AND SURFACE DISCOLORATION EVALUATION

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Abstract

Stainless steel's corrosion resistance made it a natural choice to achieve the desired longevity and aesthetic requirements of the Gateway Arch's exterior. While it is celebrated for its elegant symbolism and amazing size, many people do not realize that it was also visionary and innovative as the world's first large structural application for stainless steel. Our evaluation included metallurgical assessment of weld samples, a historic and current site corrosiveness assessment, analysis of surface deposits and visual assessment during the two inspection visits, which had the goal of determining the structural performance and integrity of the Gateway Arch's exterior stainless steel plate and welds. This paper reviews those findings while providing a historical review of the use of stainless steel as a structural material, other memorial examples, industry specifications, structural characteristics and general guidance on stainless steel specification.

Stainless Steel Specification

There are five distinct stainless steel alloy families—austenitic, ferritic, duplex, martensitic, and precipitation hardening—and hundreds of individual alloys. The austenitic, ferritic and duplex stainless steels are used for structural sections. Stainless steel family names are derived from their characteristic microstructures. Austenite gives austenitic stainless steels their name and makes them non-magnetic, very formable, and weldable. The ferrite in the microstructure of mild steel, cast iron, and ferritic stainless steels (e.g. 430, 444) makes them magnetic. Duplex stainless steels, which are increasingly being used for structural applications have a combined austenite and ferrite microstructure. The most commonly used stainless steels for building and construction are the austenitics (e.g. 304/304L, 316/316L). The designation “L” indicates low carbon levels and many producers dual certify modern plate as meeting the requirements of both the standard and low carbon alloys.

We were unable to locate the original plate or weld filler metal chemical certifications in the Gateway Arch archives however Type 304 was specified during design.

**Table 1: Common Current Specifications
For Stainless Steel Structural Products**

Standard	Specification	Description
ASTM		
Plate, sheet, strip	A240/A240M	Chemical composition and mechanical properties
	A480/A480M	Finishes, dimensional tolerance, flatness, and shipping requirements
Hollow sections*	ASTM A554	Round, square, and rectangular stainless steel mechanical and structural tubing chemical composition, mechanical property, and dimensional tolerance requirements
Bars and shapes	A1069/A1069M	Laser-fused (laser-welded) stainless steel structural shapes
	A276	Hot and cold rolled or extruded rounds, squares, hexagons, angles, tees, channels, and other structural shapes chemistry and mechanical properties
	A484/A484M	Dimensional tolerance, straightness, and finish descriptions for the products in A276
Bolts	A1082/A1082M	High-strength stainless steel bolts
Concrete reinforcement	A955	Round and deformed concrete reinforcement
	A1022	Deformed and plain stainless steel wire and welded wire mesh
American Welding Society (AWS)		
Structural**	D1.6	Structural welding code for stainless steel

* A554 includes large diameters and heavier walls; it is a more cost effective choice than 'pipe' for structural applications like bollards.

** Carbon steel welding codes should never be used for stainless steel, as there are important differences. A1069 only covers laser-welded structural shapes; all other welded structural shapes should be specified using AWS D1.6 in combination with ASTM A240 and A480.

Table 2: ASTM Minimum Mechanical Properties Of The Stainless And Carbon Steels Used For Structural Sections Today

	UNS	Common Name	Tensile Strength MPa (ksi)	Min. Yield Strength MPa (ksi)	Minimum Elongation in 50 mm (2 in.)
A240/A240M-15 Stainless steel					
Austenitic	S30400	304	515 (75)	205 (30)	40%
	S30403	304L	485 (70)	170 (25)	40%
	S31600	316	515 (75)	205 (30)	40%
	S31603	316L	485 (70)	170 (25)	40%
	S31703	317L	515 (75)	205 (30)	40%
Duplex	S32101		650 (94)*	450 (65)*	30%
	S32304	2304	600 (87)	400 (58)	25%
	S32003		655 (95)**	450 (65)*	25%
	S32205	2205	655 (95)	450 (65)	25%
A1043/A1043M-14 Carbon steel					
Grade 36			400 (58)	250 (36)	23%
Grade 50			450 (65)	345 (50)	21%

*These values apply to material of thickness greater than 5 mm (0.187 in.). For thinner material, the minimum tensile and yield strengths are 700 MPa (101 ksi) and 530 MPa (77 ksi).

**These values apply to material of thickness greater than 5 mm (0.187 in.). For thinner material, the minimum tensile and yield strengths are 690 MPa (100 ksi) and 485 MPa (70 ksi).

There has been considerable industry consolidation since the 1960's and the mills that produced the plate are now part of the corporate history of ATI Allegheny Ludlum and Outokumpu. Neither firm had retained the 50-year old mill certificates but both provided information about the technology and testing capability of that time period. The archives did not contain information about the source of the filler metal.

The stainless steel used for this project predates the installation of the first AOD (Argon Oxygen Decarburization) furnace in the United States in 1974. AOD furnaces very efficiently remove impurities, including carbon and sulfur, and make overall chemistry control easier. Metal produced prior to their widespread use typically had higher levels of both elements and would not meet the requirements of the "low carbon" Type 304L austenitic stainless steels typically specified when welding sections that are 0.125 inches (3.2 mm) in thickness or greater today.¹

During the 1960's, the Type 304 plate specified for this project would have been ordered to ASTM A167. Type 304 and other common stainless steels were moved to ASTM A240 many years ago and A167 was recently withdrawn. Table 1 provides the current relevant ASTM and American Welding Society (AWS) standards and

specifications for stainless steel; Table 2 compares the mechanical properties of the stainless and carbon steels used for structural shapes.

Structural Design Codes And Guides

Stainless steel has been used selectively since the 1940s for bridges and other structural applications.² Formal stainless steel structural design guidance first became available in 1968 when research prompted by the Gateway Arch and used in its design was published as an American Iron and Steel Institute (AISI) specification. The current version of this standard, Structural Engineering Institute/American Society of Civil Engineering (SEI/ASCE) 8, *Specification for the Design of Stainless Steel Cold-formed Structural Members*, covers light-gauge austenitic and ferritic stainless steels. It was the basis for cold-formed stainless steel structural design standards in Europe, Australia, New Zealand, South Africa, and Japan.

There has been substantial international structural stainless steel design research done since the 1960s. In 1993, work began to add heavier stainless steel sections to the European standards. EuroCode 3, *Design of Steel Structures, Supplementary Rules for Stainless Steels, Part 1-4*, includes both light and heavy austenitic and duplex stainless steel structural sections. In 1995, EuroCode 3 was used for the Type 304L and 316L structural framing of the Canadian National Archives.

Until recently, there was no North American guidance on the design of heavier structural sections. American National Standards Institute/American Institute of Steel Construction (ANSI/AISC) 360, *Specification for Structural Steel Buildings*, only covers heavier carbon steel structural sections. In September 2013, AISC Steel Design Guide 27, *Structural Stainless Steel*, was issued to provide design advice for sections 3.2 mm (0.125 in.) or greater. Capitalizing on new research that has also been incorporated into EuroCode 3, it includes welded plate fabrications, extruded and rolled shapes, hollow sections, tensile bars, and fasteners.

Weld Procedures

Welding procedure qualification records were found for the vertical and horizontal stainless steel butt joints in the archives dated January 7, 1964 (vertical) and May 18, 1963 (inclined horizontal).³ It was not clear whether either was a final procedure. Both indicated that MIG welding was to be used with different argon-CO₂ helium cover mixtures for each joint orientation. Weld clean up was to be with a stainless steel wire brush, and there were to be two weld passes and a grooved back up root treatment. A Pittsburgh-Des Moines Steel Company

letter dated December 5, 1963 mentioned removal of "weld haloes" (heat tint) using electrolytic methods.⁴

Electrolytic cleaning wands are commonly used to remove heat tint today. It is an old technology, which probably has not changed much during the past 50 years. Presumably it was used in combination with brushing to restore corrosion resistance by removing the heat tint. Oakite 33, a phosphoric acid based cleaner that is still sold today, was used to clean and degrease the surface prior to welding.⁵ Both AWS Code and ASME code Section IX were referenced in the weld procedures.

Weld Sample Collection and Analysis

Five approximately 0.75 inches (19 mm) diameter weld samples were obtained from the North leg of the Arch after examination of the welds using a lift. Larger weld beads, obvious weld repair or the other areas with visual cues that might indicate a possible imperfection were selected. All of the samples came from the lower sections of the North leg and a mixture of welds that were identified on the drawings as "field" and "shop" were selected. Table 3 summarizes the weld sample locations, weld appearance, and the imperfections that were documented during our metallurgical laboratory evaluation.

During the second site visit, the architect's daily reports were found in the archives. A report dated September 4, 1963 indicated that the carbon and stainless steel shop

welds installed up to that date had not been X-rayed properly prior to shipment. Extensive lack of weld penetration was found at these joints during field X-ray. Problems with the field welding equipment were also identified and corrected around that time period. Subsequent reports included indicated that 100% X-ray inspection of all of the welds below levels N63 and S63 had been approved. See WJE report for architects weld designations.⁶

These records implied that most if not all of the carbon and stainless steel below these levels was re-welded and the records further indicated that some areas needed additional repair after re-inspection. Therefore, all of the samples were probably welded at least twice with the second of those being a field weld. This explains the large size of the weld beads relative to what would typically be expected given the thickness of the plate. The metallographic weld cross-sections were mounted and polished and examined using optical light microscopy. Some of the samples were also examined using SEM/EDS (Scanning Electron Microscopy using Energy-Dispersive X-ray Spectroscopy) to confirm findings.

Even with today's low-carbon levels, the high levels of heat input associated with re-welding plate could cause sensitization (precipitation of carbides at grain boundaries), which decreases the corrosion resistance of the stainless steel plate adjoining the weld. Sensitization was found in the microstructures of all the samples, but neither they nor any area that was inspected exhibited the characteristic corrosion pattern associated with sensitization-related corrosion. Since higher carbon levels were often found in stainless steel produced prior to the introduction of the AOD, the sensitization observed during weld cross sectioning is not surprising. The sam-

Table 3: Weld Core Sample Locations, Observations And Imperfections

Sample No.	Face	Row	Panel	Location	Observations during sample selection	Imperfections
W1	West	9	North	12 ft. from north edge of panel	Very wide rounded weld bead with possible weld slag on the surface. Identified as a field weld.	Plate: Sensitized, small inclusions, manganese sulfide stringers Weld: Surface weld slag
W2	West	10	Center	4 ft. from south edge of panel	Somewhat larger section of an otherwise smaller shop weld	Plate: Sensitized, a small surface void that may either be pitting corrosion or an inclusion pulled from the surface during polishing Weld: Porosity
W3	West	6	North	2 ft. from north edge of panel	Weld repair area, shop weld	Plate: sensitized, plate inclusion Weld: Outside notch on weld surface, undercut, weld void
W4	West	6	North	6 ft. from north edge of panel	Somewhat recessed area shop weld with possible weld slag	Plate: sensitize Weld: Numerous small voids
W5	North extrados	8	West	1 ft. from east edge of panel	Somewhat larger weld with possible weld slag	Plate: sensitized Weld: small void, surface and subsurface weld slag

ples were from an area known to have been repeatedly re-welded. We cannot be certain that welds higher on the structure were also sensitized since the issues that led to the re-welding were apparently resolved. After 50 years of service, the lack of a characteristic corrosion pattern associated with this issue, indicates that even sensitized Type 304 is suitable for the environment.

SEM/EDS confirmed the presence of manganese sulfides in the base metal. Sulfides were seen in all the samples and can make the stainless steel more susceptible to pitting corrosion if the surface is not chemically passivated. The post-fabrication cleaning procedures indicated that passivation was to be done although we did not find confirmation of it in the archives. This would have removed surface sulfides and improved corrosion resistance.

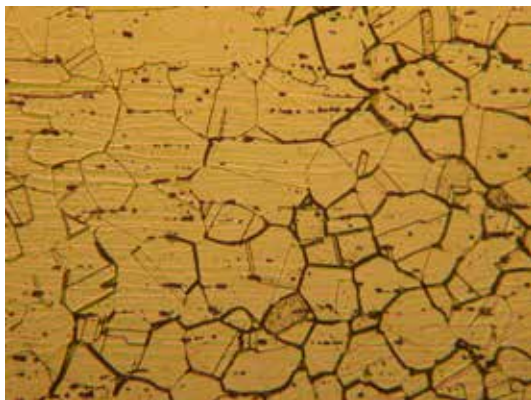


Figure 1: Micrograph of W1 in the etched condition showing sensitized grains (right) and grains that are not sensitized (left) (256x) (Photo taken by TMR in 2014)



Figure 2: Micrograph of a plate inclusion, W1, as-polished condition (517x) (Photo taken by TMR in 2014)



Figure 3: Micrograph of manganese sulfide stringers in the plate, W1, as-polished condition. (256x) (Photo taken by TMR in 2014)

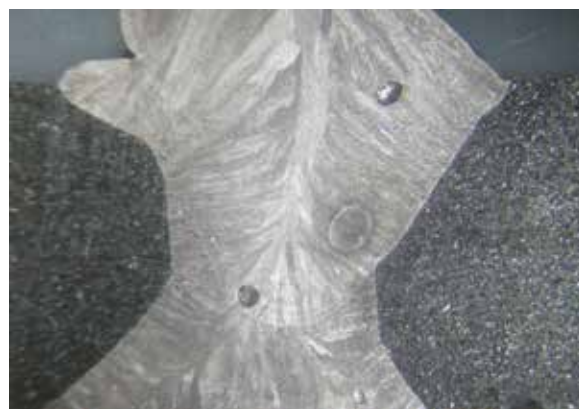


Figure 4: Macrograph, W4, etched condition, showing the most significant weld porosity found in any sample. The largest void near mid thickness has an approximate diameter of 0.04" (Photo taken by TMR in 2014)

All of the sample welds appeared to be full penetration. Numerous weld imperfections were documented during visual examination and microscopic evaluation of the weld samples, including small areas of porosity, weld spatter, weld slag and a shallow weld undercut. No cracking or significant corrosion was found at these imperfections after 50 years of service so they were not considered a concern. Figures 1 through 5 provide representative images of these imperfections, the inclusions, and the sensitization.

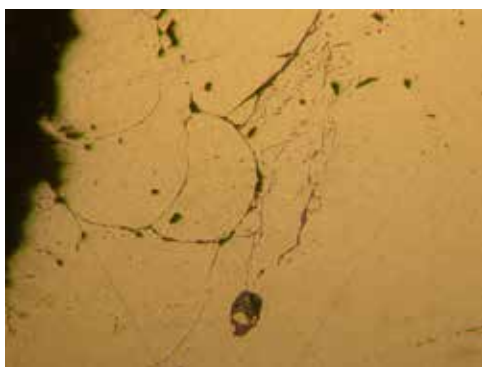


Figure 5: Micrograph W5 at the weld crown shown in the as-polished condition showing the sub surface weld slag (256x)
(Photo taken by TMR in 2014)

Table 4: SEM/EDS Chemistry Evaluation

Sample	Description	SEM/EDS Data for Primary Elements (Mass %)				
		Si	Cr	Mn	Fe	Ni
ASTM A167-1963	Type 304	1.00	18.00-20.00	2.00	Rem	8.00-12.00
A240/A240M-2015	Type 304	0.75	17.5-19.5	2.00	Rem	8.0-10.5
W1	Stainless plate	0.4	17.2	1.8	65.7	8.8
W1	Weld	0.4	17.6	1.8	61.9	8.4
W2	Stainless plate	0.4	17.8	2.0	65.3	8.4
W2	Weld	0.5	17.8	2.0	62.9	8.3
W3	Stainless plate	0.6	18.1	2.3	64.5	8.5
W3	Weld	0.4	17.2	2.1	59.8	8.0
W4	Stainless plate	0.4	17.8	1.7	65.1	8.7
W4	Weld #1	0.4	16.8	1.5	56.5	7.6
W4	Weld #2	0.4	16.6	1.5	55.7	7.6
W4	Weld #3	0.4	17.4	1.5	60.7	8.0
W5	Stainless plate	0.4	17.5	1.6	65.8	8.5
W5	Weld	0.4	17.8	1.7	61.3	8.3

Note: ASTM values are maximums unless a range is listed.

Plate and Weld Chemistry

The weld samples made it possible to determine the approximate chemistry of the base plate and welds using SEM/EDS. The small size of the plate in the weld samples and the need to retain them made it impossible to do a full laboratory chemistry evaluation. Additionally, the weld area was not large enough for a full chemical analysis. SEM/EDS chemistry is not exact and is only permissible for general alloy verification. Neither carbon nor sulfur levels can be accurately measured so neither element was included in Table 4 where the samples are identified

based on weld sample number. The carbon levels measured with SEM/EDS are typically much higher than what is physically possible due to surface contamination from handling. Unless carbon is specifically excluded from the analysis calculations, which determine element percentages, the concentrations of deliberate alloying element additions will appear lower than they actually are. Neither lab excluded carbon, so the actual alloying element concentrations are higher than shown in Table 4.

The plate appears to be the specified Type 304 with an appropriate matching chemistry filler metal. If the carbon had been eliminated from the analysis, they should meet 1963 requirements. Even if some plates or filler metal were outside of the required chemistry range, there has been no significant corrosion problem after 50 years of service, and remedial action, such as plate identification and replacement, would not be reasonable based on performance.

Surface Deposits And Site Corrosion Assessment

Samples were collected between September 29 and October 1, 2014 from the lower areas of the North leg, which were reachable by foot or lift. Inspectors climbing down the North leg collected additional samples between October 14 and 21, 2014. Gunshot residue kits, which were developed for law enforcement use, are specialized SEM/EDS sample collection tapes that can pull fine particles from the surface for analysis. Data analysis identified specific compounds associated with the different types of industry that have been in the area for the past 50 years. Full documentation can be found in our report.

Very minor amounts of deicing salts (chlorides) were found at all heights on the surface along with industrial particulates (i.e. fly ash, ferrochrome oxide, iron and steel slag, iron, copper, copper zinc, lead, and titanium), and soil constituents. Soil consists of carbon rich material (i.e. spores, pollens), clay materials, silica (sand), dolomite, mineral wool, paint particles, and calcite and magnesia alumina silicates. With the exception of normal surface "dust", the other accumulations can be explained by current and past heavy industrial activities in the area and nearby highways. The industrial pollutants could have been from plant emissions, dust generated as buildings were torn down or brown field site soil disturbed during reclamation or redevelopment. The iron particles that did not appear to be from steel mill emissions (i.e. iron without other elements) maybe carbon steel particulate from construction sites.

Various sources were reviewed to determine the industrial pollution sources that have been in the area since the construction of the Gateway Arch.⁷ Many possible

industrial plant sources of the surface deposits have shut down or changed products during the past 50 years. The industries in the area, which could have contributed to the surface deposits, included several steel mills; companies that may have had steel foundries or manufacturing steps that could generate metallic particles; St. Louis Army Ammunition Plant; Carondelet Coke Plant; three coal fired power plants; Sauget Industrial and Big River Zinc (zinc refinery); Cerro Copper (copper alloys); and chemical plants.

Fly ash (SiO_2 and CaO) is also known as flue-ash was one of the primary surface deposits found and is one of the residues generated in combustion. This ash is produced during combustion of coal (coal fired power plants, coke plants, steel mills and other coal burning industry). It used to be released into the environment and would have been present for much of the Gateway Arch's service life. In recent decades, scrubber systems have been mandated and fly ash is no longer released into the environment.

Iron rich particles were another primary surface deposit. They were mainly ferrochrome or iron and steel slag. Ferrochrome (FeCr) is an alloy of chromium and iron containing between 50% and 70% chromium. Steel production is the largest consumer of ferrochrome, especially stainless steel. The particles contained iron and chromium but no nickel; and therefore did not appear to be Type 304 stainless steel from the Gateway Arch. Iron and steel blast furnace slag is similar to fly ash in composition but it contains iron. There were also iron particles without other constituents found on the surface, which could have been from manufacturing operations or nearby construction.



Figures 6: Google Earth image (Left) showing the highways and bridges immediately around the site which are adding deicing salts (chlorides) to the environment and the superficial corrosion staining at the base caused by deicing salt exposure (Right photo taken by author in 2014)



Figures 7: Google Earth image (Left) showing the highways and bridges immediately around the site which are adding deicing salts (chlorides) to the environment and the superficial corrosion staining at the base caused by deicing salt exposure (Right photo taken by author in 2014)

Chlorides from deicing salt were found on the surface in very small concentrations at all sample heights. Highways surround the site and they are within the documented distance that deicing salt can travel. The high winds documented at elevated levels indicate that most of the structure is probably well rain-washed. It is not possible to determine how high deicing salt concentrations are in the winter and early spring but studies conducted by Argonne National Laboratory and by other researchers indicate that concentrations would be relatively low.

Other than very small, localized areas, the only corrosion staining observed on the surface was at the base, which would not be as effectively rain-washed as elevated areas. This light superficial staining was caused by microscopic deicing salt related pitting and could easily be removed. The environment is not corrosive enough for any of these deposits to have caused more than superficial discoloration after 50 years, so their presence is a purely aesthetic issue. Figures 6 and 7 show the surrounding highways and superficial corrosion staining at the base.

Embedded Iron Contamination

There were scratches on the Arch's base, which contain embedded iron particles from carbon or alloy steel. The largest of these extends along the base, are relatively deep and may have been from a snowplow. This surface contamination should be removed because the deposit creates a crevice and corrosion does not stop

when the iron has corroded away. The exposure to deicing salt increases the corrosion rate. This contamination should be removed from the deep scratches with either a handheld electro-polishing wand or stainless steel pickling paste painted on to these localized areas with a small brush in accordance with ASTM A380 followed by chemical passivation to improve the corrosion resistance.

Alloy selection

Overall the Gateway Arch is in very good condition. The service environment is less corrosive now than it has been historically due to the dramatic reduction in pollutants from heavy industry. Deicing salt has been added to the environment since the Arch's construction but surface concentrations were very low and only identifiable through SEM/EDS. The high winds combined with rain washing and a mechanically polished surface finish that is finer than most No. 4 polished plate today have made rain-washing effective for most of the surface. Type 304 appears to have been an appropriate alloy for this project. Cleaning could remove the existing discoloration.

There are numerous resources for stainless steel alloy specification for corrosion resistance.^{8 9 10} Surface finish, welding, environmental exposures and other factors can be as important as alloy selection, so specification guidance from industry associations, stainless steel producers and other resources should be obtained for new construction and restoration projects. Based on the assumption that corrosion staining is undesirable and there will be little or no maintenance cleaning, the stainless steels that would be most commonly specified today for low to moderate salt exposure or heavily polluted environments with little or no cleaning would be Type 316/316L or the duplex alloys UNS S32101 or S32304, because typically rougher finishes than a relatively smooth No. 4 are specified for monuments and sculptures. Duplex UNS S32205 provides substantially more corrosion resistance and is suitable for higher levels of industrial pollution and salt exposure, when rougher finishes are specified, or where natural heavy rain cleaning is less frequent.

Structural Stainless Steel Memorial and Sculpture Use

The first large structural stainless steel non-industrial projects to use this research were the 1964 Unisphere sculpture (World's Fair, New York City) and the following year's Gateway Arch, which were both Type 304. Because it is in a coastal environment, cleaning of the Unisphere has been necessary to maintain its appearance, and it would have been constructed from Type 316L if it had

been designed today. The 266 ft (81 M) sculptural flagstaff on the Australian Parliament building is also Type 304L. Canberra is an inland location with low pollution levels.

The 1986 restoration of the Statue of Liberty used Type 316L and the high strength proprietary duplex stainless steel UNS 32550 to replace much of the original iron support framing. It was the world's first known large non-industrial duplex structural application. There are many other examples of stainless steel's use in sculpture, memorial and building restoration throughout the world. Restoration of the Atomium in Brussels, which was built for the 1958 World's Fair and originally clad in aluminum, began in 2001, and Type 316L stainless steel was chosen to replace the poorly performing aluminum.

More recent examples of duplex stainless steel use include the large moving flag sculpture inside the entrance of the Smithsonian National Museum of American History in Washington, DC where its' high strength permitted structural section and weight reduction. A proprietary cast duplex stainless steel was used for the Pentagon 9/11 Memorial because added corrosion resistance was needed due to deicing salt exposure. By far, the largest construction-related structural application for duplex alloys (not including industrial buildings) has been pedestrian bridges.

Type 316L has been the most commonly used stainless steel for exposed structural sculpture and memorial section applications because it provides better resistance to corrosive coastal and deicing salts and pollution than Type 304/304L. Examples in the US include the US Air Force Memorial, Chicago's Cloud Gate, and the New Jersey, New York and Connecticut 9/11 Memorials. Stainless steel concrete reinforcement is used in restoration projects as well including the replacement of failing carbon steel in the seawalls around the Sidney Opera House (316L) and the Hassan II Mosque in Morocco (2205 duplex).

Statue of Liberty Restoration

Since its installation in New York in 1886, the Statue of Liberty has become one of the most well known sculptures in the world. However, many people are not aware galvanic corrosion caused structural deterioration, making a significant restoration necessary in 1986. The original structure of the 46-m (151-ft) statue had a framework of puddled iron consisting of three distinct components—a central pylon, 1,850 secondary framing beams, and armature bars. A double-helix staircase rises through the pylon's center. About 1,500 U-shaped copper saddles connect the armature to the outer copper envelope sheets.

Designers Auguste Bartholdi and Gustave Eiffel anticipated the galvanic corrosion problem and tried to elec-

trically isolate the materials. Unfortunately, the envelope design and subsequent modifications allowed salt-containing moisture and acid from pollution to seep behind the copper. Condensation from temperature and humidity changes also added the moisture necessary for corrosion. Severe corrosion of the iron armature had occurred by 1981 and caused copper damage. Type 316L stainless steel replaced the iron armature except for a few bars in the right sole of the foot. No galvanic corrosion problem would be expected between copper and stainless steel in this type of environment and their coefficients of thermal expansion are the same. A high-strength, highly corrosion-resistant duplex stainless steel UNS S32550 secondary framework was used to support the new Type 316L armature.¹¹

Conclusions

The stainless steel and welds that were inspected on the Arch all appear to be in good condition. With the exception of the base, the surface deposits on the Arch are grey, black, or brown with some scattered small areas of superficial red toned staining. These are assumed to be old deposits since the industries from which many of these particles were probably emitted have shut down. Very small amounts of chlorides (deicing salt) were found and are believed to be from the highways surrounding the site. The base and remainder of the exterior could be cleaned to restore its appearance. Unless there is a dramatic change in the environment, such as much higher chloride salt levels, there is no concern about the continued good performance of the Gateway Arch.

Endnotes

- 1 Telephone and email conversations during 2014 with multiple current and retired employees of Outokumpu and ATI who are familiar with the corporate history.
- 2 Houska C and Wilson K, Pushing the Design Envelope with Structural Stainless Steel, The Construction Specifier April 2007
- 3 JEFF Archives, McDonald, Box 11, Folder 4 and Box 17, Folder 26
- 4 JEFF Archives, McDonald, Box 10, Folder 5
- 5 JEFF Archives, Same letter as 3, McDonald, Box 10, Folder 5
- 6 JEFF Archives, Saarinen files, daily reports
- 7 See current and historic EPA records, <https://www.stlouis-mo.gov/visit-play/stlouis-history.cfm>, <http://builtstlouis.net/>, St. Louis' city website and other internet based information on current and historic industry.
- 8 Houska C, The Construction Specifier, Metals for Corrosion Resistance: Part II (November 2000), Architectural Metal Corrosion: The De-icing Salt Threat (December 2006), Designing on the Waterfront (November 2007), and Stainless Steel for Severe Corrosive Environments (September 2011)
- 9 International Molybdenum Association, Which Stainless Steel Should I Specify for Exterior Applications? and Duplex Stainless Steel Fabrication, 3rd Edition
- 10 Houska C, Nickel Institute, Stainless Steel in Architecture, Building and Construction: Guidelines for Corrosion Prevention, Reference book series No. 11 024-2014
- 11 National Association of Corrosion Engineers (NACE) and National Park Service The Statue of Liberty Restoration, Proceedings of The Statue of Liberty: Today for Tomorrow Conference, 1986

CLOSE-UP INVESTIGATION OF THE VISIBLE STAINS ON THE STAINLESS STEEL SKIN OF THE GATEWAY ARCH

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Abstract

The National Park Service and Wiss, Janney, Elstner Associates, Inc. (WJE) have been investigating the visible stains on the stainless steel skin of the Gateway Arch since 2005 with the field work of the final phase being completed in 2014. During the final phase of this investigation, areas of stainless steel that appeared discolored from grade were examined up-close for the first time using industrial rope access techniques. WJE architects, access experts, conservators, and engineers worked collaboratively using traditional techniques such as field microscopy and high powered spotter scopes as well as innovative technology including helmet mounted video cameras and real time "cloud-based" approaches to facilitate the challenging investigation. The work of all team members, including the National Park Service, was critical to identify, assess, and ultimately develop treatment recommendations for the long-term preservation of the Gateway Arch. The presentation will be jointly given by three members of the WJE inter-disciplinary team who worked closely together during the investigation. Specific topics will include developing the access program, the staining assessment, cleaning trials, and the preliminary conclusions of the study.

Introduction

Working with the National Park Service (NPS) and Bi-State Development Agency (Metro), Wiss, Janney, Elstner Associates, Inc. (WJE) completed a close-up inspection of the Gateway Arch (Arch) at the Jefferson National Expansion Memorial (JEFF) in St. Louis, Missouri in the fall of 2014. In addition to WJE, TMR Consulting (TMR) was part of the current project team. This project was the culmination of a three phase investigation to determine the cause(s) of staining of the stainless steel skin with Phase I beginning in 2005, and Phase II beginning on 2011.

The project background as well as laboratory analysis of removed samples is summarized in other articles as part

of this symposium. This article is limited to summarizing the custom industrial rope access (IRA) system, observations during field work from an aerial lift and from the IRA system, and results and conclusions about cleaning trials performed at grade.

The Arch was designed by Eero Saarinen and Associates (ES&A) and Severud Elstad Krueger Associates of New York as a 630 foot high weighted catenary arch with legs set 630 feet apart. The structure was erected using 143 prefabricated double-wall carbon steel and stainless steel stations. The interior skin is painted carbon steel and the exterior skin is stainless steel plate. These skins are 3 feet apart at ground level and 7-3/4 inches apart above the 390 foot level. Up to a height of 300 feet, the interstitial space between the skins was filled with post-tensioned concrete.

Pittsburgh-Des Moines Steel Company (PDM) fabricated the Arch stations with 1/4 inch thick Type 304 polished stainless steel plate for the exterior skin. The stainless steel plates of the Arch were specified to have a No. 3 finish, an intermediate polished finish mechanically applied by successive passes of polishing wheels or belts. The original design documents for the Arch refer to ASTM A167-63, *Standard Specification for Corrosion-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip*.

After the keystone station of the Arch was inserted, the stainless steel panels were washed and polished by hand from the top down using the creeper cranes for access. According to the approved shop drawings, grease and dirt were removed with "Oakite #33," a proprietary acidic chemical and "Minor abrasions, such as scaffold pad bruises, suction cup marks, etc., will also be removed at this time using a fine grit impregnated cloth."¹ Bolt holes in the exterior skin, used during construction, were plugged with stainless steel plugs that were welded and ground smooth.

The Arch was constructed without a means to access the stainless steel except at grade and from an access hatch at the observation deck. In order to complete the

work, WJE developed and installed a temporary access system which provided access to the extrados on one leg, as well as, one of the more heavily discolored areas on the intrados. At the base, aerial lifts were used for access and could reach up to approximately Station 65 on the extrados and Station 66 on the intrados.

Industrial Rope Access (IRA)

During Parts I and II of the corrosion investigation, the visual assessment indicated that the stainless steel was performing similarly at the north leg and the south leg. Based on the study completed during Part II to assess the feasibility of accessing the stainless steel, factors including weather, wind, and direct sunlight were determined to potentially affect the schedule for performing the IRA inspection. Since the south leg received more direct sun exposure and the stainless steel temperature would be higher in direct sunlight, the IRA work was to be completed on the north leg. Additionally, based on past weather reports, October was selected to perform the investigation because of its historically calmer weather.

WJE designed a custom IRA system to allow personnel to have hands-on access to the stainless steel skin without damage to the structure, or installation of permanent attachments to the stainless steel skin (Figure 1 and Figure 2). The IRA system allowed access to the exterior face of the north leg for the entire height, and access to the west intrados on the north leg from approximately Station 28 to Station 35. WJE used a three-dimensional scale model of the Arch to design the IRA system.

During the IRA work, WJE used helmet-mounted digital video recorders from various vantage points to document the existing stainless steel conditions with video, in addition to photographs taken by WJE personnel. The WJE team members who performed the inspection shared photographs in real time to the technical team members on the ground by using cloud based storage of their digital photographs.

The IRA system used a bridle system that spanned in tension from the hatch opening at the top of the Arch down the extrados of the north leg to the secondary anchor and then down to the base of the north leg. WJE then used an independent two-rope descent system to descend and inspect the stainless steel. No intrusive or permanent connections were made to the exterior stainless steel skin or interior structural components. Metal components of the IRA system were separated from direct contact with the stainless steel skin at all times to avoid contamination of, and/or potential damage to, the stainless steel. Additionally, WJE personnel used work boots, knee pads, and other equipment that would not leave any marks on the stainless steel skin.



Figure 1: View of custom IRA system



Figure 2: Overall view of the access at the intrados

The primary anchor point, at the center of the observation deck, consisted of two nylon anchor slings girth hitched around the observation windows on both sides of the observation deck and attached to threaded rods with custom fit adjustable angles that bracketed the edges of the extrados. To separate the system from the stainless steel, the threaded rod was passed through plastic spacer discs and nylon pads were attached to the custom fit angles.

The bridle system below the primary anchor point was composed of two synthetic ropes (twelve strand Amsteel by Samson Rope) and a series of intermediate anchor straps. Amsteel was chosen for the low stretch properties, similar to wire rope, but more importantly that it would not damage the stainless steel skin due to contact. The ropes were attached to the primary anchor point and the secondary anchor point, and were positioned to run at the approximate third points of the extrados. The intermediate anchor straps provided intermediate attachment points during installation and removal by preventing the two-rope descent systems from migrating off the extrados. The intermediate anchor straps were located at Stations 6, 10, 14, 18, 21, and 25, and were composed of synthetic straps tensioned between custom fit angles that bracketed the edges of the extrados. The secondary anchor point, located between Station 28 and Station 29, was constructed similarly to the primary anchor point. The west side of the secondary anchor point provided the upper connection point for the secondary tensioned line that was used to access the west face of the north leg intrados.

Below the secondary anchor point, the bridle system consisted of two tensioned lines extending along the extrados and were tensioned between the secondary anchor point and the primary base anchor points. These primary tensioned lines consisted of two Amsteel ropes positioned at the third points of the extrados and then tensioned using chain hoists with in-line tension meters to accurately monitor and adjust the tensions in the system as necessary during the IRA work. The primary base anchor points consisted of two 5,000 pound modular concrete barriers located north of the paver system at the base of the north leg. These primary tensioned lines were used as guide lines for the extrados inspection to prevent uncontrolled lateral movement.

To provide a guide line along the west intrados at the north leg, a secondary tensioned line was installed between the west secondary anchor point and the secondary base anchor point. The secondary base anchor point consisted of a single 5,000 pound modular concrete barrier located east of the paver system at the base of the north leg. The system was tensioned using chain hoists with in-line tension meters to accurately monitor and adjust the tensions in the system as necessary during the IRA work.

This custom IRA system allowed WJE project team members to have hands-on access to the stainless steel skin without damage to the structure. The IRA system allowed access to the exterior face of the north leg for the entire height, and access to the west intrados on the north leg from approximately Station 28 to Station 35. The IRA system could be modified to access additional locations on the intrados as needed in the future, and the system could also be used to inspect the south leg.

Archival Research from the Jefferson National Expansion Memorial Archives

Archival research, conducted as part of the project, revealed that preventing the stainless steel plates from getting damaged during shipping and construction remained a contentious issue. While the original construction documents indicate the contractor was responsible for protecting the stainless steel during construction, kraft paper and coatings were amongst the suggestions for protecting the stainless steel.² PDM was unsuccessful at identifying an appropriate material to protect the stainless steel and as a result was using "refined techniques and extreme care."³ Although the NPS remained unsatisfied with the lack of protection and "apparent negligence in protecting the stainless steel exterior surfaces."⁴

In addition to developing a process to protect the stainless steel, the design team, the NPS, and the contractor had a difficult time in establishing criteria for level of damage to the surface which was acceptable:

In order that a tentative criteria for determining the acceptability of the material can be established, it was agreed on by all present that scratches of the severity of those on the rejected plates would be cause for rejections even if washing or rubbing had not been performed. Less severe scratches and blemishes, while they should be carefully avoided, would not appear to be cause for rejection if they do not exceed in number those present in the other established. It was generally agreed that no firm definitive rules can be established. Generally, when minor scratches or blemishes are such that they do not attract the eye when viewing the entire plate, and when the viewer is required to search the surface closely to detect them, then they are not to be considered cause for rejection.

The above refers to judging of mill materials when uncrated. It was agreed that a certain amount of additional wear will take place on the plate surfaces as a result of assembly, shipping and erection. All agreed that this must be minimized, and that not until subsections are delivered, assembled, and erected can a final criteria for determining acceptability be established.⁵

In addition to evaluating repairs, the archives indicates lengthy discussion related to the repairs of bolt holes, scratches and other surface blemishes.⁶ Correspondence identified damage noted by ES&A of the stainless steel skin from dropped tools, cables, grease, scratches from ladders, runoff from water and solvents, mud, fabrication, and contact with scaffolding.⁷ In addition, areas that have been rubbed resulted in isolated "shiny spots."⁸ Damage was noted on numerous sections of the Arch throughout construction.⁹ Even by 1966, the repairs to the blemishes and marks had not been accepted by the NPS or ES&A. The damage was severe enough that the Government requested a credit of \$367,631.20 for damages to the stainless steel surface on the Arch, and

an additional credit \$86,589.00 for failing to provide the specified protection.¹⁰ PDM was ultimately unsuccessful in removing the blemishes and stated "It appears impossible to remove all marks from the stainless steel and still leave a finish completely acceptable to the Park Service."¹¹

WJE reviewed the documentary "Monument to the Dream" to gain additional information on the construction of the Arch. The film shows the blemishes and protection which may have contributed to blemishes in the stainless steel that occurred during fabrication and construction, including circular marks left on the panels from suction cups, black adhesive strips, adhesive marketing decals, connection points for the creeper derricks and several overall views of the Arch during construction show streaking and staining on the stainless panels.

Field Observations

The field investigation identified a variety of visual anomalies in the appearance of the exterior stainless steel. In general, the visual anomalies of the stainless steel skin can be classified in three categories:

1. Blemishes refer to alterations to the surface texture that create a visual aberration under specific lighting conditions and at certain observation angles (Figure 3). (During the original construction, NPS used the term "blemishes" to describe visual surface anomalies. The same word is used for consistency.)
2. Deposits refer to particles such as atmospheric pollutants on the stainless steel surface (Figure 4).
3. Discoloration refers to chemical alterations, such as superficial corrosion staining, on the stainless steel surface.

While the visual anomalies can be categorized separately as noted above, they frequently overlap where observed on the Arch. Additionally, the conditions noted are visually apparent on the south leg as well. Since the stainless steel cladding was evaluated in 2005, the visual anomalies are consistent, and are not significantly worse, than when observed in previous phases of the corrosion investigation.

Blemishes

The blemishes typically included horizontal bands, rectangular shaped where the derrick creeper was attached, vertical streaks, brush marks adjacent to welds, and circles with either 10 or 18 inch diameter. Other blemishes were also observed including large arc-shaped blemishes caused by scratches. At the base,



Figure 3. Vertical blemish within panel section (west face) shown within the dashed line



Figure 4. Deposits from run off from horizontal welds

there was incised graffiti and impact damage in the two lowest panels at the base of the Arch. The depth of the damage ranged from superficial scratches to deep hammer indents. The incised surface graffiti was generally 1 to 5 mils (0.001 to 0.005 inch) deep. Circular (ball peen) hammer indents on the center section of the extrados were approximately 6 to 11 mils deep. The deepest damage was observed at the half-moon hammer impact locations at the eastern side of the extrados, where dents were 25 to 35 mils deep. The incised graffiti is frequently associated with embedded iron particles that have corroded. An isolated dent at Station 35 was observed which had a depth up to 1/2 inch. The observed oil canning on the extrados was associated with relatively minor 1/8 inch out of plane deformations, no plate deformation was measured on the intrados.

Deposits

Surface deposits were common at many welds that were horizontal to grade. The rougher welds appear to have increased deposits as a result of trapping air borne particulates. In addition, there were irregularly shaped areas of an oily substance that collected deposits. Deposits were also present at the louvers.

Discoloration

Discoloration was present at various locations of the Arch; however the most severe was at the base including brownish-orange superficial corrosion and isolated areas of red-orange corrosion from embedded iron particles at the incised graffiti. In addition, some minor discoloration associated with heat along the welds was also observed. Isolated red-orange staining was present at the louvers. The large discoloration at the intrados had the shape of something that had spilled on the surface.

Surface Profile

In order to assess whether a difference in surface profile caused by the original finishing would result in a difference in appearance, the surface profile of the stainless steel panels near grade was measured using a Mahr Federal Pocket Surf Profilometer. A profilometer provides a measure of the surface finish profile (peaks and valleys) or roughness. A diamond stylus, similar to a phonograph needle, traverses a set distance on the steel surface. The instrument measures the surface texture and provides a value that describes the amount of surface variation or roughness. The arithmetic mean of all deviations from the mean line within the total measured length provides the Average Roughness, Ra (micro-inches). There are 1,000,000 micro-inches in an inch.

The surface roughness was measured both horizontally across the panel, in line with the direction of the finish, and vertically up and down along the panel, across the direction of the finish. The results show that the vertical cross-finish measurements were much rougher (more peaks and valleys) than the horizontal measurements made in line with the finish. The typical horizontal profile had an average Ra of 13 micro-inches, and the typical vertical profile had an average Ra of 30 micro-inches, showing that the surface profile in each direction is different. In addition, the surface measurement was measured to provide a baseline for evaluation of the cleaning trials. No significant alteration to the surface profile could occur as a result of the cleaning.

The differences in surface relief and texture between various areas of the Arch were subtle. In order to examine surfaces in microtexture using laboratory microscopy without removing historic fabric from the structure, physical molds of the stainless steel surface and repre-

sentative welds were created using the RepliSet system. RepliSet is a silicone mold-making material that replicates ultra-fine details as small as 0.1 micros.

Laboratory examination revealed that the vertical streaks below the welds corresponded to a difference in surface texture. This difference in surface texture appeared as if the finish lines in the horizontal direction overlapped. The density of the applied surface texture to the stainless steel panel was greater at the areas which appeared darker. The increased amount of texture may also collect dirt preferentially to some minor extent; however, when the surface was wiped with a solvent, the darkness remained visible. This overlapping of the finish occurred during the original polishing of the stainless steel plates during fabrication.

SEM/EDS Analysis of Removed Deposits

Gunshot residue sample (GSR) kits were used to remove samples of the surface deposits from the stainless steel skin of the Arch. The GSR kits contain an adhesive that allows the collection of surface deposits non-destructively, without causing damage to the stainless steel. The adhesive can then be analyzed using light microscopy and scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDS) for elemental analysis. The samples were taken at various locations along the height of the north leg from a variety of access points. The analysis identified carbon, oxygen aluminum, silicon, potassium, calcium, iron, and manganese. In addition, small amounts of copper, zinc, and titanium were also identified.

Based on the morphology and chemical analysis in the SEM/EDS analysis, the deposits were largely identified as carbon rich material such as spores and pollen. In addition, industrial particulates including fly ash, ferrochrome oxide, iron and steel slag, iron, copper, copper zinc lead and titanium were found on every sample. Common mineral deposits including clays, silica, dolomite, calcite, and magnesia alumina silicate were also present. These deposits are common airborne particulates that are either natural or may be a result of atmospheric pollutants from industrial plants.

Cleaning Trials

Cleaning trials were performed to evaluate the effectiveness of various cleaning systems to remove blemishes, deposits, and discoloration. WJE selected cleaning techniques for testing based on an understanding of existing conditions and our experience on previous projects. Solvents and mild detergents were selected to remove deposits; weak acids were used to remove discol-

oration; and surface refinishing techniques were tested to remove blemishes. Due to safety concerns, the chemical cleaners utilized from IRA were limited to the mildest systems. Based on the results of cleaning trials performed at the base (Figure 5), and field observations indicating that subtle differences in surface texture could create visual anomalies, no cleaning systems that could alter the surface profile of the stainless steel were used at Station 35.



Figure 5: Cleaning study test areas

First, the stainless steel was cleaned with a polar and non-polar solvent wipe to remove organic residue such as oils, waxes, lotions, etc. Then the cleaning systems were applied. The chemicals were rinsed from the surface, and the surface of the stainless steel was chemically passivated.

Some surface deposits were generally easily removed with the solvent wipe. More tenaciously bonded deposits remained after solvent and detergent cleaning. Since the blemishes are a result of a difference in surface texture, refinishing would be necessary to remove them. Because of the risk of altering the surface and results of the refinishing completed at the time of construction, the team decided refinishing options should not be recommended; however, the surface roughness measurements did indicate a similar roughness could be achieved. The orange corrosion staining from deicing salts required acidic cleaners. Acidic cleaners with a mild abrasive were most successful at removing this staining. The red staining from embedded metal particles would require chemical pickling which was not completed. Chemical cleaners may have been successful on the discolorations at the intrados, however, safety concerns prevented cleaning trials using those chemicals.

Conclusions

The exterior stainless steel of the Arch is in serviceable condition, without significant structural distress or deterioration. The visual anomalies, including a variety of blemishes, deposits, and discoloration, are not an indication of significant corrosion or distress of the stainless steel at this time, and many of these visual anomalies are from the original construction.

Archival research revealed that throughout the fabrication and construction of the Arch, the appearance of the stainless steel panels was under discussion between parties involved in the construction. The blemishes largely originated from original fabrication, damage during shipping, damage during erection or attempts to refinish in the field during construction. As a result, all of these document the process of construction.

Some of the panels generally appeared darker or lighter than adjacent panels under specific lighting conditions and at certain observation angles. No differences in the surface texture or gloss were measured between these panels, and no difference was measured in the surface texture. The perceived visual difference is likely a result of a difference in direction of the finish (left to right versus right to left), rather than any differences in the surface texture.

At the base of the Arch, incised graffiti and impact damage have created significant blemishes. Several of the cleaning trials partially reduced the visual appearance of the blemishes; however, the most effective trials required refinishing the stainless steel. While the refinishing trials largely resulted in similar profiles to the stainless steel as were present before the trials were conducted, a visual difference between the trial areas and the original finish remained. While the visual difference could likely be reduced with additional field trials to more closely match the appearance of the original finish, refinishing the base panels is not recommended.

Dark deposits were observed at various locations on the Arch. Areas with a rougher surface have collected deposits preferentially. These rougher surface areas include blemishes in the stainless steel finish, as observed in the silicon molds, field welds, and weld spatter adjacent to the welds. The deposits appear to increase the visibility of the rougher surfaces. In addition, weather patterns, such as prevailing winds, and the geometry of the Arch, have created run-down patterns of precipitation that have created dark areas.

Discoloration of the stainless steel surface refers to a chemical alteration of the stainless steel that causes a visual difference, such as superficial corrosion staining. There were no indications during this investigation that the superficial surface corrosion has resulted in significant section loss of the stainless steel or is a structural concern. In the future, if there are significant atmospher-

ic or environmental changes in the St. Louis area, there is a possibility that the corrosion could become more aggressive or deposits more extensive.

One of the more pronounced discolorations observed is the brownish-orange superficial corrosion staining near the base of the Arch, which is likely a result of chloride surface contamination related to prior use of deicing salts. It is likely that chloride deicers used near the base, prior to the installation of the snow melt system, circa 1985, contributed to this type of corrosion. In addition, airborne deicing salts from nearby roads and sidewalks may also have contributed to the chloride contamination. This corrosion was observed at the lowest eight panels. Chloride contamination of stainless steel accelerates surface corrosion, creating a brownish-orange corrosion product. Chemical cleaning using weak acids were successful in removing the chloride induced corrosion staining. Routine gentle cleaning using mild, chloride reducing cleaners will likely be sufficient to remove chloride contamination at the base of the Arch that would have the potential to accelerate surface corrosion. Discoloration was also observed on the intrados which appeared to be related to a liquid spill likely during construction. Cleaning trials were limited at this location due to safety concerns.

Additionally at the base of the Arch, the isolated red-orange corrosion observed at the lowest two panels is related to the corrosion of deposits of steel left in the surface as a result of the incised graffiti. The embedded iron can only be removed with refinishing or pickling. Pickling stainless steel involves strong oxidizing agents, such as diluted mixtures of hydrofluoric and nitric acids, to remove a thin layer of metal from the surface of the stainless steel, and can dull the finish of the stainless steel. Since pickling acids will likely dull the finish, this should be done carefully using small brushes only at the embedded iron.

Finally, park maintenance staff should be trained to safely perform routine maintenance, such as removing stickers and tape from vandalism, so as to not cause damage to the stainless steel. In addition, measures should be implemented to train the staff to prevent mechanical damage during routine maintenance involving ladders and snow removal equipment. To prevent future damage to the Arch, and especially because the graffiti is very difficult to address with treatments, improved security measures are recommended to prevent the occurrence of graffiti.

Annual visual monitoring of the stainless steel skin using high powered binoculars or spotter scopes, including photographic documentation, is recommended to document visual changes in the stainless steel. Annual monitoring close-up of the incised graffiti and scratches at the base should also be performed. These changes should be compared against previous documentation and evaluated for significance.

Endnotes

- 1 MacDonald, Box 10, Folder 5, letter from NPS from MacDonald dated December 11, 1963, and referenced PDM letter to MacDonald dated December 5, 1963.
- 2 MacDonald, Box 10, Folder 1, Shop drawings to NPS from PDM dated April 29, 1963
- 3 MacDonald, Box 9, Folder 7, Letter to ES&A from MacDonald dated December 7, 1962
- 4 MacDonald, Box 10, Folder 5 Letter to ES&A from JEFF Assistant Superintendent dated December 17, 1963, with response from ES&A dated December 20, 1963
- 5 MacDonald, Box 9, Folder 6 Minutes of Meeting dated October 26, 1962
- 6 MacDonald, Box 9, Folder 1 Conference Notes dated May 2, 1962
- 7 MacDonald, Box 9, Folder 9 Letter to MacDonald from ES&A dated March 18, 1963. MacDonald, Box 10, Folder 2, Letter to MacDonald from ES&A dated August 23, 1963. MacDonald, Box 10, Folder 3, Letter to MacDonald from ES&A dated September 24, 1963. MacDonald, Box 10, Folder 3 Letter to MacDonald from ES&A dated October 10, 1963. Letter to JEFF Superintendent from JEFF Project Supervisor dated September 14, 1966
- 8 MacDonald, Box 10, Folder 2 Field Memorandum Number 317 from ES&A dated July 25, 1963
- 9 MacDonald, Box 10, Folder 2, Field Memorandum Number 317 from ES&A dated July 25, 1963
- 10 MacDonald, Box 11, Folder 6, Letter to MacDonald from JEFF dated September 20, 1966
- 11 MacDonald, Box 14, Folder 6, Letter to JEFF from MacDonald dated May 5, 1966, including a letter to MacDonald from PDM dated May 4, 1966

PRESERVING THE GATEWAY ARCH: EVALUATING FIRE PROTECTION AND LIFE SAFETY CONDITIONS USING A PERFORMANCE BASED ANALYSIS

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Abstract

Mills + Schnoering Architects and Jensen Hughes, Inc. performed a fire/smoke modeling assessment of the Gateway Arch. The fundamental goal of the study was to evaluate fire protection and life safety risks to the public and building occupants in the event of a fire or similar emergency, with emphasis on those occupants that may be located at the observation platform at the top of the Arch. The project's primary fire safety goal was to provide an environment for occupants that is reasonably safe from fire and similar emergencies. An additional goal was to preserve historic or culturally significant building features.

The analysis highlighted and quantified areas that need to be addressed given the scenarios examined. Mitigation strategies were developed for several categories:

- Fire Safety System Modifications
- Structural Modifications
- Procedural Modifications
- Population Constraints
- Training/Documentation

Mitigation strategies were evaluated based on the results of the fire and egress analysis. Strategies were also evaluated for effectiveness, cost-effectiveness, and effects on the historic nature of the structure and facility operations.

Introduction

Mills + Schnoering Architects and Jensen Hughes performed an analysis of fire protection and life safety within the Gateway Arch in St. Louis, Missouri at the request of the National Park Service (NPS). The preservation of a structure such as the Gateway Arch must include continuous re-evaluation of fire protection and life safety strategies. New materials or architectural configurations within the structure over its lifetime may represent an increased hazard over what was originally envisioned when the structure was designed and built, and new threats may develop that could have an impact on its use and preservation.

The Gateway Arch is part of the Jefferson National Expansion Memorial along with the Old Courthouse and the Museum of Westward Expansion. In particular, the Gateway Arch is known as the "Gateway to the West" and was recognized as a National Historic Landmark on May 28, 1987. The monument is 630 ft tall and viewing access is granted to the public. Visitors enter through the Visitor's Center, an underground space that spans

the two legs of the Arch, and use one of two trams, one tram located in each leg of the Arch, as transport to the observation platform at the highest point.

The large interconnected volume of the Arch interior and limited routes for occupants to exit from the observation platform present unique challenges for life safety in the event of a fire. Traditionally, fire and life safety designs have relied on compartmentalization to prevent a fire in one area of a building or structure from affecting adjacent areas and fire protection systems (e.g. sprinklers, smoke control), to mitigate the severity of fire events. This concept forms the basis of current prescriptive code requirements. In a unique and historic structure such as the Arch, traditional fire protection methods may be impractical, ineffective, or may jeopardize the historic fabric of the structure. Therefore, a performance-based design approach was used, in which the ability of the structure's fire protection and life safety systems to meet specified goals was evaluated rather than specific adherence to prescriptive code requirements. This paper summarizes the approach and methods used to evaluate life safety within the Arch and develop design alternatives as needed to meet performance goals while preserving the Arch structure.

Performance-Based Analysis

The life safety analysis for the Arch was conducted based on a framework¹ for performance-based design developed by the Society of Fire Protection Engineers (SFPE). When properly executed, a performance-based analysis is a valuable tool that can be used when a building or structure has unique and/or historic features that make it difficult or impossible to apply standard fire protection practices. The Gateway Arch is both a unique and a historic structure in which applying standard practices would be harmful to the historic and cultural preservation of the monument and its operation. However, by conducting a performance-based analysis of fire and life safety systems within the Arch, it was possible to demonstrate an equivalent level of safety to that of the standard practices and requirements, while maintaining the historic fabric.

The first step in a performance-based analysis is to define the scope for the project. In the case of this study, the scope was limited to analyzing the existing Arch and Visitor Center portion of the building, and did not consider any changes made as part of the CityArchRiver 2015 project. The study was structured, however, to allow for the conclusions to be applied to the updated project, to the extent possible, within the framework of the existing facility.

The foundation of a performance-based analysis is definition of a performance goal that drives the development and execution of the analysis. All project stakeholders must be in agreement on the performance goals in order for the performance-based analysis to be successful. For the present study, the fundamental goal was to evaluate the fire protection and life safety risks to the public and building occupants in the event of a fire or similar emergency, with particular emphasis on those occupants that may be located at the Arch's observation platform. An additional allied goal was to preserve historic or culturally significant building features. Design deliverables for the study needed to address life safety deficiencies and must have had minimal impact on historic building features.

Having defined the performance goal, fire safety objectives were developed. Fire safety objectives are requirements that must be satisfied in order to achieve the stated goal(s). The primary fire safety objective for this project was to provide a fire safety design that would protect occupants, who are not intimate with initial fire development, for the time required to evacuate, relocate, or defend-in-place. Visitors and staff not located near the fire when it ignites should be able to reach or maintain a safe location without being exposed to hazardous conditions. Minimizing the impacts of life safety improvements to historic building elements was also an important design consideration. Therefore, the allied objective for preserving historic building features was to develop life safety improvements, where required, which minimize architectural or functional impacts to historically significant areas.

The next step was establishing criteria for determining whether the performance objectives were met. In the case of the fire and life safety objective at the Arch, the criterion was that visitors and staff must not be exposed to hazardous conditions during the time it takes them to evacuate or to reach a place of safety. This criterion leads to several specific criteria for tenability (visibility, temperature, toxic gases). In addition to the life safety objectives, the allied objectives were evaluated based on the overall effectiveness, cost-effectiveness, and impact on historical and cultural features and facility operations, with preference given to solutions that maximized effectiveness while minimizing cultural and historical impact.

With performance goals, objectives, and criteria established, it was important to define the scenarios for analysis and evaluate building performance in each scenario. For the fire and life safety study of the Arch, these scenarios took the form of several fire scenarios, varying in size, location, and building configuration (e.g. doors opened/closed). The fire scenarios were developed based on the fuel loading and building conditions observed during facility surveys, and scenarios postulated to represent anticipated or plausible conditions that might arise, such as temporary or ad hoc storage conditions. Each scenario was evaluated using two

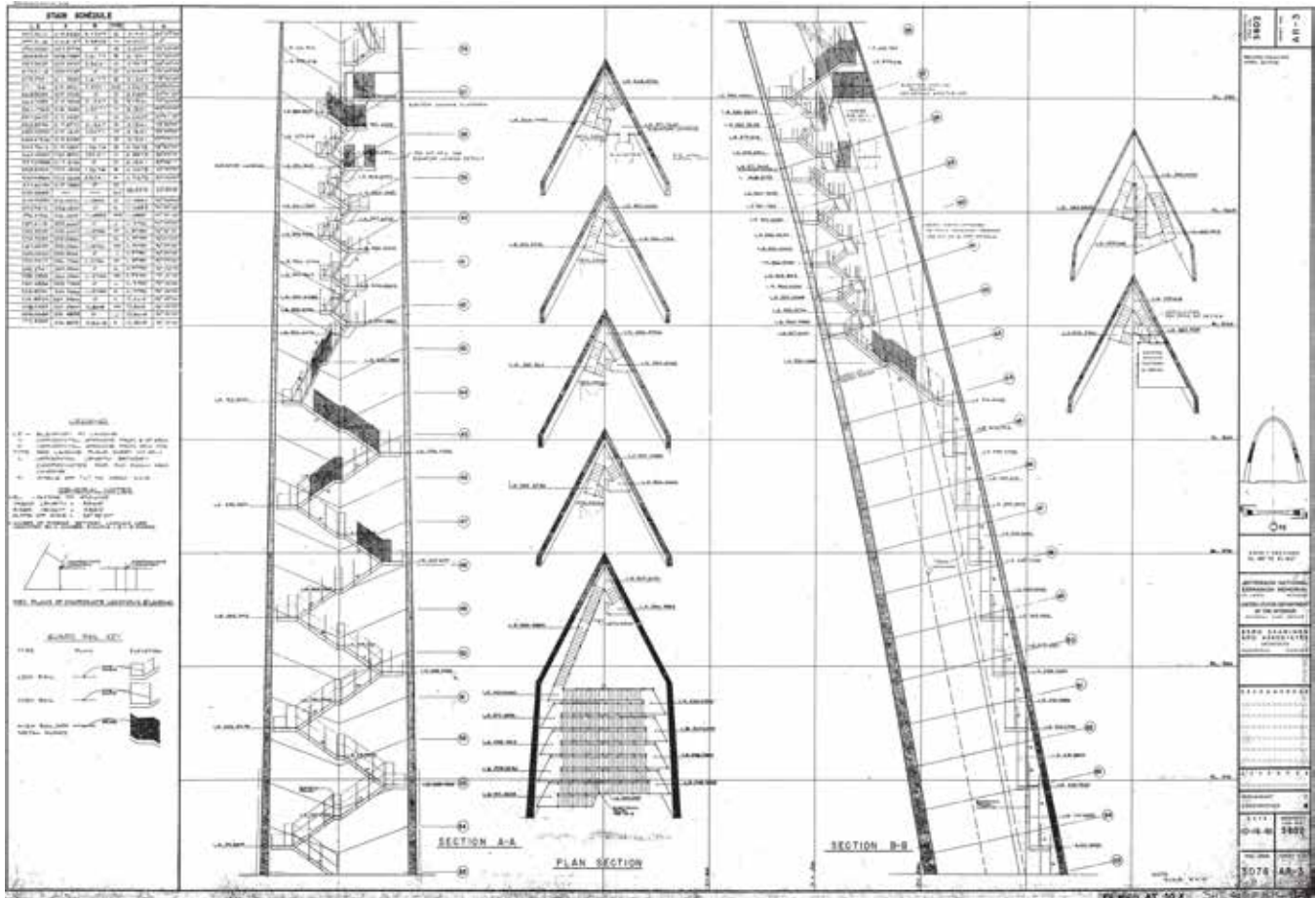


Figure 1: Excerpt from the drawings of the mid-leg

computer modeling tools. The Fire Dynamics Simulator2 (FDS), developed by the National Institute of Standards and Technology (NIST), was used to simulate the movement of smoke and heat throughout the Arch, while the building EXODUS model3, developed by the Fire Safety Engineering Group at the University of Greenwich (UK), was used to evaluate occupant movement within the Arch. Each scenario was then analyzed by comparing the results of the two models in order to determine if unsafe conditions were anticipated to affect occupants during evacuation.

The final step in a performance-based analysis is to propose and evaluate design solutions or mitigation strategies, if any are required, based on the evaluation of the fire scenarios. In the case of the life safety analysis, if occupants were not exposed to hazardous conditions or conditions that may prevent them from reaching a place of safety, then the analyzed scenario met performance objectives, and no modifications were required. Otherwise, using input provided from the modeling, mitigation strategies may be proposed and evaluated using the same techniques. The allied goal of preserving the historic and cultural features of the structure, not previously considered in the initial analysis of the existing structure, was factored into the development and se-

lection of mitigation strategies. The selection and implementation of mitigation strategies, if needed, would be decided by project stakeholders.

Three-Dimensional Modeling

In order to evaluate the fire scenarios, an accurate digital representation of the structure was required. The NPS provided copies of the original Saarinen documents for use in the project, but there were no electronic drawings. The configuration of the Arch did not lend itself to simple input into the Fire Dynamics Simulator, so Mills + Schnoering (M+Sa) created a digital model of the structure in Revit. The original drawings turned out to be extremely accurate, and the dimensions and geometric calculations were helpful in creating the model.

The scope of the digital model included the Arch itself, the loading areas, and the connected areas within the underground visitor center. Various methods were considered for constructing the model, from "tracing" the existing drawings to constructing the curves of the vertices of the Arch. The method chosen was to use the

dimensions on the drawings to model each segment of the Arch and construct it in the same manner as the structure itself had been constructed. The original drawings were also used to construct the numerous stair configurations, major ductwork and mechanical equipment, the Observation Deck, the loading and service bays, and adjacent spaces. After one leg and the Observation Deck were modeled, the leg was mirrored to create the full Arch.

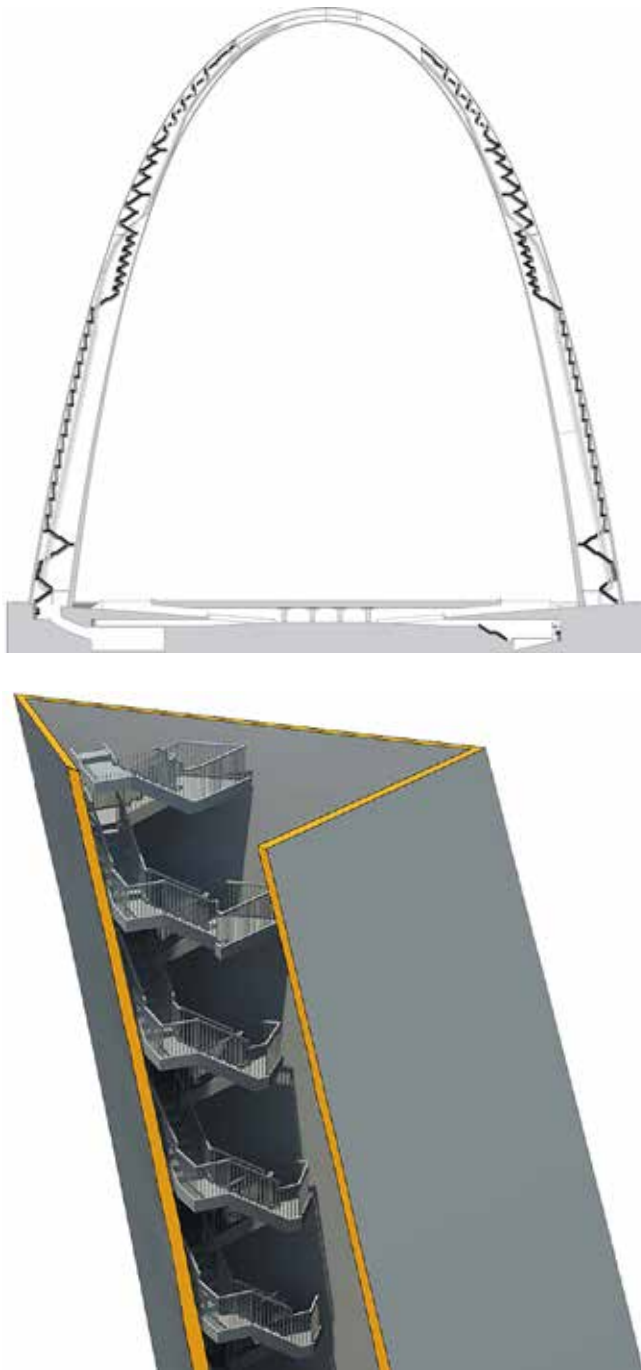


Figure 2: A view of the overall model, and a close-up of an upper section of the stair

Evaluation of the Fire Environment

In order to understand the conditions that may develop within the Arch during a fire, many fire scenarios were modeled using the Fire Dynamics Simulator's (FDS) computational fluid dynamics (CFD) computer model. The model is specifically designed with fire scenarios in mind and continues to be improved and to have its results verified. Various versions of the model have been applied to numerous outdoor and indoor fire scenarios. The current version of the model is intended to handle isolated and spreading fires in human habitable spaces in the presence of obstacles such as furniture, overhead ceiling obstructions, and other structural members.

From a fire modeling standpoint, the complex geometry of the Gateway Arch is a challenging configuration to model. The FDS model requires that the space under consideration be divided into smaller volumes or grid cells in order to resolve the smoke and heat flows. All objects within the space must conform to this grid, which requires angled or curved features to be divided into multiple smaller components. Defining the Arch geometry by hand is not possible, so other sources were sought for defining the model geometry. The Revit model developed by Mills + Schnoering Architects was used as the basis for the Arch's construction in FDS, with supplemental information provided from drawings and site observations as needed. The Revit model was somewhat simplified in that the interior spaces of the Arch were not fully resolved. In particular, it was not practical within the scope of this analysis to fully model all details of the stairs and obstructions (e.g. ducts, platforms, cabling, structural supports) in each leg of the Arch. Given the height and large volume of the Arch, the primary concern in modeling smoke flow within the Arch leg was to capture the volume reasonably and represent any choke points that would restrict the flow of smoke movement (places where the cross-sectional area of the Arch is significantly blocked by obstructions, limiting the upward flow of smoke). Using the available architectural and mechanical drawings, as well as observations from the site survey, Jensen Hughes represented the volume and critical choke points through the use of blockages in the FDS model. Significant features, such as large ducts, the observation area, and the skin of the Arch itself were represented directly in the model. A simplified version of the emergency egress stairs was also included. Figure 3 and Figure 4 show several views of key features of the FDS model geometry.

Fire Scenarios

Defining fire scenarios and sizes in historic structures can be challenging for a number of reasons. The building may lack fire protection features (e.g. sprinklers, detection) that would commonly be used today, or it may

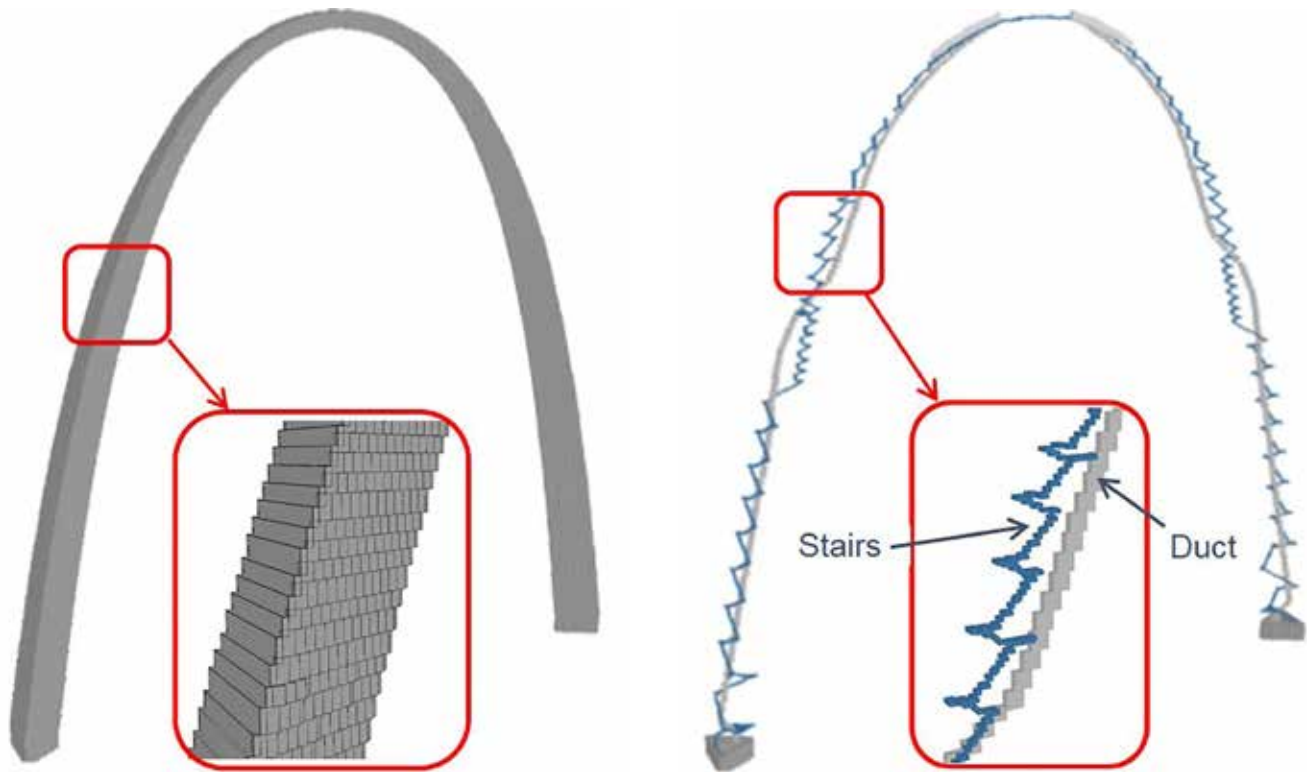


Figure 3: Isometric view of the Arch (left) and the Arch with the exterior skin hidden (right)

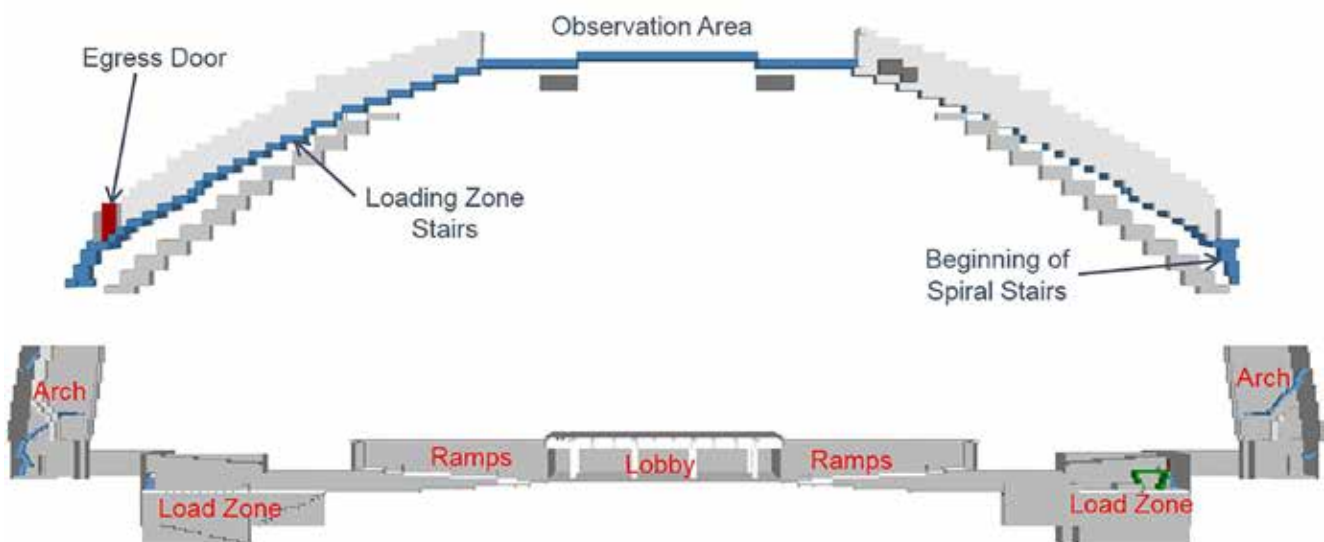


Figure 4. Section view of the Arch at the peak (top) and at the base (bottom)

have outdated versions of those features. Furthermore, historic or architectural features may preclude the use of standard fire protection systems for practical or preservation reasons. The same may be said for unusual fuels or arrangements of fuels. These unique features and limitations may be taken into consideration when conducting a performance-based analysis. An engineer may consider multiple factors, such as fuel locations and

quantities, and fire protection systems in order to develop design fires that represent plausible but conservative scenarios for the structure as it exists. By analyzing the effects of fire scenarios, an evaluation of the performance of the structure or its system(s) may be conducted and steps needed to mitigate hazards may be identified.

Several fire scenarios were modeled in order to bound the range of events and consequences that might occur in the Arch. Design fires were developed based on the fuel loading and building conditions observed during facility surveys. It was observed during on-site surveys that the fuel loading in the Arch is very low and that every effort appears to have been made to minimize the presence of combustibles throughout the structure. Typical fires would be expected to be small. In addition, many of the spaces at the base of the Arch are sprinklered. Any fires occurring in these spaces are expected to be controlled by the sprinkler system. However, larger fire scenarios can be postulated to represent anticipated or plausible conditions that might arise, such as temporary or ad hoc storage conditions.

The hoist cables used for the Arch tram system were identified as representing a unique potential fire hazard. Multiple tram cables in each leg of the Arch create a significant surface area for fire spread. Given that the hoist cables are lubricated, the concern was raised that

there may be the potential for a significant fire involving these lubricated cables. Jensen Hughes obtained and tested a sample of previously-used hoist cables from the National Park Service. When exposed to an electrical arc, very light smoke but no sustained ignition was observed. Under a direct flame from a propane torch, the cables did ignite, but the flame height was limited and the fire self-extinguished less than 90 seconds after the torch was removed, as shown in Figure 5. Based upon this testing, Jensen Hughes concluded that the Arch hoistway cable represented a negligible fire hazard and the cable was not included as the basis for further study in a fire scenario.

Fire Modeling Results

An example of the fire modeling results for a fire located at the base of the Arch is shown in Figure 6. The image on the left show a qualitative view of the extent of the smoke spread within the Arch, while the image on the



0:04



0:45



0:19



1:17

Figure 5. Ignition and self-extinguishment of cable

right provide a qualitative representation of the visibility distance. Among the three primary criteria evaluated – visibility, temperature, and toxic gas concentration – visibility is often the first to drop below the established limits, preventing occupants from safely navigating the exits. For the scenario shown, it was concluded that occupants could safely exit from the observation platform, provided that they utilized the stair in the non-fire leg.

Evaluation of Occupant Movement

As with fire protection systems, the design of historic structures can present challenges for safe occupant evacuation in the event of an emergency that would not normally be faced in contemporary buildings. These features may include a limited number of exits, exits that are smaller than required by code, or exits that are not separated (protected) from the rest of the structure, and by extension, from fire. Depending on the use of the facility, the effects of these non-standard exiting features may be balanced or exaggerated by atypical usage (e.g. varied numbers of occupants, staff-guided exiting). By using computational tools to model the movement of occupants in the space, the unique features of the structure as occupants pass through it may be taken into account, and the ability of the egress system as a whole to allow for occupants to safely exit may be analyzed.

The design of the Arch creates a potential challenge for evacuating visitors from the observation platform. During normal day-to-day operation, one or both of the trams bring visitors up and down the legs of the Arch to the observation platform at the highest elevation. Other

than tram usage, additional means of egress from the observation platform of the Gateway Arch to the Visitor Center/Museum level at the base of the legs are two exit stairs, one in each leg of the Arch, which are otherwise closed to the public. Egress in an emergency situation for occupants at the observation platform can be accomplished by using either of these two exit stairs that are located inside the legs of the Arch.

The buildingEXODUS evacuation modeling software was used in this analysis to simulate evacuation from the observation platform. EXODUS is designed to simulate the circulation and evacuation of large numbers of people from complex enclosures. The software takes into consideration people-people, people-structure, and people-fire interactions. By the use of the egress model, the unique challenges of evacuating occupants over a long, non-standard stairway through unfamiliar routes can be accounted for. These challenges include fatigue from traversing a large height (630 ft), potentially slower movement speeds due to the smaller size and unfamiliar configuration of the stairs, and limited ability to pass on the stairs. The model also allowed for several different egress scenarios to be considered, providing for a range of results based on the number of occupants, their mobility, and level of fatigue. The model results included the time to clear several different way-points in the overall egress path from the top of the Arch to the exterior of the building. These times were compared to the environmental conditions in relevant locations within the Arch to demonstrate that occupants would not be exposed to hazardous conditions in the time that they are exiting. Several team members were timed as they descended the stairs to develop checks and inputs to the modeled results.

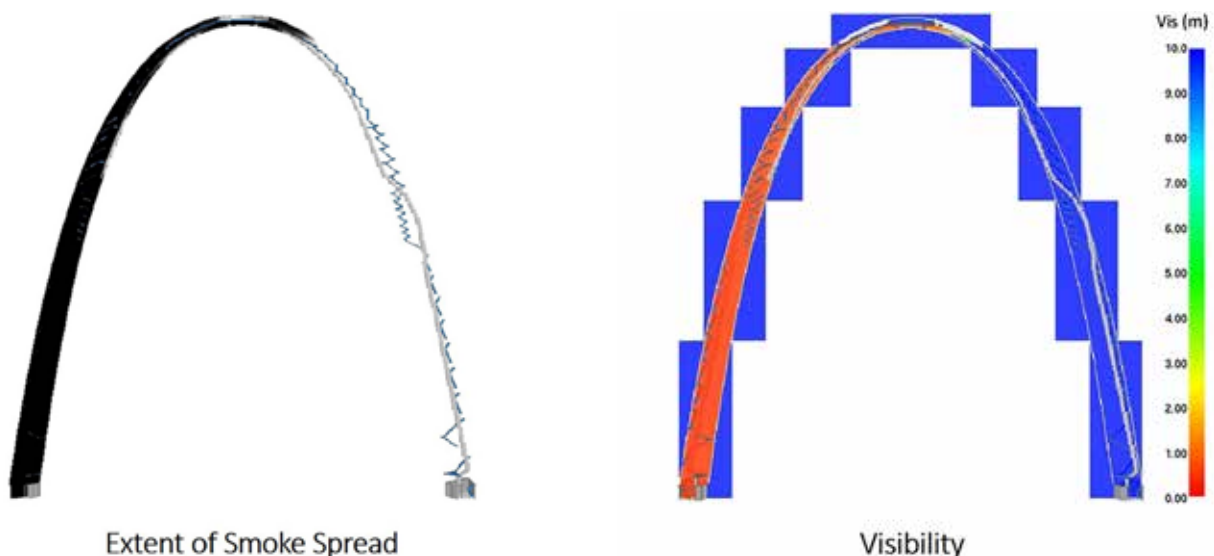


Figure 6. Fire environment modeling results

Mitigation Strategies

When a performance-based analysis of a historically significant structure determines that the fire and life safety goals of the structure are not met in its current state, one or more mitigation strategies must be developed in order to address the deficiencies. To meet preservation objectives, the effects of mitigation strategies on the historical and cultural features of the building must be taken into consideration, with preference given to strategies that minimize changes to historic fabric. Practical considerations, such as cost, ease of implementation, and impacts on facility operations must also be considered.

To meet fire and life safety objectives, mitigation strategies may fall into one of several categories: structural, fire safety systems, population constraints, procedural modifications, and supplemental training.

Structural modifications may include such changes as adding additional means of egress or barriers to contain smoke or protect exit routes. Structural modifications have the potential to provide the greatest improvements to life safety, but they also have the potential to have the greatest impact on the historic fabric of the building, as they are likely to be the most visible of the different modifications.

Modifications may be made to existing fire safety systems (i.e. suppression, detection, or alarm systems), or new systems may be provided for either the purposes of detecting and notifying occupants of a fire early in its development to facilitate more rapid occupant egress, or to improve the means for suppressing a fire that may occur to reduce the amount of smoke produced. Smoke control systems may also be considered to either contain or dilute the smoke produced from a fire. Depending on the systems to be added or updated, these changes may have a minor to moderate effect on the preservation objective.

Population constraints, procedural modifications, and supplemental training all effect the operation of a historic facility rather than the structure itself. A candidate fire safety design may incorporate occupancy limits on various portions of the structure in order to reduce congestion and reduce egress time from critical areas in the event of a fire. Procedural modifications may be implemented in order to reduce egress times and/or improve notification and procedures for optimal egress. Similarly, supplemental training of staff or education for visitors may be provided to enhance awareness of procedures to be followed, with the goal of improving egress from the structure in the event of fire.

One of the benefits of re-evaluating fire and life safety in historic structures is the ability to introduce new technologies that may not have been available at the time of

construction. One example is the use of new video image detection (VID) systems, which were recommended for installation in the legs of the Arch as a result of this analysis. A fire VID system consists of video-based analytical algorithms that integrate cameras into advanced flame and smoke detection systems. The video image from an analog or digital camera is processed by proprietary software to determine if smoke or flame from a fire is identified in the video (see Figure 7). VID systems provide unique advantages to a wide range of applications. One advantage offered is the ability to protect a larger area, while still achieving fast detection. This is particularly true for smoke VID systems compared to spot or beam smoke detectors. VID systems are able to detect smoke or flame anywhere within the field of view of the camera, whereas conventional smoke detectors require smoke to migrate to the detector. Another advantage of VID systems is the ability to have live video immediately available upon detection of a pre-alarm or alarm condition. Immediate situational awareness will allow monitoring personnel to view the protected area easily to determine the extent of the fire and to identify the location more accurately. Archiving of still and video images associated with alarm conditions also provides a means of assessing the cause of incidents, and a basis for changes in the detection system if the event were a false/nuisance alarm. VID systems are thus ideal for uses in historic structures such as the Arch, providing for rapid detection, verification, and monitoring, while requiring minimal changes to the structure.

Analysis and Selection of Mitigation Strategies

The analysis of mitigation strategies, as required by the existing conditions in an historic structure, takes place in several steps. Candidate fire safety designs, representing individual modifications that are deemed both feasible and having potential for positive impact, are first identified, and then evaluated for their impact on either the available safe egress time (ASET) or required safe egress time (RSET). Candidate modifications may be utilized alone or combined into one or more design packages that are selected to achieve overall fire and life safety goals for the project. In a performance-based design, the candidate designs may be evaluated either through the engineering methods previously defined, or by qualitative methods, to determine their relative benefit and ability to satisfy the goals and objectives.

Once the alternatives assessment is complete, the results are presented to project stakeholders. Recommendations are generally given for the design package(s) as to their relative effectiveness, cost, and impact on the historic fabric of the structure. Based on the comprehensive analysis and alternatives provided, the decision



Figure 7. Example of Video Image Detection (VID).

as to which modifications are to be made is ultimately made by the project stakeholders.

Summary

The preservation of a structure such as the Gateway Arch must include continuous re-evaluation of fire protection and life safety strategies. Changes to the materials, fuels, usage, or architectural configurations may occur over the life of the structure. Additionally, changes to the practice and understanding of the fire and life safety fields may have occurred, and new and novel protection methods may have developed since the structure was built. For unique and historic structures that do not conform to the traditional tenets of fire protection engineering, a performance-based analysis is a valuable tool that may be used to demonstrate that the structure and systems are capable of providing an equivalent level of life safety. A detailed performance-based analysis was conducted for the Gateway Arch, with the results used to inform the National Park Service on how best to maintain a safe environment from fire and smoke for visi-

tors and staff. With this approach, modeling and analysis tools allow for the assessment and improvement of life safety objectives, while minimizing the effects of such interventions on the historic fabric of the structure.

References

1. Society of Fire Protection Engineers, SFPE Engineering Guide to Performance-Based Fire Protection, 2nd Edition, The Society of Fire Protection Engineers, Bethesda, MD, 2007.
2. McGrattan K B, Hosstikka S, and Floyd J, Fire Dynamics Simulator (Version 5) Users Guide, NIST SP 1019-5, National Institute of Standards and Technology, Gaithersburg, MD, 2010.
3. Galea E R, Lawrence P J, Gwynne S, Filippidis L, Blackshields D, and Cooney D, buildingEXODUS v6.0 Application Manual, Fire Safety Engineering Group, School of Computing and Mathematical Sciences, University of Greenwich, London, UK, 2013.

ENGINEERING ANALYSIS OF ART

An Engineer's Approach to Forecast the Long-Term Effects of the Environmental Thermal Cycles on the Aluminum Works in the Artillery Sheds at the Chinati Foundation

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Abstract

Two single-story concrete and brick buildings constructed at Fort D.A. Russell in Marfa, Texas, in 1938, now known as the Artillery Sheds, house internationally important works of art, *100 Untitled Works in Mill Aluminum*, by renowned artist Donald Judd. This paper presents an engineering approach to determining the effects of the diurnal and annual temperature fluctuations on the mill aluminum works and to forecast the probable long-term effects of continued exposure. The approach includes scientific gathering of material properties, advanced computer modeling for dynamic thermal stress analysis, mechanical testing of replica parts, and data logging to validate computer modeling. Knowledge gained from the engineering study is expected to prove helpful in making decisions concerning preservation and conservation of the Artillery Sheds.

Background

Two single-story concrete and brick buildings constructed at Fort D.A. Russell in Marfa, Texas, in 1938 are now known as the Artillery Sheds and house internationally important works of art by the renowned artist Donald Judd (1928 – 1994). The buildings were originally garages with spaces for 32 trucks in each. In 1979, The Dia Art Foundation purchased the then derelict structures to support Judd's work and vision for the buildings. Judd planned the significant architectural modifications to the buildings and the 100 mill aluminum works the buildings contain together as one vision. Judd's installation of story-high glass and aluminum windows, of his design, create near fully transparent facades. The transparency in turn creates an important contextual relationship between the works of art and the landscape, and admits enormous amounts of natural light – the nature of which changes continuously from sun up to sun down. The Judd-designed glass windows and the subsequent addition of thin-gage steel barrel arches on the once flat roofs, known in the vernacular as *the huts*, have made the Artillery Sheds iconic of Judd's works in Marfa (Figure 1).



Figure 1 – Artillery Sheds with 100 Works in Mill Aluminum (1982-1986)

The Sheds and their works of art are now cared for and opened to the public by the Chinati Foundation. The buildings remain preserved as Judd created them: building elements and materials bare and exposed; interior environment unconditioned and unlit by artificial light; and experience in the space acoustically unal-

tered by building mechanical and electrical systems. However, the clear single-pane glass of the windows allows for tremendous solar radiation into the space. The aluminum works, comprising rectangular 1/2 inch thick aluminum plates creating box-like sculptures, become great sources of heat within the space when struck by sunlight. The surface temperatures of the aluminum in the direct light are much higher than other parts of the given work, creating thermal gradients that migrate throughout the day and stress the aluminum. The diurnal and annual temperature fluctuations of the space are well outside ranges commonly sought for the preservation of art. Paradoxically, common strategies to affect the indoor climate (e.g., sun screens, window shades, coated glass, and HVAC systems) alter the architecture and arguably change the observers' intrinsic experience with the installation.

Thirty years after installation, the mill aluminum works are undoubtedly changed from their original condition, though certainly not detrimental to the experience of current visitors. Their current condition relative to their original condition is part of an ongoing archival study. A large number of the works have shifted from their original location over time. Movement of Work #28, *West Row in the North Shed* (1985) since installation in 1985 is shown below (Figure 2).

Observers have heard pinging sounds emitting from the works as the works heat and cool during the day. There are slight gaps between plates in all but one of the works (Figure 3), and certain threaded fasteners have needed to be re-torqued; both of which are plausibly the result of, or at least exacerbated by, the unconditioned environment and resulting thermal cycles on the aluminum works. The extent to which this is the case is unknown. Furthermore, if the gaps and loose fasteners are the result of thermal cycles, it is unknown if the conditions have reached a state of equilibrium, or are getting worse by progressively less and less, or getting worse by progressively more and more. Engineering analysis of the aluminum works can help answer these questions.

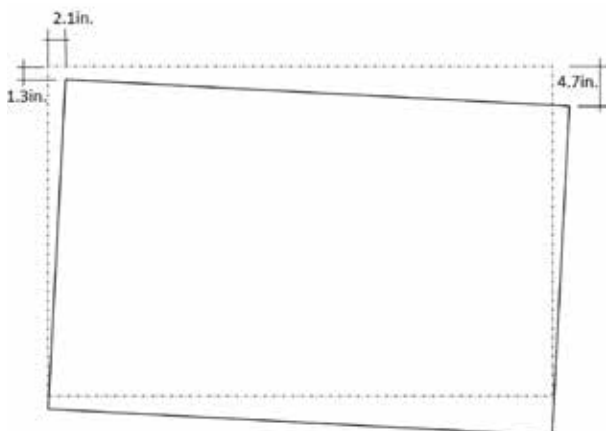


Figure 2 – Movement of Work #28



Figure 3 – Example Gap between Plates

Fabrication and Construction of Aluminum Works

Much fascinating discussion is written on Judd's design of the aluminum works and his installation of them into the Sheds. Herein, we merely describe the technical aspects of their fabrication pertinent to engineering analysis of their behavior and response to their environmental conditions.

Judd worked with Lippincott Inc. to fabricate the aluminum works. Originally Lippincott Inc. had planned on using a 5000 series alloy but switched early on to a 6061 series, ostensibly to make fabrication easier and the surfaces more resistant to damage. This material, however, it did not meet Judd's aesthetic goals, and the alloy was changed to 3003F. This caused challenges in fabricating the boxes due to the softness of the material, but the aesthetics and surface quality were a higher priority.

Each of the 100 works has the same overall dimensions of 72 inches long by 50 inches wide by 41 inches high. However, each work is of unique design and geometry within these consistent overall dimensions. Each work features 1/2 inch thick milled aluminum plates assembled with stainless steel, friction-fit, blind pins and stainless steel threaded fasteners, as well as welded connections of side plates to bottom plates. The assembled plates define the consistent overall volume but with various plate orientations and often intersecting planes at angles to the volumes' orthogonality. The plates are interconnected with the blind pins, except at certain corners where threaded fasteners go through the face of one plate and into the edge of the connecting plate.

The overall dimensions of the South Shed buildings are 75 foot (east-west) by 330 foot (north-south). The North Shed's dimensions are 75 foot (east-west) by 350 foot (north-south). Judd installed the works in an array within each Shed. Each work installed in a specific location as decided by Judd. There are 48 works in the South Shed

and 52 in the North Shed. All but four works in each shed are arranged in three parallel rows: one row down the middle of each Shed, with the other two rows equal distant to the east and to the west.

Current Interior Environment and Condition of Aluminum Works

In March 2014, we installed data loggers to collect data pertinent to the interior environment in the Sheds. Approximately every 10 minutes, we are collecting exterior air temperature, interior air temperature, and the temperature of the aluminum at four locations on three different works (Table 1). Peak aluminum temperatures logged to date range from 120°F to 125°F. Peak indoor air temperatures logged to date are as high as 111°F. For 20 June 2014, the data indicates the maximum indoor air temperature reaches 95°F; the maximum aluminum temperature reaches 104°F, with a total daily temperature swing of 28°F in the aluminum. For 10 December 2014, the data indicates the maximum indoor air temperature reaches 63°F; the maximum aluminum temperature reaches 95°F, with a total daily temperature swing of 36°F in the aluminum.

Table 1 – Temperatures Logged

Work ID	Max. Aluminum Temp	Average Aluminum Temp	Max. Daily Change	Average Daily Change	Max. E/W Differential	Peak Interior Air
1	130°F	83°F	41°F	25°F	16°F	111°F
83	125°F	86°F	46°F	27°F	23°F	111°F
68	121°F	84°F	38°F	23°F	19°F	101°F

Data logged over approximately 12 months.

These temperature fluctuations are well outside ranges commonly accepted for the preservation of art. For example, the ASHRAE handbook recommends a temperature range between 59°F and 77°F for museum galleries. The interior high air temperatures are also well above accepted ranges for human comfort. For the visiting observer, this is something which one can accept, as part of the experience. For the caretakers, the heat can be debilitating after only short work sessions during extreme periods.

Metal expands and contracts with increased and decreased temperatures, respectively. The aluminum plates in Judd's works are restrained from uniform thermal expansion or contraction because of the inter-

connection of the plates within a work. The restrained thermal movements result in thermal-induced stresses in the plates and in the fasteners between plates. Furthermore, the solar exposure is not uniform throughout a work; therefore, the temperature of the entire work is not uniform when exposed to direct solar radiation. The temperature gradient across the work also induces stresses in the plates and in the fasteners. These stresses are accompanied with commensurate deformations that distort the work, though unlikely noticeable to the observer.

In late 2013, the caretakers of the installation documented the conditions of the works, including photographs of each exposed surface of each work. They grouped the conditions and damages into four categories: (a) production-related conditions (characteristics of the metal that are generally not harmful and indicative of the production techniques used to create these works); (b) mill-related conditions (defects and damages caused during the milling process); (c) fabrication- and installation-related conditions; and (d) other conditions and damages, which include changes or damages that have occurred to the pieces since their installation in the Sheds. Gaps between plates and loose threaded fasteners are most likely Category (d) based on Judd's practice of obtaining precision in fabrication, but we do not have a record of the detailed condition of each work at the time of their installation.

Comparing weather records over the life of the works with those of the past year for which we have logged data, we expect the works have been exposed to similar thermal fluctuations for the last thirty years. In general, it is reasonable to assume that the condition of the works relative to the condition at installation, in a word the "health" of the works, is declining. However, the degradation is not measured or even subjectively estimated. We also do not know the rate of health decline and if the rate of change is ever increasing, decreasing, or if it can be described as steady.

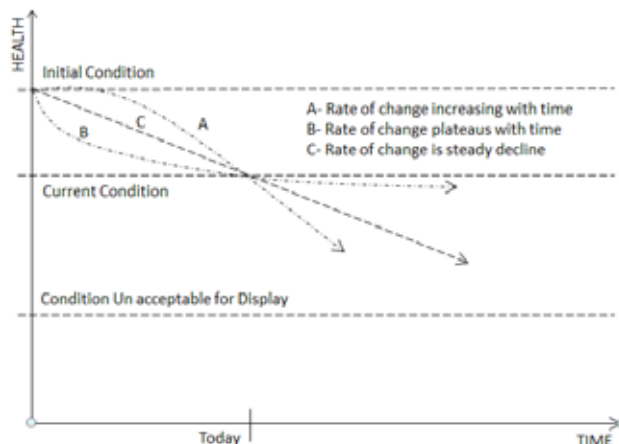


Figure 4 – Health of Aluminum Works

Though the installation and the environment of the works is just as Judd designed it, many are concerned for the welfare of the works. Alfred Lippincott, one of the fabricators, who visited in the Sheds in February 2014, likens the boxes' change to environmental change: we know that it is going on and it will continue or possibly worsen. Judd intended this work to be a permanent and unchanging installation. He is quoted saying, "Somewhere a portion of contemporary art has to exist as an example of what the art and its context were meant to be. Somewhere, just as the platinum-iridium meter guarantees the tape measure, a strict measure must exist for the art of this time and place. Otherwise art is only show and monkey business."¹ Thus, when the art preservationist thinks in terms of permanence, the exact slope of the "line of decline" is not important, as any negative slope is unacceptable and will ultimately render this work beyond repair. When the engineer imagines time as the abscissa that extends to infinity, the engineer foresees the challenges with the concept of permanence and strives to understand the prognosis for the foreseeable future and the practical actions that can favorably alter that prognosis.

When looking at the invaluable and irreplaceable resource of the mill aluminum works, any diminution that we can prevent is arguably too much diminution to accept. However, it is well documented that Judd conceived the buildings' alterations and the works the buildings contain together. The observers' intrinsic experience with the installation includes the Judd-altered and exposed architectural elements, the light admitted by the clear single pane glass, the interior environment unconditioned and silent from a mechanical system, and the connection the observer has with the landscape from within the space. Actions to control and condition the interior environment alter the way Judd conceived the space and alter the observers' experience. Thus, engineering analysis is warranted to understand the effects of the temperature fluctuations on the works and to forecast the probable long-term effects of continued exposure and of altered exposure. This way we can select appropriate intervention measures informed of their benefits to the aluminum works and assessing their compromises to the experience.

Establishing Pertinent Material Properties for Engineering Analysis

Basic material properties of the aluminum alloy 3003F (such as density, strength, thermal conductance, thermal capacitance, and thermal expansion) are well

documented for aluminum in general and for this alloy specifically. Small variations in these basic material properties will have little impact on engineering analysis results. The most critical phenomenon for our analysis will be temperature variations that occur between various plates of an individual work as it basks in the artillery shed environment. Given the large area of glazing Judd used in his alteration of the former garages, solar gain drives the environmental conditions. To properly characterize the surface temperatures of the interior building surfaces as well as the works themselves, it is critical to know the solar absorption of the material and the emissivity of the surface, as well as the incident solar radiation. The solar absorption and surface emissivity combined define the energy absorbed by the surfaces from direct and diffuse solar exposure, as well as the energy exchanged between the surfaces and their surroundings. Analyzing this heat balance defines the temperatures of materials. It requires reliable material properties. For aluminum, the emissivity is highly variable because it is so dependent on, and sensitive to, the surface finish, in this case the milled surface. To better understand this sensitive property, first consider a "black body," which is defined as a body that absorbs all radiation that falls on its surface. Actual black bodies do not exist. The emissivity of such a black body would be 1. Highly polished, clean aluminum surfaces achieve an emissivity as low as 0.05, while oxidized aluminum ranges up to 0.25 and could be higher with contaminant on the surfaces. This represents a wide variation. To accurately predict and then analyze the temperature of the aluminum plates in the works, we need accurate estimates of the emissivity of the plates, including variations throughout the 100 works.

We can obtain a reasonable baseline for the emissivity of the works by testing. Testing to measure emissivity directly requires small samples that accurately represent the existing materials. Extracting samples from the works would be destructive and is not permitted. The next best option is to test leftover stock aluminum from the fabricator or new sheet material milled from the same alloy; however, the surface must be prepped to closely match the existing surfaces of the works.

Once we better characterize a sample of the material, we will be able to expose a measured aluminum sample to the same solar gain as a plate in the work, and use sensitive infrared equipment to detect any significant emissivity differences by measuring actual surface temperatures of different plates in different works. In this way, we can understand the variation of emissivity amongst plates throughout the 100 works.

Computer Modeling of Interior Environment and Prototypical Aluminum Works

We will use state-of-the-art computer modeling to determine the response of the aluminum works to the diurnal and annual temperature fluctuations and to forecast the probable long-term effects of continued exposure to conditions similar to those of the past 30 years. Two parts comprise the computer modeling: (1) modeling the building as a whole for the purpose of predicting the interior environmental conditions (namely solar insolation intensity, air temperatures and material surface temperatures) as time-dependent responses to exterior environmental conditions (namely sun exposure and ambient temperatures) that vary throughout the day and year; and (2) modeling individual aluminum works, each of unique geometry and position in the buildings, to predict the dynamic response (namely material temperatures, stresses and deformations) to the time-dependent direct solar exposure and interior ambient temperatures.

The unique location of each work within the Sheds means each work has its own unique exposure to solar insolation throughout any given day of the year due to the specific location's shading from building elements and nearby works, as well as shading from its own parts given its geometry. Each work's geometry, in-turn, has a significant effect on the work's response to solar insolation and the interior ambient temperature, both of which are changing throughout the day. We intend to develop a whole building model of the South Shed. We have data loggers in two works in the South Shed and in one work in the North Shed. We will build three prototypical computer models of the three works for which we are gathering field-logged data. The field data will be used to calibrate our computer models and validate the computer results.

Modeling the Interior Environment and the Solar Radiation

We have performed initial studies using energy analysis software to estimate the interior space conditions, and compared them to the field-measured data. State-of-the-art energy analysis software is an engineering tool typically used to calculate heating and cooling loads for buildings to design air handlers, boilers, chillers, and cooling towers. However, the EnergyPlus software we used is uniquely suited for our analysis of the Sheds because it can accurately simulate a building without mechanical systems. EnergyPlus uses algorithms to de-

termine the interior environmental conditions given exterior environmental conditions for a simulated building. It can calculate interior air temperatures and conditions as a result of exterior environment effects, interior material properties, air infiltration, ventilation, and occupancy loads. The program includes the calculations of solar absorption and reflections, glazing transmittance, interior solar distributions, and radiant energy exchanges between surfaces of the building and its contents. It can also predict internal air flows based on wind conditions, opening locations, and air buoyancy. Unlike many other energy analysis programs, the results of these complex calculations are easily available as outputs. The simulation time step can also be reduced to one minute if necessary to refine a calculated data stream. We will use interior field-measured temperature recordings to calibrate our EnergyPlus model.

EnergyPlus uses all the relevant thermal properties of materials, including solar absorption and emissivity, and allows us to construct an internal zone roughly representative of an aluminum work and calculate temperatures around and in the representative work during the simulations. While our initial calculations were speculative and simply provided some comparative data on the relative effectiveness of proposed enclosure changes, we plan to use refined material properties from testing and field data from the data loggers to recalibrate our model as a predictor of the actual response of the works to their environment. Once calibrated, we can populate the building model with more zones representing the actual works as the interior conditions are dependent on the number and distribution of the aluminum works in the space.

The recorded data gathered with the data loggers is crucial to the calibration process and validation of the simulated temperatures. The calibration of the model is important for two reasons. First, calibrating our model with the data logged from 3 of the 100 works allows us to reliably simulate the response of the other 97 works to environmental conditions and then feed this data into more detailed computer models for each of the individual works. Second, we can then reliably use the model to estimate the benefits of possible mitigation measures such as special glass, attic insulation, and mechanical ventilation, amongst others.

Modeling the Response and Behavior of the Aluminum Works

We will develop computer-based finite element models (FEMs) of the three aluminum works that we are monitoring. Using these FEMs, we will perform heat transfer and thermal stress analyses to better understand the effects of solar radiation on the works' temperatures, deformations, and stresses. Using data from the monitoring of the

works, we will calibrate and validate the modeling techniques and parameters.

The FEM software ABAQUS is our choice for building the computer models of the works. For each work, the same FEM will be used for heat transfer analysis and thermal stress analysis. We will first perform a preliminary thermal stress analysis using the maximum temperature differentials obtained from the data loggers in place on the works. In this preliminary analysis, the applied temperature to each surface of the work will be constant, and the connectors representing the fasteners will be rigid. We will obtain gross estimates of the deformations and stresses in the aluminum, and the forces and moments in the fasteners and pins. This is the starting point for our understanding of behavior.

For heat transfer analysis, we will apply the net solar radiation (insolation) obtained from the EnergyPlus analyses on the aluminum work. Different surfaces on the work will receive different duration and intensity of insolation depending on the time of day and their angles to the sun. Also, some portions of the work may be blocked from the sun and receive no insolation. For convection, we will use the film coefficient obtained from published literature for the horizontal and vertical surfaces under natural convection. We will use the air temperature inside the building obtained from the EnergyPlus analyses as the temperature of the environment to which the film boundary losses or gains heat. For conduction, the FEM plate elements will have five points across the thickness such that any temperature gradient across the thickness will be captured. If gaps exist between the different plates on the work, we will model the interface as thermal gap. If there is no gap between the plates, we will include conduction across the interface. We will model at an ideal work with no gaps and see if gaps emerge in the simulation.

For each work, we will perform a sequentially coupled heat transfer and thermal stress transient analyses for three separate two-day periods. We will select periods where the data logging shows large temperature differential on the work. We will start each analysis early in the morning (around 5 or 6 a.m.) when temperatures are most stable, and will run the analysis for 48 hours.

Similar to the energy analysis model, we will calibrate and validate the three prototypical FEMs using the field-measured data from the data-loggers on the works. These prototypical modeling studies will inform our recommendations for the comprehensive engineering approach we develop. We will then be able to build an FEM for each individual work and reliably simulate each work's response to environmental conditions in a comprehensive manner.

Evaluating and Assessing the Long-Term Environmental Effects on the Works

We will use the results of the analyses to assess the response of the aluminum works and judge whether the conditions of the works are likely to get worse with time, or if the works have self-acclimated and their conditions near-stable.

Concerns for the works from the thermal stresses and deformations include stresses that exceed material elastic limits and fatigue-induced cracks in the material. Stresses that exceed the material's elastic limit will result in permanent deformation that is not recovered when the stress is relieved. We expect that this is most likely to occur, if it does, in the aluminum material adjacent to the stainless steel fasteners. There is potential for the stress to be concentrated in the aluminum intimate to the fastener that is restraining thermal expansion or contraction. If the stress exceeds the elastic limit, the aluminum will be permanently deformed in this area and the intimate contact with the fastener diminished. The holding power and performance of the fastener may in turn be diminished, resulting in loose connections and potential gaps between plates.

If stresses remain within the elastic limits, we expect no permanent deformations. However, even with stresses in the elastic range, there is the potential for the holding power of a friction-fit, blind pin to be overcome and allow the plates to separate as they deform from thermal deformation. When the thermal change subsides, the pin holds and results in a residual gap between the plates.

Even if elastic limits are not reached, repetitive cycles of stress can cause fatigue-induced cracks at susceptible locations if the number of stress cycles is large enough and the peak stresses are high enough. The most likely locations in the works susceptible to fatigue cracks are in or near the fasteners where stress concentrations occur at notches formed by the fastener installation.

We expect that exposure over the last 30 years has caused the works to have seen the maximums of stress they will see (or nearly so), and that any permanent deformations in and around the fasteners has taken place. In absence of fatigue-related effects, the works will have reached a certain state of equilibrium, and we would expect that deformations caused by thermal stresses over the past 30 years would become no worse in the next 30 years, barring unforeseen changes in the climate and exposure. In other words, we expect a very low probability that new extremes not yet seen will occur in the future.

However, the same cannot be said for fatigue-related effects. Potential fatigue-sensitive conditions may not have seen sufficient number of cycles yet. Furthermore, fatigue cracks can progress and progressively change the response of the work such that other parts of the work now see greater stresses. Thus the fact that the works have been exposed to conditions over the past 30 years similar to conditions expected in the future does not in and of itself mean that conditions in the works will not change. There is the potential for fatigue-related effects to worsen the condition of the works.

Computer model results alone are not likely to be sufficient for concluding the prognosis of the works. The computer modeling will provide sufficiently accurate stress in the materials and accurate forces on the fasteners. However, unless the results reveal especially low stress results near the fasteners and especially low fastener forces, mechanical testing of replica fasteners in similar aluminum alloy will be needed to establish fatigue limits and fragility. Additionally, it may prove useful to nondestructively examine the works for cracks near or in the fasteners. The computer model results will inform what testing should be done.

The results of the computer modeling and mechanical testing, if any, will inform our judgment on whether the conditions of the works are likely to get worse with additional time, or if the works have self-acclimated and their conditions near-stable. In addition, the calibrated modeling will simulate future indoor environmental conditions. These simulations will help us assess the benefits of building intervention options for the long-term health of the works.

Our preliminary modeling and studies show that introducing a mechanical HVAC system is not effective with the existing clear single-pane glass. Despite the unsustainable and unaffordable energy consumption that would result, conventional conditioning and handling of the air would have less effect on the aluminum temperatures when they are directly exposed to solar radiation. The most effective intervention with the least impact is replacing the clear single-pane glass with state-of-the-art glass with low-e coatings to minimize the amount of ultraviolet and infrared light that can pass through glass without overtly compromising the amount of visible light transmitted. Studies indicate this brings a dramatic reduction in temperature spikes and swings in the aluminum with modest improvements to the air temperatures, yet both are still outside norms for conservation and comfort. A combination of glass replacement with a mechanical HVAC system has the ability to bring the conditions closer to norms, but an HVAC system has a disagreeable impact on the architecture and the acoustics. Sun screens and sun shades are considered for the sake of completeness of the study; however, screens are obviously too detrimental to Judd's design, and the shades are only effective when drawn. Our engineering analysis can properly define the benefits of

all these options so their effectiveness can be weighed against their intrusion.

Conclusions

The diurnal and annual temperature fluctuations of the space are well outside ranges commonly sought for the preservation of art. Strategies to affect the indoor climate alter the architecture and arguably change the observers' intrinsic experience with the installation. Computer analysis and engineering evaluation can determine the effects of the diurnal and annual temperature fluctuations on the mill aluminum works and allow us to forecast the probable long-term effects of continued exposure. Knowledge gained from the engineering study will inform consequential decisions concerning preservation and conservancy of Judd's Artillery Sheds.

Reference

- 1 Judd, D., *The Chinati Foundation*, Bodmer and Weber, Switzerland, 1987.

NO THERMAL BREAK NO PROBLEM-UPGRADING THE STAINLESS STEEL WINDOWS IN LOUIS KAHN'S RICHARDS BUILDING

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Abstract

The Alfred Newton Richards Medical Research Laboratory (Richards Building) at the University of Pennsylvania is one of the most important buildings in the career of architect Louis I. Kahn and one of the great buildings of the 20th century. Designed 1957-1958 and completed in 1961 the Richards Building was at the time deemed an architectural milestone worthy of a solo exhibition at the Museum of Modern Art in New York. In 2008 the Richards Building was nominated for and granted status as a National Historic Landmark (NHL). As an NHL it must be treated with exceptional care, but as an occupied, working building it must with equal vigor and discipline consider necessary changes to its interior and exterior to better serve its functional purpose and the needs of present-day occupancy and operations.

One of the signature elements of the Richards Building is the remarkably detailed and constructed exterior envelope consisting of co-planar exposed concrete structure, brick and monolithic, polished plate, fixed glazing set in custom fabricated bent stainless steel frames. Kahn's use of heavy gauge, matte finish sheet stainless steel, both as panel and brake-formed as a framing material became a trademark – though little discussed – element of his design vocabulary until the end of his career. The use of this material begins with the American Federation of Labor (AFL) Medical Services Building in Philadelphia (demolished 1973) designed 1954-55, where we can witness Kahn's testing early details utilizing more conventional metal glazing sections before finally arriving at – and executing – a bent plate design. The system employed in the Richards Building evolves out of these early explorations into one that uses the folded steel to create both shadows and strength, enabling a frame of unique lightness and incredible elegance – that allows the glass itself to float almost weightlessly within the building frame.

A comprehensive renovation project was the catalyst for fully evaluating the exterior envelope and developing a design approach that retained the iconic visual and material characteristics of the building as viewed from both the exterior and interior while radically improving the energy performance and functional qualities of the building. This paper will review the systematic project approach that was undertaken by an integrated design team including architects, engineers, materials conservators and building envelope specialists, which on the exterior of the building focused on how best to conserve and optimize the performance of the original steel glazing system. The process included developing a detailed understanding of the original design for every aspect of the building and using that knowledge as a basis for developing design alternatives and a conservation plan that responded to the stated design objectives at different levels. In concert with the owner and the contractor a final design was developed that best balanced preservation, energy efficiency, economy and constructability.

Introduction

Louis I. Kahn's Alfred Newton Richards Medical Research Laboratory (Richards Building) at the University of Pennsylvania holds a unique place in the history of 20th century culture as one of the most influential buildings of the post war era – a work that breaks new ground in its form, detail and material expression – that is simultaneously tragically functionally challenged. Designed 1957-1958 and completed in 1961, the Richards Building's notoriety was such that it was honored with a solo exhibition at the Museum of Modern Art in New York prior to its completion. This speaks to the power of the Richards Building as an idea and a concept about space and work that was both heroic and poetic – if not exactly in line with the needs of its users. In 2008 the Richards Building was nominated for and granted status as a National Historic Landmark (NHL), and with this ultimately came a man-

date to find a way to make the building work without compromising its unique and innovative architectural expression. As an NHL it must be treated with exceptional care, with particular regard for its outward appearance and the integrity of its material palette. As an occupied, working building it must with equal vigor and discipline consider necessary changes to its interior and exterior to better serve its functional purpose and the needs of present-day occupancy and operations.

The renewal and repurposing of the Richards Building was commissioned by the University of Pennsylvania as a first step in addressing its needs and future. The project is proceeding under the direction of a large and diverse team from the University Office of Facilities and Real Estate Services that also includes representation from the School of Medicine, the Office of the Provost and the Faculty of Arts and Sciences. The consultant team is under the leadership of EYP Architecture and Engineering with Urban Engineers as MEP/FP engineers, R. A. Heintges Architects as window and glazing consultants, Keast and Hood, structural engineers, Cline Bettridge Bernstein, lighting design; and Building Conservation Associates, material conservation specialists. The construction manager for the project, brought on during the schematic design phase to provide pre-construction services

and who are now completing the initial phases of construction, is Intech Construction of Philadelphia.

Conceived as a series of square, largely glazed laboratory towers pin-wheeling around a central solid brick service tower (Figure 3 – the two towers to the right of Richards are the 1965 Goddard Labs), Richards is a quintessentially modern building in its structural expression and innovative use of building technology, and offers many of the representative challenges and opportunities that modern architecture brings to the architects, engineers and preservation professionals charged with the conservation and renewal of this large and often misunderstood component of our cultural heritage. One of the essential theoretical propositions of the architecture of the Modern Movement was the primacy of the program, and that efficient “rational” buildings are those that respond with the greatest formal elegance and efficiency to the dictates of function. Kahn’s architectural construct of “servant and served” spaces takes the notion of design to the program even further, in that individual need and function are now given structural as well as spatial boundaries. Though the result in Kahn’s hands is unique and poetic, its success is also highly dependent upon the structure’s ultimate ability to truly accommodate the program to the satisfaction of the users. Rightly heralded upon its completion by scholars



Figure 1: Richards from South-1965
(Penn Architectural Archives)



Figure 2: Richards from Northeast – 1965
(Penn Architectural Archives)

such as Vincent Scully as defining a profound new direction in the course of Modern architecture, Richards has paradoxically, through a well-documented combination of circumstances, struggled to fulfill its promise as a place for research. While Kahn offered that "I thought what they should have was a corner for thought, in a word, a studio instead of slices of space," (Figure 4) Scully himself wrote: "They are...a town of colleagues, but in a material sense they function not perfectly at all."

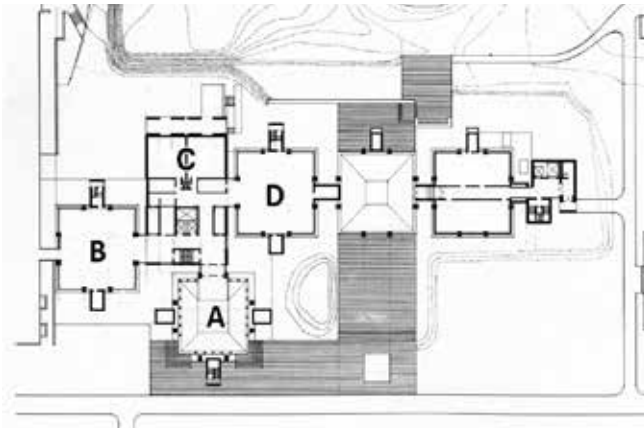


Figure 3: Richards Ground Floor Plan showing glazed A, B, D towers ©-2012 (EYP/ Romaldo Giurgola Penn Architectural Archives)



Figure 4: View from connector across two towers – © 1962; Pin-wheeling around solid Tower ©-2012 (EYP/ Romaldo Giurgola Penn Architectural Archives)

In a nutshell, the goal of this project therefore has been to define how best to balance art, performance and function. The critical first step in this process taken by

the University of Pennsylvania was to abandon the wet-lab program of the building and reposition the facility as a Center for Cognitive Research. In addition to balancing the demands of rehabilitation in accordance with its landmark status and serving the needs of its users in a way that to this point in its 50 year history it has not, Richards is also importantly, as a building of its time, inefficient from an energy use standpoint, and therefore energy performance must be optimized as the primary component of improving its sustainability quotient. It is often said that Historic Preservation is the management of change – in this case a creative reckoning between accommodating new program with comfort and efficiency – and making the repairs and technical upgrades necessary to ensure the stability, performance and longevity of the building without loss of the essential character definition that make this a pivotal work in the history of architecture.

The Richards Building has a tremendous autonomous architectural power that elevates the cultural meaning of the building beyond its function and context on the University of Pennsylvania campus. One of the key elements analyzed early in the project was how the assembly of components together enable this power, and to what degree they can and should be manipulated so that the process of programmatic transformation and technical modernization does not diminish its architectural impact. This is especially true in the A, B and D Towers, where the raw architectural spaces are significant but the overlay of interior partitions that divide up the labs and services are considered expendable as they do nothing to contribute to Richards' unique character. Therefore it is critical to take every effort to integrate and relate new partitions, casework, building systems and devices in ways that optimize both the overall interior experience and their appearance from the exterior. The interpretation of Kahn's intent – in this case Kahn's original concept in form and material examined both as an autonomous architectural idea and as an expression of the original program – is particularly complex in this instance, where the idea, in this case the open, "universal space" of the open lab tower floors – so permeates the building. The present project will fundamentally change the function of Richards, and aspects of this transformation should be and are evident in our interventions.

There are three dominant themes that particularly distinguish this building; a developing interest in the exploration of structural expression, the consequent development of a methodology for the integration of building systems within the structure, and the development of the stainless steel brake-formed glazing system that enables the signature tautness of the building skin.

As much as any of Kahn's buildings, Richards' form is dominated by its structural expression. Beginning in 1952-53 at the Yale Art Gallery, Kahn (in this case influenced by colleague Anne Tyng) began to seek an appropriate three-dimensional structural form that could

both integrate building services and serve as an appropriate architectural expression if left exposed. The tetrahedrons at Yale proved impractical for the integration of systems, and were soon discarded in favor of Vierendeel trusses, which were first used in his design for the American Federation of Labor Medical Services Building, 1954-57. It was however the relationship that he forged with structural engineer August Kommandant in 1957 – as someone whom Kahn felt could help enable his vision for a more organic integration of architecture, structure and building systems – that enabled the synthesis that dominates Richards.

The Vierendeel truss system at Richards is unique in Kahn's work as the only instance where it is brought to the exterior of the building and left exposed as a primary component of the building's architectural expression. Whereas at the Medical Services Building Kahn sheaths the structure with curtain wall, and at the Salk Institute it is subsumed within the envelope of the lab block, at Richards each element of the skin – frame, glazing system and brick infill – is designed to be co-planar. One of the chief purposes of the Vierendeel system is to create internal organized pathways for building services, and there is evidence from early on in the design (whose lead systems engineer was Fred Dubin) that the routing and consequent appearance of all systems was critically considered as part of the overall expression of the building, as this was a very early and important example of a building where the integration of structure and engineering systems so inform the architectural aesthetic. We discovered that Kahn had a carefully worked out layering scheme for the systems that organized each service in both plan and sectional zones, and ensured that the glazed zone – between the 3'-0" sill and the 8'-6" underside of lower truss was never crossed by any

service. Kahn also carries the expression of the building systems into the windowless brick service shafts, which give an exceptionally tall and architecturally exaggerated presence to the vertical building systems and stairs housed therein.

Performance Improvements- Glazing and Systems

The dominant visual element is the glazing system developed for the "served" towers (now identified as Towers A, B and D). These tower corners feature large (13'-9" x 5'-6") lights of glass set in a brake formed U-shaped stainless steel frame, an evolution of a system he first developed and employed at the AFL Medical Services Building. In that project Kahn initially explored both systems employing conventional rolled steel window sections and aluminum extrusions prior to developing and ultimately employing the brake formed assembly. This is an important development in the history of glazing and curtain wall design as, through the elimination of tubular shapes, this system both minimizes the thickness and apparent weight of the framing system and enables the glass to be pushed out as far as possible to the exterior of the building allowing the frame, brick infill panels and glass to be co-planar, which yields the character defining taught, minimal appearance. The steel itself is a matte-finished (akin to pewter in Kahn's own terms) stainless steel sheet, typically 1/4" thick except for the corner mullion and primary head framing members, which are 1/2". Although we have not yet determined who fabricated and installed the units, the steel was likely produced by either the G. O. Carlson Company or the Allegheny Steel Corp (both relatively local in Pennsylvania), who we know Kahn used in later works such as the Yale Center for British Art.

The cantilevered corners of each served tower are open and glazed above a low knee-wall of brick masonry backed with a 2" insulated cavity, and 4" CMU, that sits directly on the floor slab. The large primary (W-1) lights of 1/4" thick plate glass are glazed from the interior into a stainless steel glazing channel system that also features a cruciform corner mullion that frames only into the head channel of the primary glazing, effectively acting as a vertical cantilever. Above these are clerestory windows that scribe to the openings in the Vierendeel trusses, and are butt-glazed with stainless steel closure clips at the open corners. Aside from projections attached to the glazing channels at the head and sill that were meant to receive a system of sliding screen shading devices on select windows on the south, east and west facades, all of the exterior surfaces are flush and co-planar. The clerestory glazing on the south and west facades provide some sun control through the use of a special blue tinted glass, otherwise all glass is nominally optically clear.



**Figure 5: View from connector across typical lab floor
before construction of partitions
© 1961 (Penn Architectural Archives)**

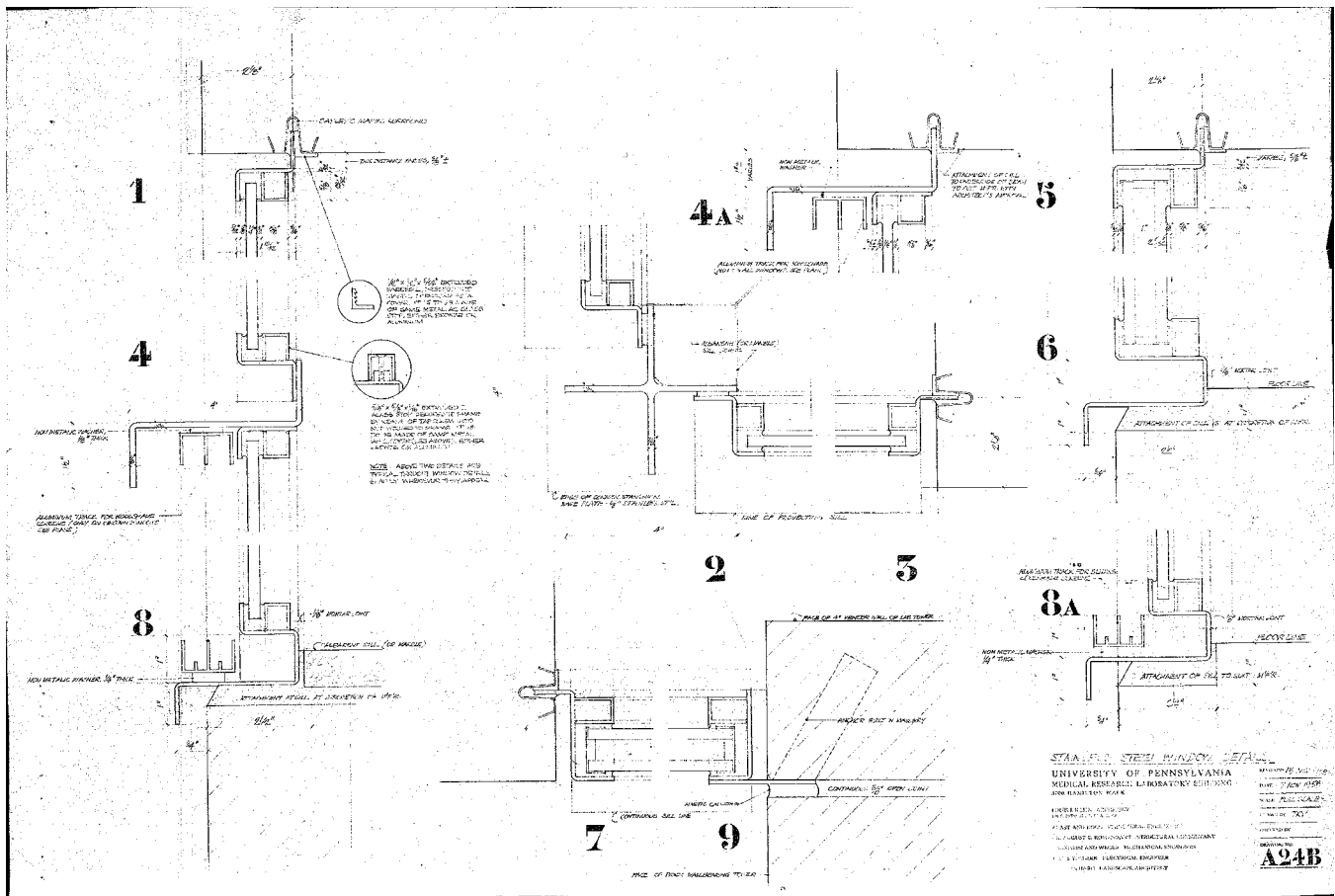


Figure 6: Original Steel Window Construction Document – 1958 (Penn Architectural Archives)

Interestingly, only the full height slot windows in the connectors between the towers were glazed with original *Thermopane* 1950s IGUs. These units were very expensive and hence used sparingly, but they utilized a technology of welding the interior spacers rather than sealing them with sealant, which has proven a more durable solution over time than contemporary IGUs. They are no longer available, but have remained intact, with no evidence of fogging from moisture penetration. Penn's charge to the EYP team was to optimize – as opposed to maximize – energy performance. The University has established aggressive standards for all of their building projects, but they recognized that the special nature of this project dictated an approach that was, in the language of the RFP, "energy frugal," one that took every possible measure to improve performance without visually compromising the appearance of the building. In the course of performing due diligence, options were developed for several scenarios that would increase the performance of the glazing system. These included three basic schemes (with some variations within each) as follows (Figure 7):

1. Treat and reseal the existing glass within the existing glazing system:

Where they remain intact, the original lights of glass are stellar examples of the sheer flatness and consistent visual quality of mid-20th century polished plate glass. However the fragility and consequent safety concerns that attend these units (many have broken over time – and they are not tempered) and poor energy performance of the existing large lights of glass were strong factors in arguing against the first, and most conservation-oriented option, and it was discarded relatively early in the design process.

2. Full replacement of the glazing system with an IGU in a thermally broken frame:

Initial design studies allowed the team to determine that while it might have been technically possible to introduce IGUs into the existing framing system (see middle diagram, Figure 7), this strategy ultimately proved unworkable because of the distortion of the existing frames (particularly the corner mullion) that had ensued as a result of over 50 years of concrete creep and expansion of the brick knee walls. In addition, there was uncertainty about both the effectiveness and appearance of the proposed stop design. As an alternative the team did study an interpretive brake formed system with a

thermally broken design, but the invasiveness of this installation (which would have involved removal of brick and cutting into the exposed concrete frame), its appearance due to the increased bulk of the new frame, and the fact that the signature corner mullion could not be thermally improved in any case ultimately rendered any IGU solution unacceptable. There was also concern with using IGUs that it is difficult to maintain the flatness characteristic of polished plate glass or any high quality monolithic glass in a light as large as the primary windows – unless a very heavy outer light is employed in the unit there is a characteristic bending of the glass toward the center as the result of pressure differential between the cavity and the exterior. IGUs also have a limited lifespan, and the cost, logistical difficulty and consequences to sustainability from a material waste standpoint when replacing lights of this size are additional factors that steered us away from this solution.

3. Introduce high-performance laminated glass into the existing glazing system:

Given that the project mandated a more robust envelope and the fact that alteration of the existing frames would be costly, technically challenging, invasive, and would compromise one of the signature character defining features of the building, our third and best option was to explore different kinds of new monolithic glazing to find the optimal balance between appearance and performance. Our criteria included safety, flatness, fit within the existing frames – both in terms of depth and ability to accommodate potentially distorted shape – color, transparency, reflectivity and optimal energy improvement over the performance of the existing $\frac{1}{4}$ " clear polished plate units. We soon ruled out tempered glass as it would be very difficult to adequately control roller wave in units of the larger size, which would unacceptably compromise the appearance of the glass. We

studied a number of options for laminated glass with interlayers and coatings of varying degrees of robustness in resisting heat gain. We could not introduce anything that would be perceived as a tint, and sought as well to avoid the purplish aura that sometimes appears in low-E coated glass when viewed in certain light – the glass had to be as optically pure as possible. Because the laminated units use two pieces of glass for each light, we also confronted the fact that typical clear glass (like the original polished plate) has a slight greenish tint which when layered becomes more pronounced, especially given that the original $\frac{1}{4}$ " thickness was being more than doubled to $\frac{9}{16}$ ". This phenomenon can be mitigated through the use of low-iron glass. Through a mock-up process that tested a number of varieties of glass make-up, interlayers and coating, we ultimately chose to evaluate a sandwich of clear and low-iron glass from Viracon, with either a VLE1-70 or VLE-85 coating on the second surface (inside of the exterior layer of glass). While the VLE-85 gave the best (by a small margin) energy performance, the VLE1-70 was a virtual match to the appearance of the original glass and was therefore selected as achieving the best balance of performance and appearance.

In addition to developing details of each of the proposed schemes, an energy model was produced to assess the value of each option relative to energy performance with the improvements designed into the new HVAC systems. Penn has a strong commitment to sustainability and reducing energy consumption in their buildings, and we had to demonstrate that we were taking every reasonable measure to improve the performance of the building. As the mechanical systems would also continue to be exposed in the renovated structure, the appearance and routing of all of the systems had to be carefully designed. In addition, the systems had to be designed for phased implementation – a situation that

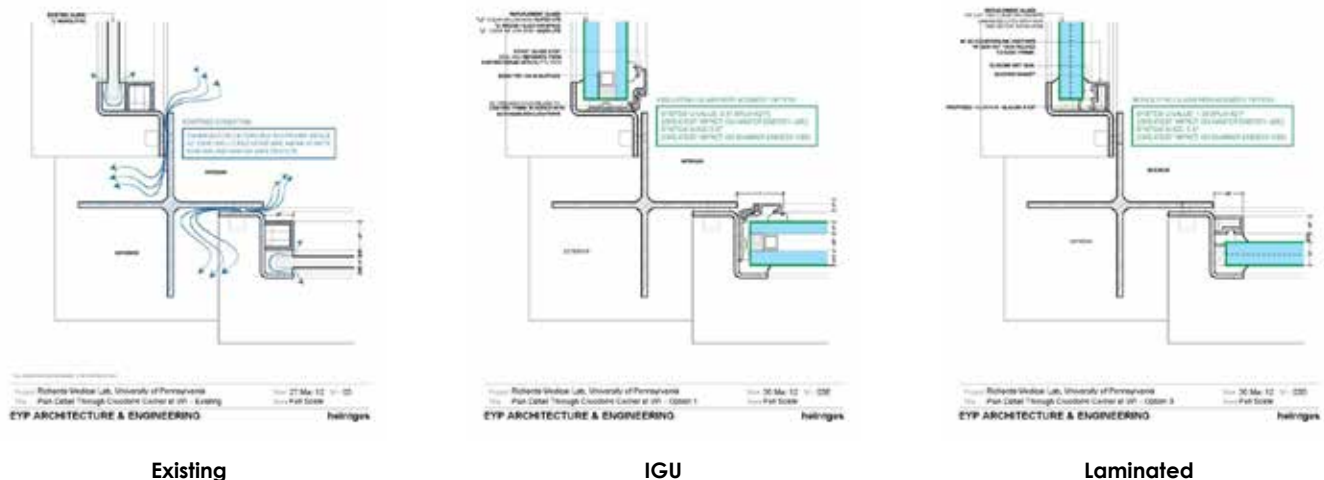
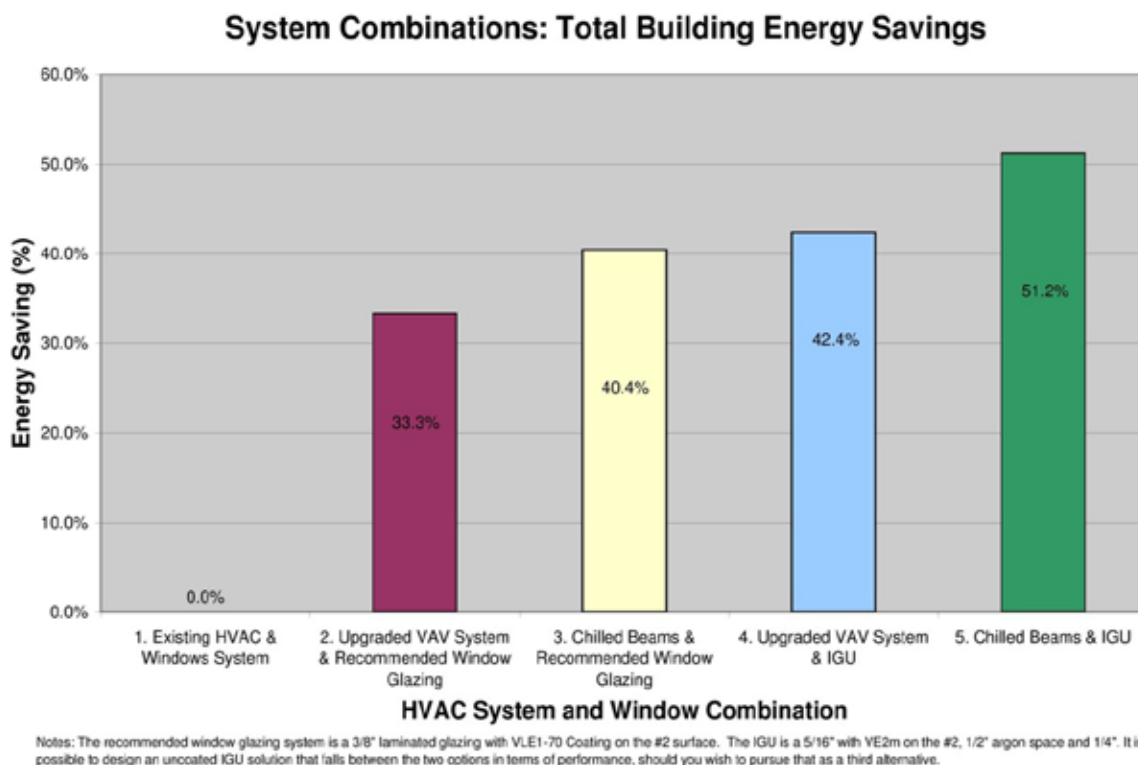


Figure 7: Glazing Options 1, 2 and 3 in existing frame – 2013 (R. A. Heintges/EYP)

Table 1: Performance metrics of different HVAC and glazing system combinations – 2012 (Urban Engineers/EYP)

made it particularly challenging to maintain some of the signature features of the original designs for the HVAC and conduit routing, notably the 'systems free' public corridor in the elevator lobby. We developed a number of options for the new HVAC system – which could be considerably downsized due to the change in use of the building away from wet laboratories to electrical and data intensive computational use.

The original design of the mechanical systems utilized constant volume air handling units, one for each tower. There were very limited controls on the air flow which resulted in significantly different interior temperatures depending on the exposure of an interior space. While the Penn engineering design standard is a Variable-Air-Volume (VAV) system with terminal control units for each zone, the University had already been exploring the use of chilled beam systems. Options analysis determined that the best and most efficient option for the current project would be to abandon the standard VAV system in favor of using chilled beams to deliver cooling. The design of the chilled beams themselves had to be carefully chosen to fit in with the overall aesthetic of the building and had to be carefully coordinated with the typical glazed tower linear light fixtures which sit directly below each unit. Energy modeling demonstrated that most of the benefit to improving the performance of the building would come through the changes to the HVAC system, and that although the maximum benefit (about 50% energy improvement) would be achieved through using an IGU in a thermally broken frame, the

laminated glass solution in the refurbished existing frame still significantly outperformed the original glass. Overall, an energy improvement of about 40% - or 80% of the maximum possible savings is achieved through the use of laminated glass and the chilled beam system (Table 1). This answers Penn's charge to the design team to produce an optimal design that would best balance performance and long term durability with optimal life cycle cost, while maintaining the historic character and appearance of the building.

Following selection of the glass through the initial round of mock-ups, full scale in-situ mock-ups were developed to test the constructability and ultimate fit of placing the new high-performance glazing, particularly the larger units, within the existing frames (Figure 9). As it was important to maintain the appearance of the glazing down to the smallest detail, the initial intent was to install the glass using a modified, two-component version of the original black anodized aluminum glazing stops. The extra thickness of the glass coupled with the dimension of the glazing pocket however necessitated reducing the depth of the stop so that it would not overlap and obscure the exposed rounded edge of the interior of the brake metal frame. Given this reduced dimension and the additional weight of the new glass, it was determined that the mechanically fastened stop would have inadequate bite on the existing frame and therefore insufficient strength to meet the structural performance requirements of the installation. Heintges and the team therefore began to work with Viracon and Dow through

US Glass & Metal (USGM), Intech's glazing subcontractor, to explore the feasibility of employing a structural silicone glazing system. Ultimately we chose a wet-seal employing Dow-Corning 995 Structural Silicone glazing compound on the outside of the glass and in the voids between the glass setting blocks. The stops were simplified to a single rectangular aluminum tube, adhered to the frame with .020 VHB glazing tape, and no mechanical fasteners (Figure 8). This system was calculated and vetted through Dow and subsequently field tested prior to approving the final glass installation. The weight of the glass and changes in code since the original construction also necessitated additional reinforcement of the attachments of the existing frames to the building structure.

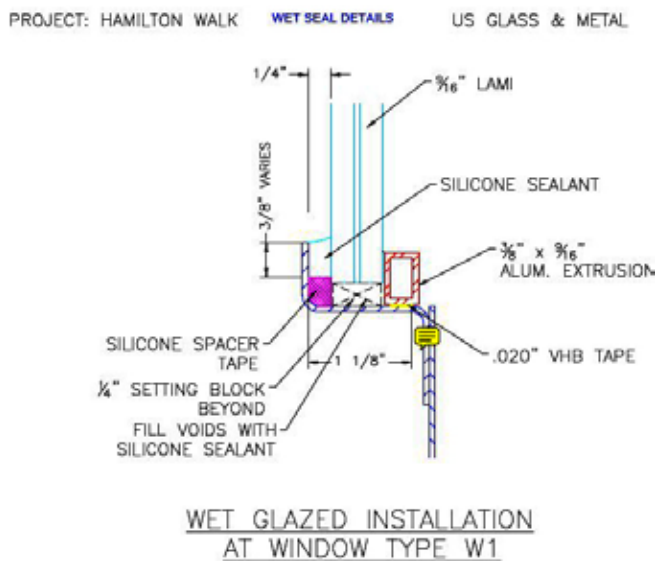


Figure 8: Fabrication detail of final glazing solution – 2014; USGM

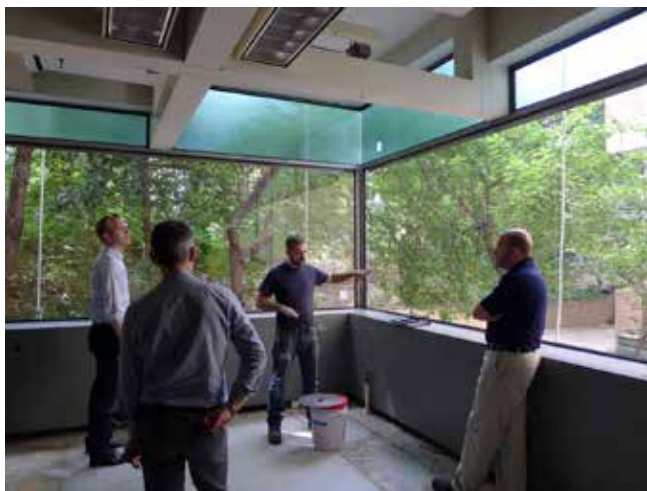


Figure 9: Review of Full Glazing mock-up – 2014(EYP)

One of the great challenges to ensuring the success of the installation was the precise calibration of each

light of glass to the opening. As noted, the building has moved over time, which has resulted in deformation of the window frames to a degree that the distortion out of vertical of the corner mullions is visually apparent. While this is perhaps an unusual mark of the evidence of age or patina to imagine in a modern building with a rigorously crisp and minimal aesthetic, there was no consideration of its being corrected as this could only have been done by taking much of the exterior skin apart, which was both unnecessary from the standpoint of building integrity and would have been contrary to the letter and intent of the preservation standards befitting the Richards' landmark status. Water and air infiltration testing of the original units confirmed the existence of significant gaps between the existing glass and the steel frames. USGM therefore carefully laser-measured each opening and scribed the individual lights to fit.

The stainless steel frames were cleaned and re-passivated to ensure the best possible adhesion of the structural silicone glazing and VHB tape. It was of critical importance however that this was to be done lightly to preserve both the original matte finish and to the degree possible the patina they had acquired over 50 years of weathering. Working with Building Conservation Associates, the team originally specified two Bradford Derustit compounds, SS-3 Stainless Steel Cleaner and Wonder-Gel to mock-up in the field. Ultimately the Wonder-Gel was chosen as producing the most consistent and least invasive results. Following the installation of the new units they again tested for conformance to water and air infiltration criteria.

Interior Kit of Parts

Although not a focus of this paper, a major design issue with great impact on the future of the building is the interior partitioning system, which is both a spatial and material concern. The original partitioning system was exposed CMU and the partitions, where employed, were aligned with the exposed structure above. This yields a condition where there are relatively large corner office or lab spaces (where they are not subdivided) that receive an over-abundance of natural light, with smaller interstitial and interior offices away from the main sources of daylight. Kahn himself was explicit in stating that his original conception for the laboratory towers was to have the floors as open as possible – in the manner of studio space – and it is clear when examining early photos taken prior to the installation of the partition system that these are spaces of great architectural power when left open (Figure 5). The new program areas were therefore designed to admit more natural light to the interior of the laboratory floors (Figure 10). Bearing this in mind, the present project views the reconfiguration of these spaces as an opportunity to develop a language of intervention that can provide an appropriate, evolu-

tionary and non-mimetic contemporary counterpoint to the existing architecture.



Figure 10: Rendering of Typical CCN Floor – 2013(EYP)

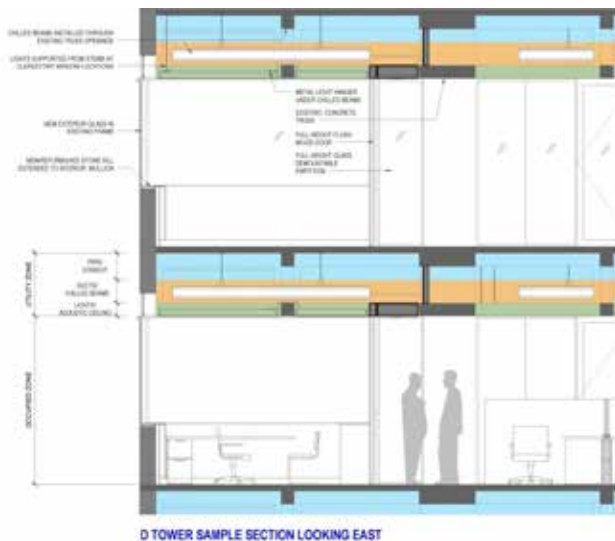


Figure 11: Diagram of systems layering strategy- 2013(EYP Preservation Guidelines)

Key criteria included devising and configuring a system that could work both on and off the structural grid, would maximize the passage of light to the interior of the floors, and would be enable the installation of replacement W-1 lights of glass should that ever be necessary.

Summary

The Phase One Richards Building renovation was conceived by Penn as a kind of pilot project in which optimal architectural and systems design and preservation strategies can be tested to ensure that the subsequent phases can be executed quickly and efficiently in a consistent and architecturally appropriate manner to the greatest degree possible. Part of the team's charge from the outset was to create a set of Design and Preservation Guidelines that enable our collective knowledge of the building, intervention strategies and the lessons learned from the build-out of Phase One to be memorialized for planned future construction, as well as any subsequent renovations and ongoing maintenance (Figure 11). These were drafted during the Phase One design period in order to inform the Phase Two design work (carried out by Atkin Olshin Schade Architects under the design guidance of EYP) which is also now in construction and will be finalized upon the completion of the present construction in fall 2015. The process of vetting mock-ups and addressing the inevitable unforeseen conditions encountered in any renovation have helped to refine our initial assumptions, and have raised our expectations that we will ultimately realize a robust and appropriate final product. The project commenced design in early 2012 and proceeded into Phase One construction in the summer of 2014. Phase One construction will be complete late summer of 2015, and Phase Two (which has been streamlined through lessons learned in Phase One) will follow in early fall.

The project addresses many of the issues that confront working with mid-century modern structures, though balancing respect for its landmark status as a signature work of Louis Kahn against solving some acute functional performance issues make this an especially exacting project. It is important to understand that this is a renovation of a working laboratory building, and that our charge was to accomplish at times radical internal change with virtually no exterior visual impact. While the Richards is in many ways perhaps a unique case, it does speak to the necessity to balance conservation of original materials with performance enhancement through the replacement of key building elements when it is necessary to ensure the continued viability of the building – and to carefully design, mock-up and test these components to ensure that they meet team expectations for both performance and appearance. This process has thus far served the team well and we are hopefully on track for a successful completion later this year – but we are still and will always be learning.

FIBERGLASS REINFORCED PLASTICS AT THE FAIR: Preserving the Future Past

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Abstract

The 1964 World's Fair presented itself as "A Millennium of Progress" and viewed part of its mission as creating a venue for companies and businesses to unveil their products of the future. The makers of fiberglass reinforced plastic (FRP) made sure they were at the forefront of this Fair. For the fair designers and fiberglass industry, fiberglass reinforce plastic was the perfect material for its temporary construction. It is a strong lightweight material that is relatively cheap and readily molded into complex shapes. At least one million pounds of the FRP was used to make pavilions, a Ferris wheel, life sized dinosaurs and benches. Two small pavilions and approximately 2 dozen benches remain at the Fair site.

A product developed during the war, FRP was used in many exhibitions after the war to show the merits of using plastics in building construction. In the late 1940s, FRP sheets began to be used in the construction industry as wall panels or roofing panels due to the panels' ability to be colored and transmit light. By the 1950s FRP was being used as cladding for buildings with steel or concrete frames, roofing trim, plastic forms for concrete, and gutters and flashing. Benches at the World's Fair used FRP slats.

Another construction technique first used in the 1940s was fiberglass sandwich construction that began use as covers for radar equipment. For this sandwich, FRP skins were laminated over a core material, typically honeycomb paper or urethane foam. Several pavilions were made using this technique at the 1964 World's Fair. Although three survived, only two remain at their original location.

At the time of the 1964 World's Fair, FRP was innovative but viewed as ephemeral. Little thought was given to how to maintain or even preserve any of the FRP structures or infrastructure. This created a problem when the benches and pavilions were handed over to the New York City Department of Parks. Weather, inappropriate maintenance, and impact damage have taken their toll on the FRP. The few remaining elements require significant conservation. Schematic preservation strategies have been developed by the engineering firm, Silman Associates and architectural conservation firm, Jablonski Building Conservation for one of the FRP sandwich shell

pavilions. Students in the Fall 2014 Conservation Workshop at Columbia University's Historic Preservation Program conserved one of the FRP benches and devised repair strategies for the maintenance of the remaining 1964 World's Fair Benches. None of the solutions for either project were perfect. This paper will discuss issues with conserving FRP and the hard choices that need to be made.

Introduction

"Take a front row seat in a new era. It is an era in which man has created for his own better enjoyment of living a whole new set of materials called plastics. They behave as no materials have before them have ever behaved. "So announced the October 1947 House Beautiful special addition on plastics. The subtitle was "A way to a better more carefree life."

Many did head the call to plastics and it is impossible to get through a day without using many types of plastic. At the beginning not everyone was enamored of this new material. While Richard Benjamin in the iconic 1967 film, *The Graduate*, rejected the call to plastics, conservators do not have this choice. Plastics are pervasive though out our built environment. As we move through the twenty first century we are finding it is a new era for conservation when working with mid-century modern materials. Trying to understand how to conserve plastics is not leading conservators to a more carefree life as there are no easy answers.

Plastic is actually an umbrella term as there are many types of plastics. I am using two case studies to illustrate the difficulties of making decisions about how to conserve one subset of plastics, fiberglass reinforced plastics, known as FRP. The two studies have two different sets of fabrication that make it more interesting, one much simpler than the other. The simple project has been completed; the other is still in the design phase but has significant useful lesions. Both of these case studies were part of the 1964/5 World's Fair in New York City.

Fiberglass Reinforced Plastics (FRP)

The development of fiberglass reinforced plastic (FRP) began in the 1930's, but it was not really used in manufacturing until the mid-century twentieth century. Fiberglass was discovered by accident in 1932 when a jet of compressed air inadvertently hit a stream of molten glass. The resulting spray of fine glass fibers was something researchers had already spent years trying to produce. In 1936 two glass companies Corning Glass and Owens-Illinois patented a glass cloth they named, Fiberglas. They then looked for a resin to embed it in. DuPont had developed polyester resin in 1936 but there were curing time issues. The German's found a solution, which was stolen by British Intelligence agents in the early days of the Second World War and given to the American manufacturers.

In 1942, Ray Green, a boat builder, fabricated a fiberglass reinforced plastic boat using fiberglass cloth reinforced with polyester resin. War uses were quickly found for this material and an industry was created. After the war, new uses had to be found for the product. With the postwar construction boom the FRP industry began promoting uses of plastic in building construction. FRP was attractive to manufacturers of building construction materials as it was lightweight and had high strength. An opportunity to show case this material was presented in the 1964/5 World's Fair based upon the pavilion requirements set out by the fair organizers.

The 1964/5 World's Fair

The basic pavilion requirements were inexpensive buildings that were easy to erect and easy to disassemble as the fairground was to revert to a park when the World's



Figure 1 An aerial view of the 1964-65 World's Fair that was a publicity photo from the 1964-65 New York World's Fair Corporation. (Courtesy of WorldsFairPhotos.com)

Fair ended. New York City waived its 20-year longevity building code for the fair structures but left the strength and stress requirements in effect.¹ It was an opportunity to demonstrate the use of modern building materials such as plastic, fiberglass, stainless steel, and tempered glass. Owens-Corning Fiberglas estimated that a million pounds of glass fiber was used at the fair to build about two dozen pavilions as well as telephone booths, dinosaurs and roofs.

The designs used with these materials were often Mid-Century modern, futuristic or kitsch and sometimes a mixture of all. While corporate pavilions with distinctive designs dominated the literature of the fair, we will be examining the small-scale fiberglass reinforced plastic elements that remain. These remnants have acquired significance, as they are some of the very few remaining in situ World's Fair relics.

First Case Study: The Bench

The 1964/5 World's Fair was spread out over nearly a square mile of land [Figure 1]. People's feet got weary and seating was a necessity. Benches were an obvious answer. 3500 fiberglass slat benches were installed at a cost of \$352,000 or about \$100 dollars a bench. These were relatively inexpensive benches and the operative driving force for the infrastructure was inexpensive. Today there are fewer than three dozen intact benches left.

The eight foot long benches [Figure 2] have a sleek almost deco design created by architect Gilmore Clarke and his firm working for Robert Moses who was in charge of the fair. The benches have three legs and eight slats; five slats for the seat and three for the backrest. The fiberglass slats were molded using pigmented polyester resin for the matrix which was encased in the pigmented gel coat. The slats are bolted to the aluminum legs. Two separate companies manufactured components of the benches, Hamden Brass and Aluminum Company of Springfield Ma cast the Aluminum legs and Universal Molded Fiber Glass Corporation of Bristol Virginia fabricated the fiberglass slats. The benches were to be maintenance free and unpainted although the aluminum legs were lacquered.



Figure 2: Benches in situ at Flushing Meadow Park.
Photograph by author

The Universal Molded Fiber Glass Corporation is now part of Strongwell Corporation. Strongwell notes on their web site that they have been working with reinforced plastics since the 1940's and they had been using since 1956 a fabrication process then called "the continuous automatic process", that is today known as "pultrusion". Three years later, the process was used to produce fiberglass ladder rail, which remains a major product for the company today.² Ladder rail and slats are similar products.

By 2013, there was concern at the New York City Parks Department that the benches were being damaged and disappearing at a very rapid rate. On a number of benches the aluminum legs were being used but the fiberglass slats were being replaced with wood slats.³ The Parks Department wanted a bench conserved so that it could be put in the Queens Museum as an example of an original bench.

In 2014, the New York City Parks Department contacted me as they were wondering if the Columbia University Historic Preservation Program's Conservation Workshop which I co-teach would be willing to conserve a 1964/5 World's Fair bench as a class project. The bench would then be displayed at the Queens Museum. How could one possibly turn down the opportunity to work with plastics? Four students: Kathryn Gardner, Corey Manchenton, Marena Wisniewski, and Dona Yu took up the challenge to work on these benches.

The bench was carefully selected as it appeared to have all of its original pieces and intact slats. While there may be close to three dozen remaining benches, they are not all in original condition and many are damaged. Broken slats are extensive and they are simply cut where the break has occurred if the damage is not extensive. We saw one slat broken while the park was being set up for the US Open. Many benches have replacement slats

harvested from other park benches. When broken slats are replaced with salvaged slats, metal washers were used as the bolt holes were often enlarged [Figure 3].



Figure 3: Replaced slat with washer under bolt due to enlarged bolt hole. Photograph by author

In the fall of 2014, an intact bench with its original fiberglass slats and aluminum legs was delivered to the Conservation Laboratory at Columbia University.

Documentation

The project began with a documentation search. The students found and then combed archives locating the original specifications and a report about testing that was undertaken on the benches prior to their large scale fabrication. A significant amount of information about the benches was located in the New York Public Library archives. The bench assembly had been thoroughly tested. Testing found that tightening of the bolts that held the fiberglass slats to the aluminum legs caused the slats to crack. Tightening short of refusal enabled the bolts to be easily removed but this would also allow vandals to easily remove the slats. To address these two issues, rubber washers were installed under the slats and bolts and an adhesive was used to help hold the bolt into the aluminum.

When the fair finished, the grounds and benches were given to New York City Department of Parks and Recreation. Specifications detailed how the benches were to be prepared and painted for the hand-over. It was noted that the slats were not to be removed. The fiberglass was to be sanded and washed with a de-waxer fluid.

The paint specified was Triple Prime Coat followed by Poly-Silicate Enamel manufactured by H.B. Fred Kuhls, Inc., a Brooklyn based marine paint and supply firm.⁴ A contractor was hired to paint the benches. Needless to say, the benches have been painted numerous times since then.

As part of the documentation, a piece of the fiberglass was sent to the Metropolitan Museum of Art for analysis of the matrix. It was confirmed that the matrix was a polyester resin. The students also examined the paint layers on the slats and identified the first paint layer on the fiberglass was a pale yellow blue green.

Deterioration of Fiberglass

After their search for documentation, the students undertook the condition assessment of the bench. It came to Columbia looking very unimpressive. The slats were heavily painted with up to 10 layers of paint and the paint was peeling. The aluminum had paint drips everywhere and was heavily corroded. This paper focuses on the FRP although the aluminum had interesting issues.

FRP can deteriorate in a number of ways. The most significant is weathering and exposure to ultraviolet light or UV. As the resin deteriorates due to weathering, the adhesion of the matrix to the fibers weakens. Once the fibers are no longer fully embedded in the resin they lift from the surface, a condition called fiberglass bloom. The immediate problem is fiberglass splinters. However, these fibers and their fiberglass mat also become part of the wicking system for water traveling through the unit accelerating the deterioration and discoloring of the FRP. Gel coats and limited exposure to ultraviolet light are two methods of keeping the bloom from occurring.

Slats that had been removed from benches taken out of commission were examined and the gel coat was less than a 16th of an inch. Gel coats that are too thin will cause the fiberglass to deteriorate more rapidly. This is probably what happened to the World's Fair benches as glass mat sheet in the center was not particularly well imbedded in the matrix and the gel coat was thin. Sanding of the benches for the painting after the fair probably did even more damage to the surface.

Fiberglass, particularly thin slats are easily damaged from movement, structural stresses and of course impact damage. Generally the damage to the bench slats is seen in the form of cracks located around the slat fasteners and impact damage that is found in the form of losses or large cracks at the location of impact.

Treatment and Maintenance of the Bench

After gaining an understanding of some of the deterioration mechanisms of FRP, the students began conserving the bench. The first item to be tackled was the paint. In order to fully assess the condition of the slats, the paint had to be removed. The decision to remove the paint was not difficult to make. Documentation from the archive was clear that the benches were not originally painted. The existing paint on the bench was in very poor condition, not well adhered and visually bubbled [Figure 4].



Figure 4: Bubbling and blistering paint on bench slats.
Photograph by author

Another important decision made was not to remove the slats. A special tool had been delivered for removing the bolts and it was tried on an additional bench. The bolt could be removed but the removal appeared to cause damage to both the slat and the bolt. Therefore, it was felt that no attempt should be made to remove the slats.

Various paint strippers were tested. Issues with safety, dwell times and location dictated some of the paint stripper parameters and a pH neutral paint stripper, Soy-Gel, manufactured by Franmar Chemical was selected.

Because the slats remained in place, stripping the paint between the slats was challenging. It took a great deal of effort to get it out of all the nooks and crannies. In addition, it was quickly discovered that the fiberglass bloom from the compromised gel coat could deliver painful splinters into inadequately protected hands.

Once the paint was removed, the color of the slats was discovered to be a very nice green that everyone, including the Parks Department liked despite staining in some areas [Figures 5 and 6]. Originally, the thought had been to paint the slats again with a color similar to the original gel coat or the current slat color. After a discussion, the decision was made to leave the slats as is because the bench was going to a museum. However, the museum needed to make clear the bench could not be sat on or touched because of the protruding glass fibers. If the bench had been going back to the park, it would have had to be coated.



Figure 5: Detail of conserved bench. Photograph by author



Figure 6: Conserved bench. Photograph by author

The aluminum legs were cleaned of most of the corrosion, lacquered, and then waxed because if the legs were not coated they would corrode. Maintenance of the conserved bench requires cleaning with either a damp cloth or with a pH neutral detergent on an as-needed basis and the aluminum legs need to be waxed periodically to provide a protective coating against corrosion.

Treatment Recommendations for Benches to Remain in the Park

For benches to remain in the park, the students determined the treatment needed to be quite different from the bench going to the museum. The slats had to be repainted as the gel coat was damaged beyond in situ repair. This would allow repairs to be made without having to match the original matrix or gel coat colors. Easier slat repairs will increase the probability of keeping original fabric.

Before any new painting can occur, the current paint must be removed. The slats need to then be degreased and carefully washed down with a pH neutral detergent. Repairs can then be made to the slats, such as repairing losses and cracks using polyester fiberglass fills and gel coats. Repairing gel coats is never easy. It is imperative that the matrix material is identified before selecting a repair material. Incompatible gel coats or unsuitable resins applied during repairs cause deterioration often in the form of crazing or fine surface cracks that then allow water to permeate. Scratches are sanded out and built back up with a compatible gel coat. If there are gouges or deep scratches, they are filled using a compatible filler and gel coat. The World's Fair slats are difficult to repair as they are tightly spaced and cannot be removed without significant damage.

Finally, a marine grade primer and paint designed for use on fiberglass should then be applied. The color of the paint should be matched as closely as possible to the original gel coat. The students felt repairing the fiberglass should be done by someone experienced in fiberglass repair which could include people experienced in boat repair.

For benches with severely damaged slats, replacement of the slats was suggested using fiberglass or a very similar material that did not require painting. If extra slats were made, then it would be easy to replace damaged slats. It is also possible that replacing slats will make the benches easier to maintain than trying to paint them every five years.

The Pavilions

Most of the fiberglass structures at the 1964/65 World's Fair, particularly the pavilions, were more complex than the benches. All that remain of the FRP pavilions are two small ancillary structures. As with all good projects, there was a team working on the study of the two remaining pavilions. Ed Meade from Silman Associates headed the team, which included his associates Amy Hwang and Sylvester Black and conservators from the firm Jablonski Building Conservation, Mary Jablonski and Brandi Hayes.

Three fiberglass marina pavilions were built at the 1964/5 World's Fair marina. They were part of the experiment in the structural application of fiberglass reinforced plastics. Two other pavilions built for the fair used FRP as a major structural component. One was the 7-Up pavilion with a two story central structure and 16 freestanding FRP canopied modules [Figure 7]. The other was the West Virginia pavilion that had two large RFP domes on a flat roof. The rest of the pavilion was steel frame with a curtain wall. These structures were designed to be temporary and easy to dismantle. FRP allowed for efficient design for minimal construction time on the site and short service life.



Figure 7: Postcard of 7 Up Pavilion at 1964/65 World's Fair

The marina pavilions were designed by the architectural firm Peter Schladermunt Associates and the engineering firm Strobel and Rongved. The FRP panels were fabricated by Ray Greene and Co. and erected by A Munder & Sons Contractors. Owens Corning fabricated the FRP for the larger pavilions⁵ and appears to have provided the fiberglass materials for these pavilions.⁶

The marina pavilions [Figure 8] were built of 12 RFP pre-fabricated sandwich panels with joints at the four axes of symmetry. These panels were connected by "Roto-lock" connectors. Glass windows with metal mullions originally enclosed and supported the arched structures, preventing drooping of the vaulted shell.⁷ The pavilions are supported at the four corners by steel angles embedded in the column portion of the shell and extending into the foundation. The columns forms a

27 foot square. The shell has two perpendicular groin arches that create a vaulted dome in the center that rises 14 feet from the ground.⁸ As with the benches, the pavilions were not originally painted but had a colored, in this case white, gel coat.



Figure 8: Marine pavilion used by Coast Guard during the 1964/65 World's Fair
Found on the website
<http://candelastructures.org/exhibit.html>
From the Collection of Mike Kraus

At the end of the fair, the structures were auctioned off. One private buyer bought one pavilion for his weekend residence in the Adirondacks. It is still in use by the family.⁹ A contractor purchased the glass and mullions of the other two pavilions leaving only the remaining FRP shells [Figure 9].¹⁰



Figure 9: Current view of one of the two remaining marine pavilions. Photograph by author

FRP Construction of Pavilions

The sandwich panels consist of 1/8 inch plastic matrix skins enclosing a 2" thick by 4 inch wide preformed polyurethane foam blocks. This was different from the other two pavilions with FRP which used honey-comb paper for the core instead of the polyurethane foam. The skin on the outside is a 0.015-inch (1/8 inch) thick gel coat. Beneath this skin is a 10-ounce fiberglass cloth, at 1.5-ounce fiberglass mat, and then a 24 ounce woven fiberglass roving set in polyester resin [Figure 10]. The skins were thickened in several areas such as the exterior panel edges and the span over the window mullions.

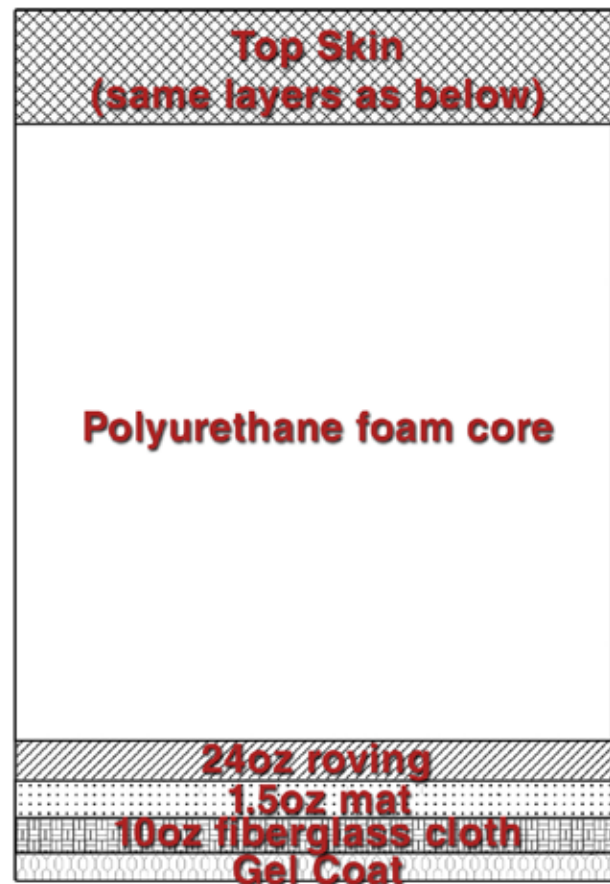


Figure 10: Sketch of FRP sandwich panel construction of the marine pavilions. Sketch by Brandi Hayes

Each panel was built from a single wood mold. Wax was applied to the mold to aid in the release of the panel after curing. For the inner skin, a gel coat was poured and rolled out into the mold. Then the cloth, mat, and roving were placed with the polyester resin. Before it could cure, the polyurethane foam blocks and shear ties were installed. Once the inner skin had cured, the outer skin was created and laid on top of the blocks. After everything had cured, the interior surface was buffed

to provide a smooth finish. The exterior surface required more treatment and sanding, as it was not in contact with a mold.

FRP shear ties were also included in the panels to tie the out and inner skins together every third block. These ties were embedded with the foam blocks when the polyester resin was poured into the mold and cured.

Roto-Lock fasteners were installed at intervals of 12" on center for vertical joints and 8" on center for horizontal joints. These fasteners were set in premolded inserts. The lock has a bronze disk in one piece that is then rotated with an allen wrench to engage in the lip of the neighboring piece.

Deterioration of the Pavilions

Time, poor repairs, and a lack of understanding of FRP structures and how to maintain them have taken their toll on the pavilions. There are similar material problems found in the bench fiberglass and the pavilion fiberglass skin. However, the pavilion FRP problems are compounded by structural issues. Silman Associates undertook the structural analysis which is broadly summarized here.

FRP sandwich construction can easily deteriorate from movement and thermal stresses. In sandwich construction, air is often trapped between the core and skin. As these air pockets are heated, they expand causing rippling or bubbling of the panel surface. Differential movement between the skin and core, or movement from the flexure of the panels can cause a breakdown of the FRP.

The FRP pavilions of the World's Fair were carefully studied at the 2-year mark, before they were disassembled. The 7-Up and West Virginia State pavilions had used honeycomb paper instead of the foam core had significant delamination of the fiberglass skins from the paper core. The marina pavilions examined at the same time did not show any signs of delamination from the foam core.

Movement of the structure from natural forces such as wind or snow load or even settling of the foundation creates stress that can cause the panels to crack or separate at the joints. The remaining pavilions have experienced all three. While snow load perhaps has the least effect on the structures, once the windows and aluminum mullion system were removed, wind flowed through the pavilions and in storms there is significant movement, which has led to joint cracking. Increased cracking is also the result of corroding embedded steel in the legs. Cracks in the joints have led to water infiltration, which

leads to more corrosion, which leads to widening of the joint cracks.

Impact damage is also problematic. The most severe damage was caused when a car hit one column leg of a pavilion and the crack at the joint above is quite large. There has also been the problem of people climbing up the pavilions, skateboarding on the pavilions, riding bikes up the column legs, and kicking soccer balls at the interior ceiling. Needless to say, there is damage. One person appears to have had quite a significant fall and broken through a panel at the top of one pavilion.

During a prior repair, a contractor sanded the gel coat down significantly to paint the pavilions. The sanding may have been done to address cracks and other deterioration in the gel coat, which has significantly yellowed. In some areas the gel coat was completely removed down to the fiberglass roving.

Paint loss on the top of the pavilions is a significant issue. Because of the loss of much of the gel coat in many areas, the paint is almost on top of the fiber mat. It is the paint that is protecting the skin of the pavilions. However, the fiberglass bloom appears much less than that found on the bench, possibly because the gel coat was always much thicker and the glass mats were more thoroughly embedded in the matrix.

In addition, biodegradation is very evident, not only on the surface of the pavilion but also within the panels where there are edge cracks. Water is trapped inside the panel and in the foam offering excellent breeding grounds for biological organisms such as moss.

Initial Proposed Repairs

If it was solely a matter of repairing the FRP material, there would be several options and most of the repairs would be relatively similar to those required for the bench slats with the exception of foam repairs.

Unfortunately, there are two significant structural issues. The removal of the window system in the pavilions subjects the structure, particularly in storms with high winds to high wind loads that put stress on the joints. However, in the end, it is probably the Roto-locks that will dictate the overall repair strategy. They must be replaced and to do this there is no choice other to take the pavilions apart to repair them. The third pavilion was disassembled and reassembled in a new location in the Adirondacks so this can be done.

In addition to repairing the mechanism for locking the panels in place, there is concern about the panels that have cracked open and what to do with the foam in-

side. This foam has a structural component. Any foam that has been exposed due to damage to the panels will need to be replaced possibly with injected foam. The foam must be compatible with the existing polyurethane foam and it cannot exert pressure on the fiberglass skin. If there are problems with this injection mode of application, the panels may have to be cut open and new foam cut to size inserted into the panels before the joints are closed.

Given the damage to the gel coat and past repairs, the pavilions will probably have to remain painted. Paint and biological growth can be easily removed, fiberglass cracks and losses can be repaired and the gel coat reinstalled on the panels.

Conclusion

In the small built elements examined in this paper, there are repair solutions dictated by use and by failure of fasteners. Maintenance and regular repair are required for many materials, including FRP. For the well maintained pavilion in the Adirondacks with its intact aluminum and glass walls, repairs and maintenance are very different than what is required for the remaining pavilions in the park that have been stripped of significant structural support.

Those three small pavilions at the fair appear to have inspired at least one company to produce FRP sandwich panel houses. The August 1973 *Science and Mechanics* has an article about 12 fiberglass homes. The article states "A factory-built modular, bolted-together house with maintenance free fiberglass wall-roof segments is now being offered by the Rudkin-Whiley Corp. of Stratford, Conn."¹¹ Three of the first houses were built in Southbury, Tolland, and Bristol, CT. Somewhere out there must be at least one surviving house waiting for discovery.

Plastics and fiberglass are everywhere in our buildings. Until we learn more about plastic materials we will not know what is possible for repair. Let us increase our understanding about how to preserve and conserve plastics so we do not lose an important component of our mid-century modern built environment.

Endnotes

- 1 Lee, John M, *Plastics Abound in Fair Buildings: Industry Seeks to Capitalize on Construction Showcase*, New York Times, April 26, 1964. ProQuest Historical Newspapers: the New York Times, P.85.
- 2 <https://www.strongwell.com/about/history/>
- 3 I will verify that the fiberglass slat benches are far more comfortable than the wood slat benches as I tried out both.
- 4 H. B. Fred Kuhls. *Established 1889. 1920s at Sixty Fifth Street and Third Avenue in Brooklyn. Had fiberglass boat maintenance products by 1960s.*
- 5 Heger, Frank J. and Chambers, Richard. *Design, Analysis and Economics of Fiberglass Reinforced Plastics World's Fair Structures*. Presented at the 21st Annual Meeting of the Reinforced Plastics Division. Chicago, Illinois. 1966
- 6 Owens Corning Fiberglas Corporation. *Reinforced Plastics Guide to Hand Lay-Up & Spray-Up Prototyping and Fabrication*. 1970. Cover has an image of a 1964/65 World's Fair Marine Pavilion.
- 7 Ibid.
- 8 Ibid.
- 9 Lukas, Paul and Kirsten Hively. "Now That's a Souvenir", New York Times. May 24, 2013. <http://www.nytimes.com/2013/05/26/nyregion/how-a-worlds-fair-pavilion-became-a-family-cabin.html?r=0>.
- 10 Lukas, Paul. "About this Research Project". *The 'Candela' Structures*. <http://candelastructures.org/about2.html#2>.
- 11 Hass, Alan D., "New Modular Fiberglass House", *Science & Mechanics*, Vol. 44, No. 8, August 1973. P. 42.

MID-CENTURY COMMERCIAL MODERNISM: DESIGN AND MATERIALS

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Abstract

During the mid-20th century unparalleled and dramatic changes in the design of commercial buildings transpired across the United States. Much of the current analysis and attention given to recent-past resources has focused on larger scale high-rise buildings, high-style single family examples or signature architect designed institutional buildings. Often, however, it was the more humble mid-20th century bank, clothing shop, cinema or automobile dealership that was the first architectural expression of modernism to reach a town or city. Advances in materials manufacturing, product design and marketing all had a decisive impact on the mid-century commercial setting.

Many of these modern commercial designs were created by some of the more talented architects and designers practicing across the country, many of whom wrote publications on store design that widely influenced commercial construction. Meanwhile, the companies that produced many modern materials, such as glass and aluminum, also heavily promoted commercial building renovation. Glossy brochures showing sophisticated shoppers coaxed store owners into updating their stores in order to match the newest styles of goods and fashion.

Newly constructed, Exaggerated Modern massing and experimental structures captured the interest of the modern consumer. Savings and loans displayed folded plate roofs, while restaurants contrasted rustic wood with large areas of glazing. Owners of older downtown buildings covered unused upper story windows with porcelain enamel, gold-anodized aluminum, Vitrolux glass or plastic slipcovered facades. Channel-set and reverse-set neon, internally illuminated backlit signs and cursive or sans serif stainless steel letters all broadcast a new modernity to a fast-moving, auto-driving public.

Asymmetrical and angled storefronts reduced glare while their diagonal plans drew the shopper into the store. Picture-framed, cantilevered, projecting or inset display cases were crafted out of tempered glass and extruded aluminum framing. Tempered glass storefronts turned store interiors into a new form of window display. Vertically stacked textured brick, tile or structural glass contrasted with sleek white or gold metals. Glassy store-

fronts spilled new lighting methods onto busy sidewalks for evening shoppers. The results were striking, celebrating up-to-date looks worthy of an optimistic post-war age. In short, main street became modern.

This paper addresses smaller scale commercial and downtown resources such as specialty shops, restaurants and banks. A discussion of these resources within their mid-century design and commercial context will be augmented by analysis and illustration of their commonly used modern materials and design vocabulary.

Mid-Century Commercial Modernism: Design and Materials

In the mid-20th century, countless owners of shops, banks, restaurants and other commercial businesses built new buildings, or were inspired to update and modernize their existing ones. At the same time, whole new categories of 20th-century building types and automobile-oriented businesses multiplied, including gas stations, car dealerships, drive-up banks, fast-food restaurants, shopping plazas and shopping centers. Often, these buildings were the first architectural expression of modernism to reach a community. These new and modern, or newly modernized commercial buildings fully utilized a variety of new materials in their quest for an up-to-date image.

New materials fostering new design is not an unknown phenomenon for commercial buildings. In the mid-19th century, architectural cast iron columns and lintels replaced huskier storefronts of brick and stone, allowing for larger plate glass display windows.¹ Near the end of the 19th century, the introduction of the steel shelf angle lintel allowed for full storefront expanses of glazing to replace the 8-foot spacing of cast iron columns, increasing the front display area and allowing more daylight inside the store.² Also at the end of the 19th century, prism glass transoms above store displays came into use and bounced light a reputed 30 feet inside the building.³ Now the need for front store windows was reduced, and commercial buildings with prism glass transoms could

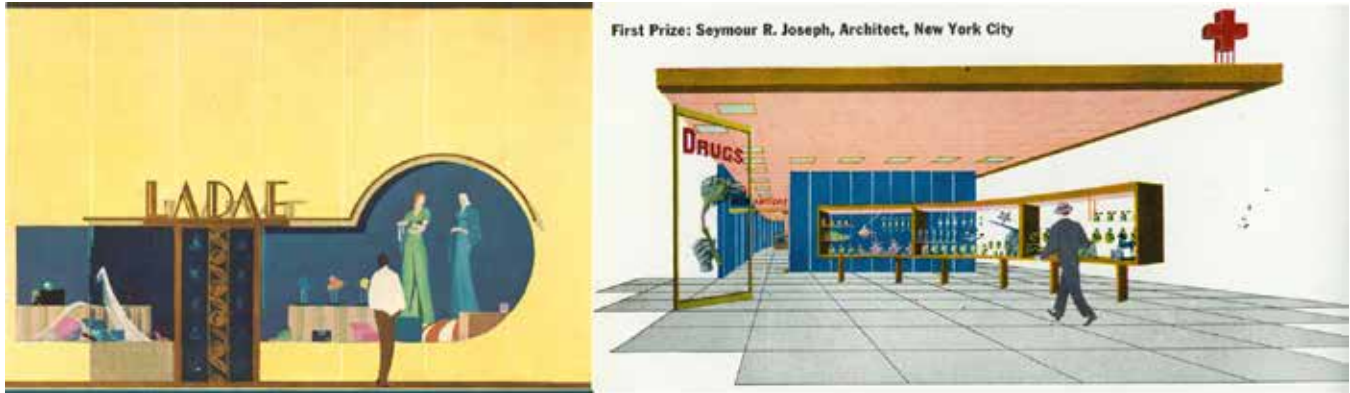


Figure 1: Left, a Vitrolite-clad clothing shop entry in the 1935 Modernize Main Street Competition. Right, the Store Fronts of Tomorrow Competition First Prize winning entry shows a new “deconstruction” of the front facade, *New Pencil Points Magazine*, 1943

have shorter floor-to-ceiling heights.⁴ In the 1930s, commercial buildings benefitted from new pre-fabricated storefront systems that incorporated plate glass windows with structural glass or porcelain enamel panels, mounted within extruded aluminum or stainless steel framing in strikingly modern designs.⁵

Business owners, attuned to new styles and trends, recognized new materials as a means of proclaiming their modernity.⁶ Storefronts reflected updated styles, while banks displayed modern efficiency.⁷ Commercial business owners were encouraged in their quest for modernity by construction product marketing, professional journals and even the federal government. New Deal programs aimed at strengthening commerce during the Great Depression⁸ led to the Libbey-Owens-Ford Company (LOF) sponsoring the “Modernize Main Street” competition in 1935.⁹ This competition, and resultant publication, showcased elegant modern facades utilizing Vitrolite, LOF’s colorful opaque structural glass. Competition entries combined intensely colored structural and plate glass with white metals into two-dimensional Art Moderne and Art Deco partis.¹⁰ Most designs were colorful, planar and glossy. However, some merchandise display boxes and stainless steel or aluminum pro-

jecting canopies hinted at the three-dimensional revolution that was to become common in the next decades.

To try to combat the dampening effect of the depression, architectural journals, as well as glass, aluminum and steel storefront advertising, aggressively promoted designs similar to the Modernize Main Street design competition. Structural glass was praised not only as a glamorous, sleek and colorful new material, but also because it could be easily fastened with mastic to both new construction and existing masonry walls.¹¹ Porcelain steel manufacturers also published examples of similar recladdings utilizing colorful modular porcelain enamel panels.¹² Even less durable laminated veneer panels such as the Formica Insulation Company’s were promoted as solutions to updating facades in the 1930s.¹³ The marketing combined with federal incentives was effective; a surprising number of storefronts, theaters and gas stations were reclad.¹⁴ However, by the end of the 1930s, US commercial design began to move beyond two-dimensional Moderne designs to a new aesthetic.¹⁵

During the Second World War, the architectural journal *New Pencil Points* published another competition, entitled “Store Fronts of Tomorrow.”¹⁶ While the Modernize



Figure 2: Left, a Libbey-Owens-Ford Glass Co. brochure: *Visual Fronts*, 1942. Center, a Libbey-Owens-Ford advertisement in the *Saturday Evening Post*, October 15, 1949: “How to make the sidewalk an AISLE OF YOUR STORE.” Right, a simple open front from Danville, Illinois, photo: IHPA archives



Figure 3: Left, The Rambles hardware store design by Ketchum, Gina and Sharp combines dramatic signage with linear display boxes that run from the exterior plywood and aluminum frame through the open front and on into the store. The sign and slat backing are porcelain enamel and the exposed columns are polished aluminum. From *Machines for Selling*, Kawner, Niles Michigan, 1946. Right, the Hub Clothiers, formerly in Springfield, Illinois, displayed dramatic porcelain enamel signage on a granite textured porcelain enamel backdrop above the stone veneer and plate glass lower floor, photo: author

Main Street competition had tried to overcome the depressed construction and consumer economy of the 1930s, Store Fronts of Tomorrow was looking ahead to the post-war promise of greater availability of construction materials. The 1935 Modernize Main Street facades had been primarily still two-dimensional, excluding some aluminum and steel canopy projections. But by 1943, this new competition illustrated how the front wall of a commercial building could be more dramatically altered. The Store Fronts of Tomorrow competition showcased new "open fronts" and more three-dimensionality.

World War II inspired a wealth of research into the creation and development of new materials and new stan-

dardization of production that benefited construction.¹⁷ At the end of the war, as a post-war economy burst into action, modern commercial designs utilizing new materials filled architectural journals, design books and product advertising. Dramatic commercial building designs by signature designers such as Raymond Loewy, Morris Lapidus, Victor Gruen and Morris Ketchum Jr., were widely published and promoted to architects and building owners.¹⁸

Another influential publication came out immediately after the war. *Machines for Selling* was published by the storefront company Kawneer in 1946. The publication explains how in the 20th century, a "new generation of



Figure 4: Left, a Freeport, Illinois, angled stone pylon. Center, a Moline, Illinois example of the common post-war angled open storefront, shown here in structural glass. Right, a much more unusual design angles the entire porcelain enamel facade out from top to base. Left photo: author, center and right photos: IHPA archives



Figure 5: Cantilevered display cases in outdoor lobbies deconstructed the front plane of retail buildings. Left, a design in Long Beach, California, from *Design for Modern Merchandizing*, April 1948, p. 126. Center, similar displays in Bloomington, Illinois. Right, the former Bakers Shoes in Chicago, Illinois, had a free-standing display table, well lit cantilevered display cases and a curved open front display window on the second floor, photo: author. Center photo: IHPA archives.

store designers" was incorporating new machine-age research into commercial building design. These designers gained insight by talking to business owners and observing consumer preferences. "They studied materials and construction—worked with cabinet workers, store-front manufacturers...They found that success depended on machine-like coordination of every working part of a store...From sidewalk to service alley, stores should be 'Machines for Selling'.'" ¹⁹ The machine-age aesthetic of modernism was coming to main street.

The result of the competitions, advertisements, new technology, post-war material availability and a vibrant growing economy was that the front facades of commercial buildings moved from streamlined Moderne to

exciting new designs. The commercial facade was no longer two-dimensional; rather, it combined an open glazed front with dynamic three-dimensional features to create a deconstructed front facade. ²⁰

With steel lintels now easily spanning across an entire facade, transparent "open" fronts replaced earlier opaquely-backed display windows, and the well-lit store, theater lobby or restaurant seating area itself became the display. Perfectly flat and clear plate glass, now easily produced and transported in sheets as large as 10 by 25 feet, allowed direct visual connection between the building interior and the sidewalk. ²¹ The terms "open front" and "visual front" were utilized by glass and storefront manufacturing companies to describe



Figure 6: Right, the University Bank of Carbondale, by the Bloomsdale Bank Building & Equipment Co., c. 1960, combines a white metal curtain wall and projecting canopy with stone and brick. Between the customers and car, the modern bank vault door is visible through the open front. This bank was clearly influenced by the widespread publicity about Manufacturers Hanover Trust Branch Bank in New York. Left, a photo of the New York bank's vault door visible through the open front glazing, photo: author. Rendering: author's collection.



Figure 7: Left, a Taylorville, Illinois cinema was refaced in the mid-century with polychromed porcelain enamel panels and a swooping stainless steel and aluminum canopy, roof and dramatic pylon, photo: IHPA archives. Middle, the elegant Oklahoma City, Oklahoma, Central Motor Bank drive-up, built in 1959, combines a thin-shell concrete roof with bright blue mosaic tile encased piers, photo: Ann V. Swallow. Right, precast concrete columns surround a dark curtain wall on this Moline, Illinois, bank, designed by John Van Schellema of the Illinois Bank Building Corporation in the 1970s, photo: John Van Schellema.

this dramatic new look.²² Large windows allowing a view inside the business now appeared in a variety of commercial structures, including theaters, gas stations, restaurants and shops.

Many of the most evocative new designs were found in retail because of the emphasis on consumer tastes and current styles. Furthermore, new mid-century retail methods directly linked consumers and products. Customers no longer waited at a counter for a clerk to bring them an item; they could browse through the shop to look at items, and the shop was designed to draw them in. Glass facades were entered through entry doors of heat-toughened tempered glass, completely clear with only minimal hinges and stylish handles. Butt-glazed glass corners and slim metal framework further opened the facades.²³ After World War II, anodized aluminum in transparent or colored shades of champagne and gold joined the earlier clear-coat and mill-finished aluminum framing.^{24 25} Interiors were brightly lit with affordable fluorescent lighting to further show the interior business to the passersby.²⁶

Post-war designers further experimented with the front plane of commercial buildings beyond the open front. Another design component that occurred parallel with, and often as part of, open front design was the asymmetrical angled front. Glass front walls were dramatically angled—either pitched inward from top to bottom to reduce glare, or angled back on a horizontal plane towards the entrance in plan. Simple asymmetrical open fronts, angled back in plan towards a tempered glass door, were repeated widely all across the country. Some walls curved instead of angled, but still led the custom-

ers into the store. Facades were nearly always asymmetrical. The symmetrical plans of recessed, arcaded, exterior lobby fronts of the 1920s reoccur, but by now had become strongly asymmetrical. Angles were everywhere. Stone pylon walls projected out at jaunty angles from front facades. Large angular signage or angled rooflines appear and reinforce the dynamism.²⁷

Not all modern storefronts were completely open. Dramatic post-war designs showed front facades further deconstructed into three dimensions. Picture box display cases were embedded into solid side walls that flanked an open front or projected proudly from glazed or solid planes. Some glazed front windows were enframed with heavier fluted aluminum trim, turning the front into a picture frame for interior displays. Freestanding “table” display cases, or projecting display boxes, appeared outside within asymmetrical exterior lobbies.²⁸ Further deconstructing the front plane, steel or aluminum canopies jutted out horizontally, or sliced at an angle through the glass front wall.²⁹

As the 1950s and 1960s moved forward, more evidence of modernism appeared in commercial buildings. Buildings were clad in steel or aluminum curtain wall systems, combining plate glass with colored spandrel glass or porcelain enamel panels. The use of porcelain enamel continued throughout the 1950s in curtain walls and facade recladdings, but it now included stamped patterns or rougher textures.³⁰

Sleek International style buildings utilized both metal storefront and curtain wall systems on main street. One noteworthy example was the highly publicized 1953



Figure 8: A close-up of the Octilinear Grille by Sculptura panels, Kansas City, Missouri, St. Mary's Bank. Center, "The Art of Refacing the New Art in Architecture," Julius Blum & Co.'s Curtainscreen, 1965. Right, Burnside and Co., Danville, Illinois, is an excellent example of a gold anodized aluminum slipcover, a cantilevered display case, tiled storefront and period signage. Photos: IHPA archives

Manufacturers Hanover Trust Branch Bank in New York City. Designed by Skidmore, Owings and Merrill, the bank was nationally influential in bank design.³¹ This building incorporated immense 10-by-24 foot plate glass vertical sheets in its curtain wall design. Following the concept of the open front, the bank showcased its modern efficiency by placing the Henry Dreyfuss newly designed bank vault door right behind the "storefront" window of the glass.³² This type of symbolic proclamation of a bank's functional modernity to attract progressive-minded customers was taken up by other bank designers of the period such as the University Bank of Carbondale in Illinois.³³

In the post-war period, curtain wall systems combined with other materials into boxy, basic designs found their way to downtowns across the country. Many of these designs incorporated rectilinear blocks of brick or stone laced together with curtain-walled entrance lobbies or

partially glazed facades. The University Bank of Carbondale, discussed above, is just one example.

Other mid-century commercial buildings utilized progressive new structural forms by the 1960s. Some buildings might be simple masonry or curtain wall boxes but dramatically topped with experimental roof forms, such as metal folded plate, or thin-shelled concrete vaults. In other examples the unusual structure became more integral to the entire design. Theaters, restaurants, savings and loans and bowling alleys were among the common representatives of this style. Dramatic pylons, soaring rooflines and expressive structural and sculptural massing all contributed to a style called "Ultra-Modern" at the time, or defined by Chester Liebs in *Main Street to Miracle Mile* as "Exaggerated Modern."³⁴ These buildings sometimes combined atomic and space-age imagery in signs, pylons and structure.



Figure 9: Left, Block & Kuhl's "California style" remodeling by Raymond Loewy Associates in Danville Illinois. From the *National Magazine of the Home Furnishings*, August 1948, 43. Right, the Kankakee Title and Trust in Kankakee, IL, also combines wood, stone and asymmetry in its elegant facade. Photo: IHPA archives.



Figure 10: A vigorous public campaign saved the St. Louis Saucer from demolition. The fully renovated building now hosts a coffee shop and restaurant. It was originally built as a Phillips 66 gas station in 1968. Left photo by David Carson dcarson@post-dispatch.com, Right photo from: <http://blogs.riverfronttimes.com/gutcheck/chipotlegrandave550.jpg>

Structural Expressionism, Neo-Formalism and Brutalism all brought concrete to main street. Brutalist concrete structures appeared primarily in the 1960s and their brusque qualities were more often accepted for large or institutional buildings like parking structures, hotels, banks or service offices than for retail buildings. Formwork was often designed to create rough textures deliberately left on the concrete surface. Some smaller scale Brutalist style buildings were brick but had similar blocky massing and geometric cutouts. More refined examples of concrete included Neo-Formalist banks or offices ringed with smooth precast concrete columns in the style of Minoru Yamasaki or Edward Durrell Stone in the 1960s to 1980s.³⁵ Concrete screen block panels also faced more elegant commercial buildings as well.³⁶

Beginning in the 1960s, changing downtown economics created vacant or underutilized upper floors. Now upper floor windows could be covered, and whole facades could be “slipcovered” with glass curtain walls, porce-

lain enamel panels or aluminum spandrels during modernizations. When daylight was still desirable on upper floors, open weave metal, usually lightweight aluminum, or plastic grills could be used.

Installing these metal or rigid synthetic material grills or opaque panels over the upper floors not only created a new modern image but also a backdrop for giant signage, clearly legible to a driving public. Often, earlier cornices or window hoods were sheared off to simplify the installation. Some of these building recladdings were elegantly designed and representative of an important time in commercial history. When they still exist today as part of an overall facade design, complete with a contemporary modern shopfront below, they deserve serious evaluation by preservationists.³⁷

Not all mid-century commercial building materials were new in the mid-20th century. Older materials were retooled to create newer modern effects. Starting in the

A Mid-Twentieth Century Storefront Components Guide

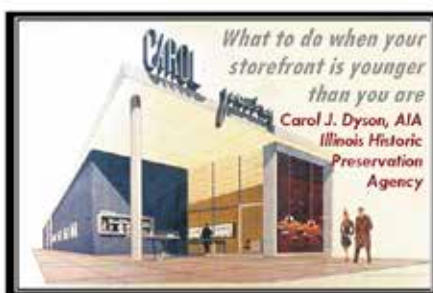


Figure 11: For additional photographs and information about mid-century modern storefront components and materials, along with examples of design solutions, (such as the design for Moxie in Springfield, Illinois, by IHPA designer Anna Margaret Barris, shown right), go to: *How to work with Storefronts of the Mid-Twentieth Century: A Mid-Twentieth Century Storefronts Components Guide* by Carol J. Dyson, posted on the Illinois Historic Preservation Agency's website: www.illinois.gov/iHPA/Preserve/mid-century/Documents/modern-storefront-glossary.pdf

1940s, "natural materials" such as brick, stone and wood show up on commercial structures. The use of these materials was often described as "suburban" or "California style" in contemporary literature."³⁸ Brick veneers, often in blond colors or with darker textured surfaces, were stacked with continuous vertical joints rather than in running bond. Tile, formerly found in storefront bulkheads, now added color, texture and pattern to entire facades. Small, glazed mosaic tile in bright multi-color patterns was used frequently. Wooden walls with rough-sawn siding were often juxtaposed with brick. In the 1950s and 1960s, panelized imitation stone, concrete or tile veneer became affordable alternatives to the natural materials.³⁹

Even in downtowns, the influence of a more casual suburban lifestyle was evident. In 1948, Raymond Loewy Associates designed a new first floor shopfront and interior for the Block & Kuhl Company's downtown Danville, Illinois, furniture store.⁴⁰ The president of Block & Kuhl proudly described the storefront of Tennessee field stone and rough cypress, saying that the building was like a "rambling, but solid looking country club house...(and the) 'California atmosphere' of stone, wood and plants was carried on in the interior."⁴¹

Conclusion

During the 20th century, advances in materials manufacturing, product design and commerce all had a decisive impact on mid-century commercial building design. Although often overlooked today, mid-20th century banks, shops, cinemas and gas stations were often the first example of modernism to reach a city or town. These buildings reflect important developments in style, design, economics and technology that resonated across a new consumer-oriented America.

Unfortunately, many fine examples of these mid-century commercial designs have been demolished or irretrievably remodeled, and many of those that remain are endangered. Although materials such as aluminum, steel, brick, stone and tile, along with plate, structural or spandrel glass, are relatively durable, the bulkhead or sign zone areas of remaining structures may exhibit damage, or materials may look tired from lack of maintenance or changing aesthetics. Inexpensive and convenient new coverings, such as synthetic stucco or vinyl siding, may be as seductive today as elegant slipcovers were forty years ago. Often, the building design intent may not read well due to loss of historic signs.⁴² Distinguished signage, whether over-scaled, in elegant script fonts or brightly lit, were integral to mid-century commercial designs.⁴³ Due to new ownership, changing tastes or cheaper alternatives, most of these distinctive graphic messages have been removed and replaced with inappropriate signage. Thankfully, some communities have

recognized their historic recent-past signs in surveys or even designation.⁴⁴

Commerce by nature must be sensitive to shifts in consumer taste. Just as the desire to have buildings reflect up-to-date styles led to mid-century commercial designs, those same commercial buildings are imperiled by the perception of their being out of step with current styles. The popularity of retro-styled furniture or the *Mad Men* television series has not always led to a fuller appreciation of the built environment. Mid-century modern homes are starting to be recognized and appreciated. However, the same recognition does not seem to inspire public appreciation for many of the commercial buildings of the period.

There are, however, success stories worthy of recognition. In St. Louis, Missouri, the former Phillips 66 gas station, nicknamed the "Flying Saucer," was saved from demolition by a groundswell of popular support.⁴⁵ Twitter and Facebook campaigns helped convince the developer to save the building. Now fully rehabilitated, the saucer houses a popular Starbucks and Chipotle restaurant.

Taste and maintenance issues aside, over fifty years of commercial migration away from city cores has contributed to the under-utilization of commercial historic buildings in downtowns or older suburbs. There is, however, definite progress being made. Historic downtown redevelopment initiatives such as the National Main Street Program are creating encouraging turnarounds for many communities. Some designers and mid-century enthusiasts are trying to grow appreciation for these buildings. The Illinois Historic Preservation Agency's Architecture Section has made available on the web facade designs that work sensitively with mid-century commercial buildings.⁴⁶ Other communities, such as Philadelphia, Tulsa, Los Angeles and St. Louis, have sponsored tours, surveys or designation of their mid-century commercial resources. Surveys can lead to designation, and designation can lead to tax incentives inspiring sensitive renovations. The Flying Saucer in St. Louis was saved from demolition by enthusiastic public support, listed on the National Register and renovated utilizing historic tax credits.

Commercial buildings of the mid-century are symbols of a period of American optimism, economic prosperity, and growth. They represent post-war America's unwavering belief in new technology and materials, and showcase dramatic changes in relationships between consumers and products. It is to be hoped that efforts to recognize and retain these structures will continue to grow.

Endnotes

- 1 Jandl H W, Rehabilitating Historic Storefronts, Preservation Briefs 11, Washington, DC, Technical Preservation Services Division, US Department of the Interior, Washington DC, 1982, 2.
- 2 Mike Jackson's "Storefronts of Tomorrow" paper, is a thorough discussion of American Storefront Design from 1940 to 1970. See Jackson M, Storefronts of Tomorrow: American Storefront Design from 1940 to 1970, In Preserving the Recent Past 2, Slaton D and Foulks W G, Eds. Historic Preservation Education Foundation, National Park Service, and Association for Preservation Technology International, Washington, DC, 2000, 2-57-78.
- 3 Neumann D, The Century's Triumph in Lighting: The Luxor Prism Companies and their Contribution to Early Modern Architecture, Journal of the Society of Architectural Historians, March 1995, 54:1, 24-53.
- 4 Jackson M, Main Street Meets Mid-Century Design, Main Street Now, Chicago, IL, Summer 2014, 6-53.
- 5 Dyson C J and Mansberger F, Structural Glass, Preserving the Recent Past, Slaton D and Shiffer R A, Eds. Historic Preservation Education Foundation, National Park Service, Washington, DC, 1995, IV 87-95.
- 6 Isenberg A, Downtown America: A history of the Place and the People Who Made it: Historical Studies of Urban America. University of Chicago Press, Chicago, 2004.
- 7 Dyson C J and Rubano A, Banking on the Future: Modernism and the Local Bank, In: Preserving the Recent Past 2, ed. Slaton, D and Foulks W G Eds. Historic Preservation Education Foundation, National Park Service, and Association for Preservation Technology International, Washington DC, 2000, 2-43 to 2-56.
- 8 Espardy G, Modernizing Main Street: Architecture and Consumer Culture in the New Deal, University of Chicago Press, Chicago IL, 2008.
- 9 Libbey-Owens-Ford Glass Co., 52 Designs to Modernize Main Street with Glass, Toledo, Libbey-Owens-Ford Glass Co., Ohio: 1935.
- 10 Dyson C J, Structural Glass, In: Twentieth Century building Materials: History and Conservation, Jester T C, Ed. McGraw-Hill Companies, Washington D C, 1995, 200-205.
- 11 Dyson C and Mansberger F.
- 12 Jester T, Porcelain Enamel, In: Twentieth-Century Building Materials: History and Conservation, Jester T C, Ed. McGraw Hill, New York, 1995, 254-261.
- 13 The Formica Insulation Company, Modern & Striking Storefronts with Formica and Bright Metal, Cincinnati OH, c. 1936.
- 14 Espardy G, Modernizing Main Street.
- 15 Gruen V, Ketchum M, Lapidus M, Welch K, Schwartzman D, What Makes a 1940 Store Obsolete?
- 16 ____ Store Fronts of Tomorrow, K. Reid Ed., The New Pencil Points Magazine, Reinhold Publishing Corporation, East Stroudsburg, February 1943, PA, 30-70.
- 17 Simpson P. Cheap, Quick and Easy: Imitative Architectural Materials, 1870-1930, University of Tennessee Press, Knoxville, Tennessee, 1999.
- 18 Gruen V, Ketchum M, Lapidus M, Welch K, Schwartzman D, The Vanishing Store Front, Architectural Forum 1950 , 7, 64-66. Also Ketchum M, Shops & Stores: Revised Edition, Progressive Architecture Library, Reinhold Publishing Corporation, New York, 1957.
- 19 Kawneer Co., Machines for Selling, Niles, MI, 1946, 4.
- 20 Dyson C J, Selling to the Future: Preservation of the Post-War Downtown Commercial Building, In Symposium: Identification, Advocacy and Protection of Post-World War II Heritage, Proceedings of ICOMOS Joint Scientific Committee Meeting, IIT, Chicago, IL, 21-23 June 2007, Kelley S J, and Harboe T G, Eds. Chicago, IL, 2007, 65-113.
- 21 McGrath R, Glass in Architecture and Decoration, The Architectural Press, London, 1961.
- 22 The editors of Architectural Forum, "Trade," *Architectural Forum*, October 1946, 132.
- 23 Kawneer Co., Aluminum Storefronts, Niles, MI, 1960.
- 24 Kelley S J, Aluminum, In: Twentieth-Century Building Materials: History and Conservation, Jester T C, Ed. McGraw Hill, New York, 1995, 47-51.
- 25 Wernick S and Pinner R, The Surface Treatment and Finishing of Aluminum and its Alloys, Clare o' Molesey Ltd, Molesey, Surrey, 1964.
- 26 Ketchum M, Shops & Stores: Revised Edition, Progressive Architecture Library, Reinhold Publishing Corporation, New York, 1957, 133-142.
- 27 Dyson, Selling to the Future, 2007.
- 28 Kawneer Co., Machines for Selling, 1946.
- 29 Dyson, Selling to the Future, 2007.
- 30 Jester T, Porcelain Enamel, In: Twentieth-Century Building Materials: History and Conservation, Jester T C, Ed. McGraw Hill, New York, 1995, 254-261.
- 31 Dyson and Rubano, Banking on the Future, 2000.
- 32 "They Stood in the Rain and Stared...", Advertisement for Mosler Safe Co., *Burroughs Clearing House* 39 (December 1954): 47.
- 33 Dyson and Rubano, Banking on the Future, 2000.
- 34 Leibs C J, Main Street to Miracle Mile: American Roadside Architecture, John Hopkins University Press, Baltimore, 1995, 59-64.
- 35 Dyson and Rubano, Banking on the Future, 2000.
- 36 Rubano A, The Grille Is Gone: The Rise and Fall of Screen Block, In: Preserving the Recent Past 2, ed. Slaton, D and Foulks W G Eds. Historic Preservation Education Foundation, National Park Service and Association for Preservation Technology International, Washington DC, 2000, 3-89-99.

- 37 Dyson C J, How to work with storefronts of the Mid-Twentieth Century: A Mid-Twentieth Century Storefronts Components Guide, published for National Main Street Meeting, Philadelphia, PA, April 2, 2008, published on the web: <https://www.illinois.gov/iHPA/Preserve/mid-century/Documents/modern-storefront-glossary.pdf>.
- 38 ____ Design for Modern Merchandising: Stores, Shopping Centers, Showrooms, F W Dodge Corporation, New York, 1954, 88-96.
- 39 Dyson, How to work with storefronts, 2008.
- 40 ReVeal A, Store that was Inspired by Television, Furniture Age: The National Magazine of the Home Furnishings Industry for 27 years, August 1948, 43.
- 41 Ibid.
- 42 Dyson, Selling to the Future, 2007.
- 43 Treu M, Signs, Streets, and Storefronts, Johns Hopkins University Press, Baltimore, 2012.
- 44 Phillips P H, Sign Controls for Historic Signs, America Planning Association, November 1988.
- 45 Allen M R, Starbucks in a Flying Saucer: STL Preservationists Embrace Modernism, Nextcity, October 4, 2012, <https://nextcity.org/daily/entry/how-two-st.-louis-landmarks-were-spared-the-wrecking-ball> (accessed March 16, 2015).
- 46 Illinois Historic Preservation Agency website has a page dedicated to Mid-Twentieth Century Preservation: <http://www.illinois.gov/iHPA/Preserve/mid-century/Pages/midcentury.aspx>.

LOW, LIGHT AND LIVABLE: FROM MODERN TO RANCH IN ARKANSAS 1945-1970

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Abstract

This paper examines the advent of mid-century modernism and how it resulted in the iconic ranch form in Arkansas during the period from 1945 to 1970. I outline the convergence of Modernism and the popular Ranch form by examining the bureaucratic, social, cultural and economic factors that contributed to significant transformations in domestic architecture. The context looks at the historic international and national architectural foundations of mid-century structures and sociological reasons, such as the Progressive movement, for the widespread acceptance of a dramatically altered house form. I use a mix of books, government documents and mid-century newspaper and magazine articles and advertisements to analyze the human forces behind Modernism and the Ranch. In particular, I follow the contributions of women to the design of the mid-century home through gradual changes in family dynamics and popular culture. Evidence of the impact of women on the house form is gathered from their participation in movements like Better Homes, Inc., Women's Congress and Congress on Better Living. Such movements threw light on the fact that women were influential on house design without actually drawing up plans or being given credit until the 1950s. The solicitation of ideas from the sector of society who spent the most time in the home was key to groundbreaking mid-century architectural and neighborhood planning transformations.

Compatible Styles

The home is where the heart is—and the rumpus room, the carport for the Pontiac Strato Streak, the garden court, the work center and the master bath. Amenities like these marked a mid-century transition in residential design, family dynamics and neighborhood planning. Mid-century homes were more than just a slavish rehash of the tried and true; they were the malleable statement of the post-World War II family.

The metamorphosis to Modern and Ranch-type homes from Craftsman Bungalows (disregard bungalow capitalization) or historic revival styles was groundbreaking. Beginning with the Modernist movement, the styles dramatically impacted architecture from the period just be-

fore World War I and up to three decades after World War II. Several factors influenced the increasing use of modern as a residential style by the mid-1940s. Women entering the workforce or becoming heads of households with fewer children changed the family structure.¹ Other dynamics such as wartime shortages of building materials (which subsequently led to the invention of innovative construction materials), new building techniques, open interior arrangements and popular culture added to a growing acceptance of Modern homes.

Ranch architecture was extolled as the home of choice in 1950s subdivisions as suburban shifts became more frequent for young families. Modern and Ranch co-existed but large-scale developers could see that the Ranch form lent itself more readily to prefabrication and quick construction in large numbers. Government agencies were hesitant to finance Modern houses in the beginning because they were outside the norm. As a result, the Ranch became a prevalent style that was reproduced in many sizes and forms in subdivisions across Arkansas for decades. The Ranch shared architectural characteristics as well as the attitude of Modern architecture and it could be said to have evolved from that style as it quickly overshadowed it. (disregard)

Progressive Space

Precedence for the minimalistic trends of mid-century Modern and Ranch surfaced at the close of the 19th century. The fussiness of the Victorian era was abandoned for simplicity and balance in exterior and interior treatments of homes. Central to this was the comfort of the middle-class family. Previously, the familiar domestic unit adhered to prescribed behavior. The stay-at-home mother under the authority of a hands-off father would serve as supervisor of the children and the house. By 1910, technology and economic growth allowed for a shift in women's roles. Women were exploring new life purposes outside the home. This trend led to the popularity of straightforward architecture with less furniture, fewer rooms and reduced maintenance.

Fresh interior arrangements deleted warrens of rooms with traditional uses and opened the house by eliminating walls. This was progressive space that could be enjoyed by every member of the family without worrying about bric-a-brac and florid furniture. Simplification of

surfaces and furnishings was advocated by sanitarians because microbe-carrying dust particles were partial to the embellishments of Victorian carving and heavy curtains.

During the Progressive era (1880-1920), architects and reformists attacked the large complicated Victorian house. Honesty became a frequent catchword for the new age. This referred to the integrity of man's casual beginnings and a return to a more humble environment in a smaller house (the bungalow) constructed with natural materials and authentic textures. Similar to the tracts of Ranches in the 1950s, neighborhoods of bungalows furthered changes in social conventions. These small homes were considered to be appropriate for young people just beginning their lives. They were not meant to be monuments to the familial line and it was acceptable that ownership changed frequently. Hardy, comfortable spaces and furniture invited the enjoyment and participation of children as active members of the household. These ideals contributed to the popularity of the bungalow form within suburban settings. [Figure 1]



Figure 1: "An Attractive Cottage of the Bungalow Type"

Like the bungalows, mid-century houses in communities with schools, parks and shopping centers were attractive to young newlyweds. Military families were ready to create their independent lives with an up-to-the-minute environment hand-picked from developer's plans. Those plans continued the bungalow trend of including spaces that were appropriate for children. The Servicemen's Readjustment Act enabled veterans to turn their dreams of a new home into realities through federal loans. Suburban movement was also spurred by the trend of the media and architects to promote the traits of healthful environments as well as the Progressive standby—honesty in choosing new home design.

The path to mid-century Modern and Ranch forms could previously be seen in the general architectural elements of the West Coast bungalow. The forms shared characteristics, such as, primarily, a single-story plan under a low roof, wide eaves and a relationship to nature via ribbons of windows that allowed enjoyment of outdoor spaces and natural light. Mid-century homes were inexpensive to build and the interior floor space echoed the new informal relationship of the family with rooms that could be used for many purposes. Light rooms with large glass expanses that revealed private garden areas were also emphasized with "visor" eaves that provided shade.²

The transformation of architecture was facilitated by the automobile, which in turn allowed advanced suburban growth, new technologies, new cultural values and modern family needs. Each was a historic reason for the change in architecture and each dovetailed into the same underlying rationale for building characteristics: function. The population of certain eras looked at their lives and chose the requirements that were pertinent to them.

By the mid-1940s, the facade became less purposeful than the interior. Eventually a grand entry was replaced by the terse punctuation of a severe front door with minimal porch or stoop, windows of linear rectangles and perhaps a nod to variety with combinations of exterior veneer and integrated planters. The interior offered more of a glimpse into the mid-century family relationship via the floor plan, number of rooms, uses for rooms and inventive methods of storage and lighting. Modern and Ranch architecture was comparatively more sparse than the Craftsman bungalow and other earlier styles; however, the selling point of Ranch and mid-century homes was similar in that they offered what the mid-century family needed. For their part, Arkansas developers and home builders conveyed the prevailing needs of the nation. Subdivisions and individual commissions after World War II to 1970 included Modern as well as the wildly popular Ranch examples throughout the state.

Modernism

Events like the Depression and WWII were searing experiences that imposed self-denial. Families began to lighten up with the end of the war and an improved economy. Arkansans welcomed a new philosophy of life when they didn't have to ration or make do with scarce food, resources and possessions. People were encouraged to relax, partake and have fun. The architectural personification of this attitude was American modernism.

The term Modern regarding mid-century architecture was rather amorphous in popular culture. It could be used to describe academic examples of Modernism or to describe any groundbreaking architecture (Ranch included). The Federal Housing Administration's (FHA)

early take on the term referred more to a new way of life revolving around consumerism and updated technology in home furnishing, appliances and utilities. Modernism branched into several subtypes famously manifested in multi-story commercial and institutional structures or for large, high-income residential commissions to the 1970s. The examples that this context considers are the small vernacular or developer-produced forms of Modernism. Often, "contemporary" was used as a description in the mid-century for what could also be included in the modern genre. For those reasons, "Modern" here refers to the most basic form and elements borrowed by the Ranch.

Louis Sullivan and Frank Lloyd Wright famously expressed the philosophy and articulation of the Modern American trend in architecture and its link to the American Progressive social movement. Sullivan and Wright advocated humanism in architecture—designing a building to connect the inhabitants emotionally to the site—not seeking to emulate traditional formalism. The architect was looked upon as an artist with a blank canvas whose craft evolved without input from tradition or client. European Modernists before World War I were influenced by Wright's geometric forms featuring reduced ornament.

European craft did differ though, in that nature and the building site were not considered in the design philosophy. The goal was to create a rational international style that could be grasped by anyone, anywhere. Industrial forms of the architecture and its statement of function used a different vocabulary from the humanists—Internationalism.³

Prefabrication as Modern

The introduction of revolutionary building methods in the mid-century resulted in Modern forms reminiscent of the Bauhaus school and displaying smooth facades and cubic forms. Prefabrication used in home construction was touted as a fast and economic method of building and it soon became wildly popular. World Wars I and II contributed to increased use of prefabrication for war housing, which became acceptable for mainstream residential design. Several companies emerged in the 1930s that marketed pioneering homebuilding products and techniques borrowed from factory processes. These companies partnered with others that produced Modern home products to build demonstration houses to showcase their state of the art lines. Naturally, the homes had to be eye-catching to pique the curiosity of customers, so most settings for display and advertising were in the Modern style.⁴



Figure 2: Tennessee Valley Authority houses

Some prefabricated homes were of traditional design, but the point was speed and economy, which often imitated the lines of Modernism. Homes produced by the US Forest Products Laboratory in 1935 displayed low profiles, flat roofs, corner windows, ribbon windows and simple facades. The Tennessee Valley Authority offered funds for the construction of prefab houses that could be motored to location. The separate pieces of the house, much like today's double-wide trailers, were fitted together on site. When complete, they, too, were decidedly Modern with flat roofs, cantilevered overhangs and high ribbon windows.

In 1935, Robert McLaughlin, Jr. offered the steel and asbestos American Homes, Inc. "Motohome." McLaughlin's flat, steel-roofed houses—initially designed to provide worker housing for miners—were sheathed with modular wall panels on a steel frame. They featured asymmetrical entries and corner casement windows. The Motohome came in twelve models, including a two-story version, and it was introduced at Wanamaker's Department Store in New York City, wrapped in cellophane and tied with a red ribbon.⁵

Similar to the Motohome was the Lustron, which was developed in the mid-1940s. Ranch-type porcelain-enameled steel homes of 1,000 square feet were produced in a factory then transported by tractor trailer to the building site. They were favored by the Truman Administration to ease the WWII housing shortage and were marketed nationwide. The Lustron had low-gabled roofs, asymmetrical entries and large picture windows. Before the company was foreclosed on by the Reconstruction Finance Corporation (RFC) in 1950, 2,500 Lustrons were built nationwide. Arkansas had a few known examples of these in Little Rock, North Little Rock and West Helena; twelve in total were shipped to the state. Reasons for the small numbers and isolated appearance of Lustrons in Arkansas could be the documented hesitation on the part of the FHA to finance

mortgages on out of the ordinary homes and the existence of traditionalist building codes.⁶

Arkansas Modernism

In 1929 the International style hit New York when the Museum of Modern Art launched an exhibit praising Modernism for its aesthetics. The simplicity of the American International style was appealing to clients because of its abstracted format and economical construction. This was in contrast to the European representation of Internationalism as an expression of political ideals or rising technology. The form was articulated in flat roofs, low massing, flush ribbons of windows, unornamented entries and stark stucco veneers.⁷

The International style in Arkansas was largely manifested in commercial buildings but there are a few recorded International residences in the archives of the Arkansas Historic Preservation Program. Local examples include the Justin Matthews House in North Little Rock (NR 12/19/1990), the Werner-Faith-Knoop House in the Hillcrest Historic District, Little Rock (NR 12/18/1990) and the Parker House in Star City (NR 06/02/2000).

Modernism exhibiting Art Deco, Art Moderne and International influences, as well as vernacular interpretations, were popular choices for commercial, institutional and industrial buildings in Arkansas from the late 1940s to 1970. International and basic copies derived from standardized plans could be found stretching along newly-laid highways with suburbs feathering out from the edges. These squat buildings were centered in a pool of asphalt for easy parking.

The earlier Art Deco and Art Moderne were often the result of late- to early 19th-century storefront remodeling projects shouldered on the Main Streets of historic downtowns. In Arkansas, Art Deco was used sparingly on industrial structures like the Stebbins and Roberts Building in Little Rock and the Jackson Cookie Factory in North Little Rock (destroyed). Movie theaters, banks and commercial structures tended to be a little more flamboyant but Arkansas examples were not as exuberant as those found in Miami, Florida or Tulsa, Oklahoma. Many of the Art Deco buildings in the state have been destroyed or, regrettably, altered. The number of Art Deco commercial structures that have been surveyed in Arkansas is higher than Moderne examples, residential and commercial. International forms are scattered throughout various neighborhoods and stand out as lone representatives among more traditional forms.

Mid-century Modern tentatively stepped into Arkansas subdivisions but only a few identified areas contain a concentration of the style. One small grouping is found at Coffeepot Lane in Little Rock. Four homes constructed on a cul-de-sac, circa 1954, offer the gamut of Modern features. The low houses roamed over multiple levels

have rooflines with extensive sheds and large banks of windows, as well as high ribbon and clerestory openings.⁸

The Miramar Subdivision in Pine Bluff, completed in 1952, contains the largest grouping of Modern cottages known in the state. Three curving streets are lined with low-gabled, shed- and flat-roofed homes. These houses are less high-style than the Coffeepot Lane residences and exhibit a repetition of plans typical of tract housing.

High Point subdivision, located on High Drive and West 37th Street in Little Rock, was approved by the Planning Commission in 1950. The homes were constructed circa 1958. The two-street addition features Modern middle-income homes with shed roofs, small clerestory windows and ribbon window configurations designed to take advantage of the views. These small homes are conspicuous among the late 19th- to early 20th-century houses on Martin Luther King Drive (formerly Wolf Street) leading to the addition.⁹

Sierra Madre Drive in North Little Rock features several Modern duplexes built circa 1960 to 1966. Some of the duplexes are built on top of enclosed garages, while others have open carports. It is unknown if the garages were always enclosed or were open as well. Modern features found on the low, front-facing gabled-roofed duplexes are clerestory windows in the pediment and ceiling beams continuing from the interior to the narrow overhang of the roof, which provides shade to the multi-windowed front facade and minimal shelter for the front entries.¹⁰

Sometimes Modern examples were early unique construction in undeveloped areas that were later subdivided and filled with more "normal" styles by developers, which can explain their intrusion into rows of ranches.¹¹ The modular Arnold House in Little Rock is such an example. The flat-roofed house was situated in the country to the west of the city's center in 1950 until development exploded in the area in the late 1960s. Today, it is sited in a small wooded lot surrounded on all sides by shopping centers, subdivisions of Ranches, Split-levels and apartments. A second Modern home to the east of the house was destroyed circa 2010.

Rejection of Mass-Produced Modernism

The reasons for the lack of subdivisions exhibiting Modern architecture were sometimes governmental or cultural, but also practical on the part of the developers. As prefabricated methods of home building became more popular in the late 1940s, building material and appliance industries heavily promoted Modern residential design. Advertising and homebuilder magazines

would showcase their new technologically advanced products within a functionally spare Modern setting. Such promotion techniques were a logical outgrowth of what Americans had learned from the war as far as using progressive products and the confidence they had that postwar life could go nowhere but up.¹² However, it was not always so easy to implement on a large scale.

Adjustment for Nonconformity

Despite the growing attention to Modernism, Mary Gillies of *McCall's* magazine cautioned in her 1945 report "Let's Plan a Peacetime Home" that early functional planning went too far. In her opinion, the move away from the usual led to a trend toward homes that "had beauty only for a surrealist. The neighbors called them 'monstrosities.'" The authoritative Gillies referred to Modern homes as a fad in a national publication.¹³ The spread of these novel residences was also hindered by the fact that local building regulations in many areas did not commonly approve new building techniques or materials. As early as 1936, the FHA addressed the suitability of Modern design. The agency exhibited a degree of tolerance of such houses but left the option open for denial in their technical bulletin *Addressing Modern*. It was noted that FHA Circular No. 2: Property Standards did not contain anything that would outright disqualify homes with Modern design for insurance but they still had to run the gauntlet of risk-rating procedures.

A house might receive a low property rating from the FHA if the design was so far left of "... the norm of acceptable houses, and how greatly such departure is in the direction of public receptivity or anticipated receptivity." Also, architectural inspectors might not be able to divorce their own feelings about the appropriateness of a house style while conducting architectural attractiveness rating assessments. Consideration for adjustment for nonconformity might determine that a Modern house was too nonconformist to fit into an established neighborhood of more traditional design.¹⁴

This circular was released during the popularity of International, Art Deco and Streamline Moderne styles. At that time cantilevered porches, disjointed modules, flying rooflines, monitors and banks of asymmetrical windows had not yet come to the forefront for residential design. The FHA eventually accepted that such architecture was not fleeting and by the end of the 1950s agency standards were updated to give Modern designs at least a chance. However, in the long run, its own uniqueness prevented Modernism from being widely used in subdivisions in many areas. Compared to the Ranch, the number of Modern house forms in Arkansas was definitely on the low side.



Figure 3: Planning for Peacetime

Despite the Usonian

In the mid-1930s, Frank Lloyd Wright advocated that standardization in subdivisions could be avoided through consideration of the climate, use of local materials and involvement of the owner in the design. Developers, however, were interested in speed of construction and quantity at a reasonable cost when they built prefabricated homes for mid-century subdivisions; fitting their designs to the environment or forging an identity with the site and owner was not always possible or economical for the tract developer.

Wright's Modern Usonian designs introduced new technologies and home forms that represented the progression of a dawning era. The reality was that most developments were built by unskilled labor and that the technology was mostly concentrated on appliances and amenities for the interior. The basic rectangle was a cost-saving measure, as was mass purchase and mass assembly. Homebuyers of the mid-century were primarily force-fed the choice of three or four Ranch plans interspersed through the neighborhood. These homes could be quickly built by using prefabrication rooted in traditional building processes. A touch of Modern could be utilized but not to the extent of the Usonian.¹⁵

Cultural Roadblocks

Besides the economic and governmental reasons for the rebuff of Modernism in subdivisions, there were cultural indicators that perpetuated safety in conventional architecture. Even in the movies of the 1950s and 1960s, Modernism and Modern interior design was used to symbolize breaking from the norm—being an outsider. For example, Rock Hudson and Doris Day love stories typically began with the bachelor bad-boy in his Modern apartment, often complete with a remote-controlled fireplace. The usual conclusion to the movie was that, after they were safely married, the love interests ended up in a more customary home, symbolizing permanence. Females characters found in Modern settings were usually portrayed as fringe artist types. As with the male counterparts, these characters were individualized—not, in other words, the average housewife.¹⁶

Homebuilder magazines featured the avant-garde in architecture and interior design in order to sell their products. *American Home* showcased many Modern houses across the United States, but these were primarily designed by the owner or a hired architect on isolated tracts. Similar homes were secluded vacation cottages. The styles were like exotic animals; they were not side by side with hundreds of other similar homes on a cul-de-sac. Modernism was expressed most exuberantly in the 1940s in such magazines until the Ranch caught on.

Liberty Kit Homes and Aladdin Homes also tended to offer the accepted to the masses. Up until circa 1962, Aladdin Homes offered the same low Ranch form with double-hung windows. In that year, houses with a distinctly Modern look were featured, including the Split-level. Clerestory windows, window walls and ceiling beams that followed the ridge line from the outside of the home into the interior were new features. The plans were still basically the low rectangle but the areas of glass were becoming more prominent and forms more varied with L-plans.¹⁷ Yet even these were not a radical break with the prescribed domesticity that neighborhoods characteristically exhibited.

Locally, the realtor sections of the *Arkansas Gazette* and *Arkansas Democrat* primarily stuck with the basic Ranch, which mimicked the WWII cottage and Colonial Revival or Minimal Traditional styling through the 1970s. Higher-income neighborhoods might introduce several spots of Modernism but additions primarily composed of Modern homes were small and few in comparison to Ranch-filled subdivisions.

Arkansas' Modernists

Three Arkansas architects made contributions to the state's Modern movement. Two internationally-known proponents of post-WWII Modernism from Arkansas were

Edward Durrell Stone and Eunine Fay Jones. Stone and Jones, both residing in Fayetteville, were inspired by Frank Lloyd Wright's use of natural materials, modular forms and arrangement of light and place. Both followed his "Organic" movement to produce landmark institutional and residential buildings in the state and across the world. Yandell Johnson was a contemporary of Stone and Jones based in Little Rock, but his work drew from different influences. Nonetheless, the Johnson form was a distinctive example of Modernism in Arkansas.

Edward Durrell Stone

Stone had a field office in Fayetteville, Arkansas from 1955 to 1959. The campus of the University of Arkansas, Fayetteville held Stone commissions that utilized Modern forms. These buildings differed from his Arkansas residential works in his use of contemporary materials and planned landscaping. The 1950 Fine Arts Center's ribbons of windows were shaded by cantilevered concrete awnings. Its core of linear buildings was softened with integrated outdoor areas and an amphitheater. The 1957 married student dormitory Carlson Terrace (destroyed 2005), a group of two-story flat-roofed buildings arranged around a centered courtyard, was designed to introduce a sense of community. The new language of Modernism that celebrated openness and bringing the outdoors in was expressed by Stone in this campus complex. Stone grillwork punctuated by cantilevered concrete block balconies provided privacy and shade while involving the inhabitants with the outdoors. The grillwork was considered by *Architectural Record* to mute the institutional feel that such structures at the time could convey, and were deemed a modern return to ornament by Stone. In 1954, Edward Durrell Stone designed the United States Embassy in New Delhi, which paired his classical training with modern materials.¹⁸

Although Stone rejected the term Modern to identify his work by the late 1950s, his examples in Arkansas exhibit typical characteristics of the form. By that time Stone's work had evolved from the strict International style of the 1930s to long, low structures with horizontal emphasis, window walls and clerestory lighting. Stone's Modern homes in Arkansas—the Felix Smart House in Pine Bluff, the Jay Lewis House in McGehee (NR 01/20/2005) and the Willis Noll House in Fayetteville (NR, 01/20/2005)—reflected Wright's influence in the embrace of the land and natural materials.¹⁹

The commissions Stone received in the mid-1950s were mainly for institutional and commercial structures across the world. However, he returned to Arkansas in the 1960s to execute the 1968 Pine Bluff Civic Center (NR 06/01/05) and the 1969 First National Bank in Hot Springs. The Civic Center was heavily influenced by his United States Embassy and displayed grillwork, colonnades, underground parking and courtyards, as did the embassy. These were Stone's last Modern works in Arkansas.²⁰

Eunine Fay Jones

Eunine Fay Jones' designs were expressed in a different manner than Stone's, but he was also an admirer of Wright's work. Jones used that influence to introduce a similar compatibility with the landscape. Using native materials and expressing functionalism, Jones was able to employ light and the Arkansas Ozark topography to move air and illuminate open floor plans. His earliest works in Fayetteville, such as the Hantz House (NR 11/19/2001), the Adrian Fletcher Residence (NR 5/28/2013) and his own home—the E. Fay and Gus Jones House (NR 4/28/2000)—were unique to the state and the nation at the time. Jones' belief was that he was a success if it looked as though he had collaborated with the earth. But Jones was not averse to tweaking nature when siting a building to ensure that the translation was appropriate. Using this method, the end result was humanistic. Jones' hope was that this interaction would inspire an appreciation for nature on the part of the resident and the viewer.²¹

E. Fay Jones maintained his architectural link to the environment throughout his career and held that the situation of a house should not replace the beauty of a hill top; rather, the house should grow from the hill. In his interaction with potential clients he stated that he examined the effect of nature and geology on the site, then formed what the family needed to accord with the natural space. His larger and more well-known commissions could be considered more decorative than the typical Modern form because of his use of "dripping eaves," custom-designed light fixtures and stabilizing cross-bracing that created tracery effects. However, the ornament on Jones' buildings was not a gratuitous element; it added tensile strength, concealed ductwork or served to fit the structure to the site more efficiently.²²

Jones incorporated overhanging eaves, window walls, chimney walls, clerestory windows, skylights and exposed beams with a signature all his own. These features could be found on low, rambling commissions like Pine Knoll (Little Rock), the Blass House (Little Rock) and Raheen (Fayetteville). Jones' designs are recognizable for his individual execution but his mid-century buildings are unmistakably Modern as well.

Yandell Johnson

Architect Yandell Johnson was less known for using organic influences in his Modern works and his Arkansas buildings were more inspired by the Bauhaus School. Johnson and his wife Mary moved to Jonesboro, Arkansas in 1938. Both were architects and in 1946 the couple started an architectural practice in Little Rock. Their work was described as "ultra-modern." Mary addressed that with her definition of Modernism as "... a state of mind, not an architectural style, and the state of mind can be applied to any preferred type of building."²³

From the mid-1940s to 1978, Johnson designed over 300 residential and commercial structures in the state. Although he could count several traditional Colonial Revival-influenced Ranch designs among his commissions, many displayed International influences. The most notable was the National Old Line Insurance Company in Little Rock. The seven-story office building, constructed in 1955, featured strong lines of ribbon windows topped with continuous cantilevered stone awnings. The awnings and windows wrapped the building, creating a strongly horizontal symmetrical facade broken by vertical elements.²⁴ Johnson's smaller commissions often used cantilevered porch coverings; such was the case in the remodeled first story of his 19th-century office building at 113 East 9th Street in Little Rock; the remodel of Red Crown Cleaners, Cumberland Street in Little Rock (destroyed); and the Murdock Acceptance Corporation on West 6th in Little Rock. His residential designs displayed cantilevered elements as well, adding to the horizontality. Johnson's home at 3325 Lakeview, North Little Rock (remodeled), featured a continuous cantilever that linked rambling flat-roofed modules.

Johnson used windows of varying sizes and styles placed asymmetrically on the same elevation. His favored window type was the awning and it could be found in pairs, multi-paned banks, window walls and short single openings, or he would incorporate them into ribbons placed high on the elevation. Often he used folded rooflines with monitors and projecting eaves with close-set rafter tails that swept upward from shingled elevations. His individual commissions revealed his modern take on architecture, which sometimes translated into a more typical Ranch form. Johnson also collaborated with Jack Bracey of Bralei Homes to contribute small, middle-class houses for Meadowcliff Subdivision in Little Rock. It is unclear if Johnson designed all the homes or just a few in the mid-1950s neighborhood. Meadowcliff features a mix of traditional small Ranch houses with an occasional exaggerated folded gable or shed roof with multi-paned picture windows that look much like Johnson's larger individual commissions.

Yandell Johnson also designed the small homes in the 1952 Miramar Subdivision in Pine Bluff. Streets conjuring idyllic floral motifs such as Jonquil, Iris and Rose are lined with flat-roofed and low, front-gabled Modern cottages. Each home reveals the typical Johnson stamp of varying window types: use of shingle siding and exaggerated shed roof slopes, or flat roofs.²⁵ Yandell Johnson joined two other Arkansas architectural firms after 1966 and retired in 1978. He introduced his modern "state of mind" to Arkansas' built environment through his application of Modern facades to historic buildings and by constructing middle-class mass-produced housing.

Ranch

As the 1950s wore on, the Ranch came to be more prevalent in Arkansas than the Modern style, which was often architect-designed for upper-middle class individuals. High-style Ranch homes emerged nationally in the 1920s and 1930s but these were more expansive and more expensive than the mid-century homes built for the average post-WWII population. Eventually, the influence of Modernism melded with the Ranch in the use of glass and the incorporation of the outdoors with the interior as well as the use of exposed structural elements.

In contrast to Modernism, the Ranch could be translated into small, economical units. These could be quickly constructed by a developer or spread across the division by an architect utilizing the panoply of Ranch characteristics on a small scale. During the Depression, the uncomplicated construction of the Ranch was also embraced by the Farm Security Administration in an effort to provide low-cost housing.²⁶ The origin of the Ranch style is logically linked to the colonial Spanish complexes found in the 19th century Southwest. The climate, available materials and the influence of missions and pueblos led to the well-known 1950s incarnation, which surfaced first in California.

The Hispanic adobe home and the rustic 19th-century farmhouses of California, New Mexico and Texas inspired West Coast architects Charles and Henry Greene in the early 20th century. They produced Craftsman bungalows wrapped around courtyards modeled on the low, casual residences of organic materials historically found in those areas. The popularity of period revival forms in the 1920s and 1930s continued to filter from architecture influenced by Hispanic building traditions.²⁷

The thread between Modernism and Ranch could be seen in the joining of interior and exterior and the manipulation of light sources through cove lighting, skylights, glass walls and a low profile that was linked to the earth. California home designer Cliff May used these elements in his early examples of Ranch homes in the mid-1930s. Author Alan Hess stated that rather than a palette for formalism or an expression of the machine, May's designs were part of a movement to "hospitable modernism." May said his designs were a reaction to the typical "box" with a garage. His plans called for residences that focused on a backyard patio and provided cross-ventilation with spread-out rooms. Such a form was appropriate for the mild weather in California and the use of backyard patios and courtyard entries were almost required on the Ranch because of it.²⁸

The western Ranch form was nebulous, its purpose being easygoing living more so than a prescribed presentation. Even as it spread across the nation and was mass-expressed in developments, several subtypes emerged and in some instances historic architectural influences

were minimally articulated. In Arkansas there was little Hispanic inspiration in the mid-century Ranch house and few displayed an overtly "western" character. By the 1970s, a small number of homes with Ranch characteristics exhibited neo-Hispanic elements like grillwork, arcades and stucco veneer. Most influences were Colonial Revival (also referred to as Traditional in realtor ads) or straightforward minimal with typical picture window, wrought-iron porch posts and integral planters. Some Arkansas Ranch homes in the late 1950s were described as Gallic or French Provincial.

Hess wrote, "The Ranch House reflected a mass taste that cut across social class." Although he was referring to California, Arkansas Ranches also demonstrated that equitable distribution. Early 1950s Little Rock Ranch developments such as Broadmoor and Coolwood were small middle-class examples; but contemporaneously, there were larger Ranch homes built as individual commissions on expansive acreage. [Figure 2] By the mid-1950s to the 1960s, several subdivisions in the Heights of Little Rock, West Little Rock and in the Lakewood area of North Little Rock contained large Ranches. Headlines in the women's sections of local newspapers through the 1950s never let Arkansans forget that the Ranch "... seems here to stay."²⁹

Subdivision growth continued throughout the state in the 1960s but the Ranch seemed to become more compact and developed an identity crisis. The 1962 Parade of Homes included houses built in "Contemporary, Traditional, Cape Cod, French Cottage, Cape Cod/Texas Ranch, Colonial and Transitional," which were all less exuberant takes on the original Ranch form.³⁰



Figure 4: The Broadmoor Development

Mid-Century Government Assistance and Guidelines for Subdivisions

The natural habitat of the Ranch—the subdivision—was not new to the state at the mid-century mark. However, such layouts became synonymous with Ranch and Modern architecture as a result of societal transformations and government, industry and municipal standardization after WWII. Sprawling neighborhoods of homogenous homes were a symbol of progress, sophistication and the attainment of a certain station in life. Families were getting a leg up through increased household incomes. Their new cars were funneling them out of the decaying city centers via improved roadways to the suburbs. Movies, television, advertising and magazines promoted the image of domestic goddess and a professional head of household interacting with children within an efficient symbol of orderly lives—a Modern or Ranch home.

Better Homes in America, Inc.

The explosion of mid-century subdivisions was a continuation of 1920s suburban expansion buoyed by the federal government. Secretary of Commerce, Herbert Hoover encouraged efforts to remedy a dearth of housing stock by using the federal government to stem shortages. With the support of the government, the Architects' Small House Service Bureau, formed in 1921, drew up traditional house plans at a modest price and assisted in classes on do-it-yourself construction projects. Hoover instituted the "Own Your Home" campaign to aid war industry workers in purchasing homes through long-term mortgages. He was also a supporter of the 1923 Better Homes in America, Inc. Program, which sponsored tour houses in rural and urban areas to promote owning and maintaining a home during Better Homes Week.



Figure 5: Better Homes in America Program

In Arkansas, White and Pulaski counties participated in Better Homes Week during the early 1930s. Clytice Ross, county chairwoman and home demonstration agent, filed a report on White County activities in 1931. Ross stated that Little Rock had hosted a Better Homes School. There were County Better Homes Schools as well as District Better Homes Schools that provided ideas for various county campaigns during Better Homes Week. Timely reports from these campaigns resulted in prizes for activities that "...encouraged thrift for home ownership and to help make accessible to all American families homes of beauty, comfort and convenience." Homeowners in Pangburn, Beebe and Searcy took part in tours that showcased landscaping, interior decoration and remodeling projects.³¹

Government assistance eventually moved from encouraging the proper mindset for home ownership to actual involvement in fiscal assistance for potential home buyers. The first steps were taken by Hoover in 1931 when he held the President's Conference on Building and Homeownership. After Roosevelt came to office, the Federal Housing Administration grew out of the National Housing Act. This agency provided low-interest, long-term mortgages to boost the economy. The administration allowed developers to obtain bank loans for subdivision of land and construction of homes, which became a more lucrative process for the developers by the post-WWII era. Technical bulletins distributed by the FHA provided guidelines for subdivisions. The agency recommended in 1939 that developments should reflect a cohesive sense of community that allowed each occupant to take a proprietary interest in maintaining their home. This had the effect of promoting long-term mortgage security.³²

World War II truncated the success of the low-interest mortgage program because of limits on construction and materials. The Veterans Administration's (VA) mortgage guarantee program of 1944 attempted to staunch the WWII housing shortage by eliminating down payments on new homes for veterans. The Housing Act of 1949 provided for safe and adequate construction to create a "suitable" situation for families. This would be overseen by the Housing and Home Finance Agency among other federal agencies.

The Veterans Emergency Housing Program (VEHP), headed by the National Housing Expediter, was organized in 1945. This program ensured that scarce building materials would continue to be routed to middle- and low-cost housing for veterans despite the push for decontrol. By the 1940s, FHA standards included the stipulation that older neighborhoods were not eligible for assistance—a clue to the character and proliferation of mid-century subdivisions outside the city core. The transformation of residential neighborhoods continued into the 1950s despite a sputter in building because of restrictions imposed due to the Korean War. Government aid and the post-war housing need combined to change the way developments were constructed. Developers

didn't just sell lots; they also built the homes, instituting tract housing.

In 1958, the FHA standards were upgraded allowing for homebuilders to choose "modern or 'revolutionary' architectural techniques." Distinctive Modern architecture in comparison to tract housing was usually favored by clients who wanted their homes to reveal their economic or social standing. They were not interested in fitting in and being inconspicuous. Fear of this unorthodox mindset could reasonably be a factor in why the FHA stuck with conservative design and gave Modern buildings low rates on "Adjustment for Conformity." People with those attitudes would hurt mortgage security for everybody. By 1959, houses showcased in the women's section of the *Arkansas Gazette* began to include more innovative designs in Modern forms, but still the numbers did not reach the level of Ranch examples.³³

Federal and Municipal Impact on the Form of Subdivisions

Evolving house styles gave rise to plans and studies by city and federal governments, which dictated the size and physical layout of subdivisions. City planning had emerged in America by 1909 with the formation of the First National Conference on City Planning and the Problems of Congestion in Washington, DC. The planners addressed issues similar to those that are officially named sprawl today, and sought to tackle the problem of tying a sense of community to disparate neighborhoods. The emerging mobility of Americans made street patterns a prominent factor in plans. From the first technical circular produced by the FHA in 1935, the agency advocated for accommodating the natural environment of a proposed subdivision in order for a developer to receive guaranteed mortgage insurance. A monotonous street grid was rejected for a calming conformation to the land. Other patterns that promoted safety, saved money on paving and provided a pleasing setting, were cul-de-sacs, courts and lanes separated by grassy medians. Such arrangements became typical of early mid-century neighborhoods in Arkansas and were easy to accomplish given the hilly land over the majority of the state. Thus, in addition to being a concession to government assistance, the shape of Arkansas' suburbs was easily dictated by natural features.³⁴

Most of the residential expansion in central Arkansas followed the typical grid pattern until the introduction of Progressive ideals. The Hillcrest, Prospect Terrace, Edgewood, Cliffwood, Shadowlawn and Capitol View neighborhoods of Little Rock reflected this with their curving lanes that followed the lay of the land. Midland

Hills Addition, established in Hillcrest at the turn of the century, was the first area in Little Rock to utilize such patterns. Edgemont's Skyline Drive in Park Hill, North Little Rock also meanders along a hilltop in an irregular path above I-40.³⁵ Burgeoning subdivision development in the 1950s took full advantage of the sinuous road pattern and it was a standard feature in that decade.

The Amorphous Subdivision Lot

In the 1940s the typical shape of lots in subdivisions was being altered as neighborhoods evolved from checkerboard road plans. Narrow lots were historically favored for putting distance between outbuildings and the house. The lot orientation began to change as the backyard became a focal point of the home and the desire for more privacy led to new planning methods.³⁶

The lot size for homes in the 1907 Wat Worthen Addition of Little Rock was 45 feet wide by approximately 150 feet long. By 1942, Cammack Woods Addition was offering lots at 50 feet by 145 feet. In 1950, the Little Rock City Planning Commission revised its regulations for the first time since 1939. The commission regulated that lot widths were to be 60 feet and should not contain less than 6,000 square feet. In that year, the Coolwood Addition plat map showed that lots were between 60 and 70 feet wide. The irregular contours of the addition, which is situated at the bottom of a hill, provided for lot depths of 117 to 301 feet. The upper-income Scenic Heights subdivision, established in 1950, featured some lot widths up to 142 feet.³⁷ An increase in lot sizes made it easier to comfortably construct the wider Ranch home with a carport. In comparison to Coolwood, the homes in Scenic Heights are wider and would be considered high-style examples of the Ranch.

The Car

Discussion of the Ranch or Modern subdivision cannot exclude the automobile. Roads that made life simpler in the subdivision by calming traffic were amped up for feeder routes in order to move cars to suburbia faster. After World War II, the car was proclaimed a necessity of life by the Bureau of Labor Statistics.³⁸ No other method of transportation contributed as much to the growth of homebuilding and symbiotic links of commercial strips on former farmland. The car is synonymous with not just the movement of neighborhoods, but also with new forms of housing and new cultural forms of family life. Road building and upgrading projects kickstarted the advancement.

The Arkansas Highway Commission managed to amass funds for desperately needed road improvements by 1941; however, WWII resulted in the Defense Highway Act. Road building in Arkansas during the war was con-

tained to access roads for war-related industries or training facilities. Improvements were bumped up after the war when Governor Sid McMath pushed for a general obligation bond issue to boost highway maintenance and construction, but the state continued to lag behind the national average. Although promises to the public regarding a highway construction program did not meet expectations, McMath did get 1,458 miles of road paved by 1952. Construction of the state's interstate highway system was started in that year and Arkansas began to shake off the doldrums of lackluster industrial development. The National System of Interstate and Defense Highways of 1956 and the Arkansas Highway Commission's "Critical Inventory of the State Highway System," provided funds for access highways. Improved roads contributed to the growth of rural areas ripe for residential and industrial growth.³⁹

The Auto and the Shopping Center

Roads and cars began the process of suctioning life from the city core to cheaper, more plentiful land. Arch Booth of the 1956 National Chamber of Commerce attributed the stretch of subdivisions to "motorization" and electricity for "mechanical servants." Booth noted the natural progression of stores and office buildings following residential construction. Such development flourished because of campus-like landscaping on ample land and free parking right at the door. His concern for the diaspora of business from the city was countered by his advocacy of urban renewal—"clearing structures that block progress." The solution was auto-centric. To keep up, said Booth, downtowns must oblige the automobile and provide attached parking and drive-in facilities.⁴⁰ In the end, efforts to become one with the auto were not enough to break the link between suburbanites and the movement of residential and commercial cores.

In 1957, *Redbook* magazine encouraged "living by the automobile in the age of the pushbutton." The magazine sponsored promotions called "Easy Living" and "Happy Go Buy It" to young suburban residents. Shopping centers were vibrant and used youthful, multi-colored schemes. Some provided nurseries and activities for kids so unfettered parents could easily acquire goods to fill their cars.⁴¹

The American Planning and Civic Association held a conference in Little Rock in 1957 on the revamping and maintenance of downtown shopping areas, although several shopping centers were in the works on the peripheries of Little Rock. Victor Gruen, the keynote speaker, prophetically warned that "hordes of mechanical monsters" were contributing to the downfall of Main Street.⁴² Little Rock's downtown planners were not quite ready to accept the progressive method of scaling for humans in landscaping and architecture to resuscitate downtown. They plunged into the spirit of catering to the car.



Figure 6: Louisiana Street Parking Deck

The 1957 opening of a parking deck at Fourth and Louisiana streets in Little Rock was marked by a foreign sports car parade and flowers for female drivers. It made the newspaper when a second parking deck with drive-in facilities for Worthen Bank on Main Street was built the next month. Downtown Little Rock was not ready to succumb just yet, but the propagation of modern shopping centers would not be checked.⁴³

Early note was made of construction on a 1955 shopping center in southwest Little Rock. The center was close to a new industrial development complex and the Meadowcliff, Rolling Hills and Sunset additions were nearby. Plans for the Village Shopping Center in Little Rock, at the intersection of the new US 67-70 highway, were also documented in 1955.⁴⁴ The 1956 Town and Country Shopping Center was described as the "first integrated shopping center with all the stores under one roof." This center was also located at the intersection of US 67-70 and was less than a mile from the burgeoning Broadmoor neighborhood.⁴⁵

The *Arkansas Gazette* proclaimed 1959 the year of the shopping center for Little Rock. The construction of Park Plaza Shopping Center and a center in Pine Bluff with the Arkansas-based Gus Blass Company store as an anchor were publicized in the late 1950s. This was the first time Blass

had moved outside of downtown Little Rock since its early 19th-century inception. Store officials felt that their original locations still had enough potential to control commerce so expansion would necessarily have to be outside of the metropolitan area. Although the merchants resisted it, this was a sign that the tendrils of suburbanism were beginning to tear at Little Rock's Main Street. The large Little Rock department stores managed to barely maintain their downtown locations through the 1980s when Main Street commerce stalled for several decades.⁴⁶

University Avenue (then known as Hayes Street) was still a dirt road circa 1954, but road improvements were enabling developers like Elbert Fausett and Jack Bracey to entice families to their massive subdivisions, Broadmoor and Meadowcliff. The increasingly active developers knew that the national trend of bringing goods to the people would work in Little Rock and also would encourage home sales. Fausett was responsible for the construction of the EZ Center on Hayes Street at the entrance to Broadmoor and he also developed the Park Plaza Shopping Center north of Broadmoor on Hayes. Hayes Street was becoming the new Main Street. The *Arkansas Gazette* reported in 1958 that, "At all of these developments, provisions are being made in advance to insure plenty of parking space—something not taken into consideration in development of the downtown area...The shopping centers will provide stiff competition for downtown stores."⁴⁷

The design of the twenty-acre Park Plaza Shopping Center and its 1,870-slot parking lot was a new wave in commercial architecture. The parking lot was planned to eliminate traversing busy intersections and customers never had to walk more than a block from their cars to get to the center. In addition, covered walkways protected them from inclement weather. Consumers could easily get to the center via "mechanical monsters" on a wide, paved thoroughfare but they could be parked within a comfortable distance of a collection of stores in a condensed area.⁴⁸ The lure of piped-in music and the soothing fountains in the courtyards of a modern shopping center became irresistible to Arkansas suburbanites. Soon, an associated shopping center became an expected feature of new development.

Role of Women in Mid-Century Home Design

By the middle of the century, American women were becoming more active outside the home but the roles of housekeeper and caregiver were still traditionally attributed to mother. The average age of married women fell from twenty-two to twenty in 1953. The birth rate rose and the wartime stacking of multiple family members in an apartment or single home was reduced to an av-

erage of fewer than five people in the nuclear family. Before World War II, the number of women in the American labor force was 10,752,000. By 1950 it had risen to 18,369,000. The social upheavals of the 1960s helped women up their entry into the workforce and by 1970 there were 31,543,000 working women. The percentage of women in the labor force with children under eighteen in 1955 stood at 27%, a level that incrementally increased to 35% in 1965 and 47.4% by 1975.⁴⁹

Family spending jumped with the increase in income provided by working mothers. The growing number of families purchasing single-family homes fueled consumerism. Even though more women were working, merchandisers knew that home was still the domain of the female. Cultural documentation of the mid-century reflected that women were the force behind housing styles and needs.

Advertisements in *American Home* magazine from the 1940s through 1970 were significantly geared toward women. Every Sunday, the *Arkansas Gazette* women's section would feature a new home with photos of the interiors. The woman of the house was always photographed alone in the living room or the kids would be posed in their bedrooms; typically, dad was nowhere to be found.

By World War II, the opinions of women on house needs and forms were increasingly sought after. In 1944, *McCall's* magazine held contests for war bonds that resulted in 4 reports: "What Women Want in their Living Rooms of Tomorrow," "What Women Want in their Dining Rooms of Tomorrow," "What Women Want in their Kitchens of Tomorrow" and "What Women Want in their Bedrooms of Tomorrow." [Figure 3] The last report included statistics on what kind of house the participants would like to build or buy. The choices were Traditional and Modern. Out of the 10,848 contestants, 4,432 indicated that they would be building or buying a home. Two-thousand-forty-six people of that group stated that they wanted to have a Modern home built to order, rather than a Traditional one. As for interiors, the Modern camp preferred corner windows, built-in storage, uncluttered rooms that were easier to clean and a balance of masculine and feminine decor—all traits that were typical of Modern homes and eventually the Ranch.⁵⁰

Science began to back up the influence of women on architecture, even if it didn't stray far from the accepted opinion of their place in society. The University of Michigan undertook a 1947 study on the sociological impact of house size and space arrangements. The goal was to determine the level at which a house became unhealthy and unsatisfactory for family life. A main concern was how large the house could be before the housewife became fatigued while working outside the home and caring for children. Cost per room and the amount of housework needed to maintain them were benchmarks.⁵¹



Figure 7: What Women Want in their Bedrooms of Tomorrow, McCall's

Women's Congress

The passive role of women as markers of housing trends evolved to actual implementation of female ideas and needs in house design. In 1956, the Housing and Home Finance Agency hosted 103 women in Washington, DC for a Women's Congress. They were asked to offer their thoughts on single-family home design for the interior and exterior.

The congress allowed women to relate what they thought builders and architects were doing wrong in design. Their contributions were applied to three "dream homes" constructed in 1956 in the "ideal mid-America location" of Munster, Indiana. The majority of the participants in the congress expressed a preference for single-story homes but a split-level was also constructed in the White Oak Manor division of Munster. Fifty-nine features included in each house expressed what the women felt would make life psychologically, economically and strategically better. Their thoughts were validated by a total of 3,500 people who came from across America to view and tour the homes.

All of these features were enveloped in Ranch-style forms and expressed the new tenets of mid-century life, including efficient use of space, open forms and segregated public/private and adult/children areas. While the interiors were considered cutting edge, the exteriors were reported as presenting nothing new beyond the standard Ranch, "...built around activities and family values, rather than pretty architecture."⁵²

McCall's Congress on Better Living

The successor to the Women's Congress was McCall's 1957 Congress on Better Living. Again, women convened in Washington. The expectations of 100 women for the exterior of the home had evolved from acceptance of the usual. Despite a trend toward individuality, however, most still wanted a home that conformed to the neighborhood image—nothing "flashy" (perhaps a code word for ultra-modern). The agenda of the representatives remained design for comfort, but a new outreach tool was the awarding of congressional certificates to builders for "excellence of design" and "ease of living."⁵³

The opinions and solicited ideas of women were significant in the form of the mid-century house. As they gained more traction in society their vocabulary for living shaped the interiors in particular, which subsequently influenced the exteriors. The hand of the woman continued to shape the house through the 1970s, as evidenced by the home magazines that enduringly appealed to females with articles and advertising. In the 1960s and 1970s, many schools of architecture set mandated female enrollment levels at 50%. Women served as faculty, took places in private architectural practices and often teamed with their husbands professionally as the mid-century wore on. So the perspective and the actual role of the woman in design trends became a dominant factor in the form of the Ranch in particular.⁵⁴

Modern and Ranch Forms from the Inside Out

The Modern and Ranch were the thinking man's dwellings. In the mid-century, society had changed so drastically that shelter began to come alive, taking on a vibrant personality that stretched out of the traditional boundaries of architecture. The home was always the calling card of status and family. By the 1950s it truly projected the honesty of the Progressives as the face of the family and the neighborhood. Part of this honesty was the characteristic of individuality. The findings of the 1956 Women's Congress on Housing ultimately concluded that there was no across-the-board arrangement for every family.⁵⁵ This was a sign of the loosening of societal strictures. New configurations, room sizes and modern technology were cultural indicators that revealed the characteristics of the mid-century family. These features contributed to changing conclusions about neighborhoods and the roles of family members.

Efficiency, Efficiency, Efficiency

Informal, convenience, easygoing, efficiency, livability—these were catchwords used in realtor ads and home magazines to describe the Ranch phenomenon. Cliff May's theory was that the Ranch home should be easy to traverse. The open flow of the house should be unencumbered with steps and the outdoor areas should be on a plane with the house. This was the California ethos that came to represent the informal character of the mid-century family through a throwback to "the careless aristocratic air of the old ranchos."⁵⁶ Ranch and Modern houses in Arkansas could present informality through a single-story form from the street, but often a basement level was concealed by the hills of the subdivisions.

Yandell Johnson's wife stated in 1952 that women were inherently lazy; therefore, movement through the house should stem from a single central hallway. Open rooms radiating from the hall would provide an efficient circulation pattern for the busy woman.⁵⁷ Some forms of Modern could be multi-level, but the movement of interior space was free and not confined by steep enclosed staircases or dark hallways. Loft areas and use of window walls gave mid-century Modernism a relaxed quality.

The mid-century house was metamorphosed by the family but in some instances the house could be said to have altered them. During WWII, couples were encouraged to start dream books for their new homes. In 1945, *McCall's* magazine counseled that couples should not decide on the architecture of their home first, but rather take the "modern, scientific" route and start with the inside.⁵⁸

Growing mid-century families called for adaptability, beginning with the interior footage. The 1947 Levittown homes were very small but they included attics that could be finished out later as needed.⁵⁹ Rooms could be simply transformed for different uses through a new furniture arrangement rather than remain chained to a single function. It was easier to introduce changes to rooms in a single-story home such as the small Modern and Ranch because the added complication of a second story was eliminated.⁶⁰ That possibility of expansion invited young families to embrace the expanding tract home environment and also led to the acceptance of less ornate exteriors as the inside was now the nexus and character of the family.

The Society of the Mid-Century House

The seemingly primary location of mom—the kitchen—was evolving as a consequence of women's new roles in the family and the world. Home building and decorating magazines heavily emphasized the design of the kitchen. In 1953, author Robert Woods Kennedy stated, "The housewife cannot be expected to enjoy cooking as long as it is thought of and expressed as a duty which interferes with life. It must be a part, an important part, of life itself."⁶¹

Architectural Record had suggested in 1949 that the absence of servants and the access of guests to the kitchen dictated that it be divorced from its reputation as a room for drudgery. It should be a center for family and social life, perhaps by combining it with the dining room or living room.⁶² Mom was at the helm of the kitchen and in a mid-century floor plan she could participate actively in home life while still getting the job done. Pass-throughs and strategically placed windows allowing for supervision of the kids as well as juxtaposition to a family room or living room gave the kitchen the new designation—"work center" or "living kitchen."⁶³

The kitchen figured into the early supervision needs of children in that an open plan and windows on the yard allowed mothers to keep an eye on their kids in any situation. In the mid-century, more consideration was being given to the mental development of children. As they grew, it became important to provide bedrooms for each child as well as informal family rooms. This allowed children and teens to learn from their interactions with adults and visitors in the family room then take what they had learned to their bedrooms. There, they could be their own individuals but they could practice responsibilities and respect learned from exchanges in the family room.

The women who participated in the Women's Congress on Housing felt that the bedrooms should be separated from the family areas for quiet and privacy. Separating bedrooms from the public rooms had long been done with two-story homes but the rectangular single-story Ranch or Modern lent itself to creating "active zones" and "quiet zones." The parents' bedroom or the master bedroom with associated master bath emerged in larger homes. The adult area usually included the formal living room, which created a space for dad to get away from the kids after a long day at work and allowed for adult interaction between the parents.⁶⁴ These configurations emerged because of the economic sensibility of the mid-century house and the expression of the family dynamic. There was no wasted space and every inch of the house had an everyday use so there was no superfluous nook or cranny.

Why Sizzle While You Watch TV?

The withdrawal of the family into their homes because of technological progressions such as air conditioning and the television set shaped exterior architecture and interior space in the mid-century. Air conditioning had been used in industrial and commercial settings during WWII. As the blue collar sector grew, people weren't happy about coming home to a sweat box after spending the day in a cooled office.⁶⁵ Family life became more insular because of these modern amenities. There was a diaspora from the porch and public interior spaces were increasingly oriented toward the backyard, which was sheltered from the public via various methods.

Window units for the home were must-have items in Arkansas by 1953. This coincided with mushrooming residential development and change in the house form. Design of the air-conditioned home utilized the old technique of alignment on the lot, which was not new but had become more pertinent by the early 1950s. Many builders moved large window openings to the north or south elevation. In Ranch or Modern plans, a picture window or sliding glass door in these spaces was ideally situated toward a private landscaped backyard.

Windows on the west and east could be eliminated because air conditioning did away with the need for cross-ventilation. This meant that fenestration could also be moved higher in the wall or placed away from the center of the elevation because it wasn't needed for anything but light. High, asymmetrical windows contributed to mid-century privacy in bedrooms and bathrooms.⁶⁶ Living rooms with sliding glass doors or window walls could have a dual purpose as rear porches or indoor rooms because of air conditioning. Entire walls could be composed of glass. Of course, the Arkansas summer sun could be brutal even with cooled air. The popular and characteristic solution of incorporating a hood or cantilevered porch over these areas was suitable for mid-century homes in the state.⁶⁷

Statistics showed that, by 1954, eight of ten people with air units tended to stay home more. Air conditioning was said to contribute to a decline in movie attendance and fewer visits to parks, pools and the countryside, resulting in more opportunities for home entertaining and home-cooked meals.⁶⁸ It wasn't just mom who was staying at home; families were retreating en masse from the public realm.



Figure 8: "Televiewing"

As early as 1950, architects were faced with the accommodation of the television set. Housing and Home Finance Agency director Dr. Richard Ratcliff cited the findings of research done in collaboration with various agencies regarding the effect of the television on home life. He felt that the television was disruptive to others in the family and he suggested that the findings would indicate the creation of a new room for the sole purpose of television viewing.⁶⁹ Little Rock received its first TV station in 1953. An avalanche of information regarding television poured forth in the state's newspapers. Among the TV set advertisements and technical articles, a complicated guide to appropriate furniture arrangement was published in the 1953 *Arkansas Democrat*. Consideration for lighting, "televiewing" distance to combat eye-fatigue, placement of lamps and manipulation of blinds for best illumination were covered. Of course, any seldom-used room could be converted to a televiewing room, but accommodations could also be included in new construction.⁷⁰ A family room, also known as a rum-pus room, could be devoted entirely to the noisy pastime of TV or children's recreation. An adaptable home would be more amenable to the creation of a space devoted to society's modern needs.

The extensive change in leisure-time activities due to the television were reported to have been instrumental in the closing of movie theaters in Arkansas. The Juroy in North Little Rock was one of nine theaters that had closed within the three years prior to 1957. The trend was attributed to the impact of television as well as air conditioning.⁷¹ Both were major factors in the shape and presentation of the mid-century home. They were also a factor in how the family changed in its interactions with the community in order to embrace them.

Turning Your Back to the World

The mid-century home was increasingly becoming more of a retreat. The outlook of the family that the facade should indicate its social standing had been abandoned and architecture of the time was often described as having no back or front. Money was better spent on the interior and, as *House Beautiful* stated in 1948, houses should be "...good for us to live in, rather than look imposing for others." The magazine reported that the luxury of the inside was disguised by austere exterior styling and families should plan "...to gain the advantages of turning your back to the world."⁷²

These new attitudes led to major changes to the facade of the home. The front porch as a significant area for interaction shrank or was relegated to the back yard. A trend toward the presentation of a less ornate and less welcoming facade was the result of what *House Beautiful* called the "impersonal and noncommittal" house.⁷³ Restrictions on access were carried to the interior. Beginning at the principal entrance, small foyer areas with trellises or half-walls served to retain delivery men or un-

invited visitors before they were granted a pass into the family space. The backyard and privacy of the area were prominently mentioned in the women's pages of the *Arkansas Gazette* and *Arkansas Democrat*.

As people concurrently rejected the licentiousness of the street, they ironically began embracing the outdoors, just not the part that could be seen from the street. The extensive use of glass at the rear of the home served to bring the outdoors in, but it was outdoors on the terms of the homeowner. Nature was overpowered by graveling or paving to provide a patio, offering the illusion that the house and yard were a continuous space. The catchphrase of home magazines in the early 1950s for the marrying of those spaces was "outdoor living room." [Figure 4] Fay Jones used this system extensively by flooring interior spaces with flagstone that continued uninterrupted through window walls to outdoor patios.



Figure 9: The "outdoor living room"

The commissions that Jones received were primarily in the scenic Arkansas Ozarks with large wooded lots. Most subdivisions in the state did not provide the extensive acreage or hillside situations that would make for exclusive backyard living. Close set houses on small lots meant that the neighbors could be part of family time in the yard whether they were invited or not. Devices such as fencing, plantings, screens, end walls and solid walls provided privacy for outdoor activities.⁷⁴ Some houses included an inner court open to the sky and wrapped completely by the interior walls. This space was not seen as often in Arkansas as the screened porch, a favored element of Yandell Johnson, who used it on his own home in Lakewood.⁷⁵ In Arkansas, most lower- to middle-income subdivisions developed in bulk did not

include an elaborate patio area with BBQ grill, terracing and landscaping. However, a sliding glass door, wildly popular in the 1960s, could provide the proper portal to the yard and perhaps a small concrete pad.

Planning for those private areas to the rear of the home meant that the placement of the garage needed to be considered. Garage spaces in a front wing took up footage for the yard because they placed the house farther back on the lot. The solution was to make the garage or carport contiguous with the front facade. This method of building can be seen principally in Arkansas subdivisions built for middle-class customers, rather than the higher-income neighborhoods with larger lot lines.⁷⁶ The more expensive homes were more of the rambler style and could include a front-facing ell to provide a garage.

The Cul-de-Sacs of Arkansas

The trendy form of the Modern and Ranch home became popular in Arkansas subdivisions by 1951. In the early 1950s, Little Rock and North Little Rock grew outward from historic central areas by the Arkansas River. Subdivisions in Little Rock were being built in large numbers in the 1950s despite a decline in state population, which had begun in the 1940s. Little Rock's population did not fall during that period, but its growth rate was the lowest it had been since the early 20th century. Increase continued at a sluggish rate into 1960 but between then and 1970 there was a rise in the city of 24,670 people.⁷⁷

During World War II, the Little Rock Chamber of Commerce actively planned for job creation to occupy the state's veterans and war workers at the end of the conflict. After the war, the city recognized that further industry expansion was critical. Improvements that assisted the state and the city in job formation were updates to the Little Rock airport and the construction of US Interstate 30, the McClellan-Kerr Arkansas River Navigation System and the Little Rock Port Authority. In the mid-1950s, the Little Rock Industrial District was also completed and the 1955 Little Rock Air Force Base in Jacksonville contributed mightily to the economy.⁷⁸

An expansion of Little Rock's city limits five miles in each cardinal direction was advocated by a new county planning code in 1952. Larger boundaries and industrial expansion were aided by modern roads and upgrades. In that year, Pulaski County Judge Arch Campbell built Hayes Street (now University Avenue), facilitating a north-south connection between Arkansas Highway 10 and Asher Avenue, or State Highway 5. It was paved in increments, the second phase in 1955. Campbell was credited with paving about 200 miles of road in the county by 1959.⁷⁹ In that year, other road projects in-

cluded the construction of expressways, road widening and extensions.

By the late 1940s the confidence of American developers swelled because government financing programs made their jobs more lucrative. In Arkansas it had become easier to obtain GI loans; 13,840 veterans were funded for new homes or improvements by 1949. The building industry felt that the imminent end of rent control had an influence on the higher numbers of new construction. The increase in mortgage funds from the Federal National Mortgage Association, the openness of private investors to honor the 4% interest rate on mortgages and the availability of low-priced houses were also cited as reasons more people were buying homes.⁸⁰

Optimism characterized the news about construction in Arkansas. The *Arkansas Democrat* reported in 1950 that the \$7 million dollar mark had been reached in new construction within the first five months of the year. Despite a slow start because of a shortage of mortgage money, in 1954 home construction eventually reached 92% above totals for 1953. Figures for 1955 showed that new home building in Arkansas had reached the highest level since 1950.⁸¹ The population of Arkansas grew in the decade between 1960 and 1970 by 8%, an increase of 137,000. The central area of the state—Little Rock, North Little Rock and Pine Bluff—increased in population by 19%; however, much of this rise was attributed to annexation. Housing units statewide increased by 15%. Although this total included multi-family homes, it was affirmation that the central downtown areas of Little Rock and North Little Rock had suffered from the movement to new western and southwestern subdivisions. The 1960s through the 1980s were the worst years for historic downtowns in Arkansas because associated goods and services followed the neighborhoods.⁸² Nationally, the FHA encouraged suburban growth over urban density, which played right into the hands of the state's developers. This led to a trend of developer-built homes, which brought in a higher profit and resulted in larger numbers of houses being built within additions.⁸³

Local and national dynamics made it easier for developers to market their single-family homes and from 1950 through the 1960s they took full advantage. The Little Rock City Planning Commission approved sixteen subdivisions in 1950 and twenty-seven in 1959.⁸⁴ During the boom years of the early 1950s for construction, Little Rock spread west and southwest while North Little Rock extended north and northwest toward the new air force base.⁸⁵

How to Sell a Ranch

Home-shopping was an event in mid-century Little Rock. The annual Parade of Homes, sponsored by the Arkansas Home Builders Association, began in Little Rock in 1952. Twelve houses were presented at the parade,

which was attended by 30,000 people over the period of a week. Attendees could use the tour to help them make decisions on building products, technological advances and housing styles that would be most appropriate for their families. The decision on which houses to feature fell to an American Institute of Architects committee that reviewed plans presented by Pulaski County builders.⁸⁶ The homes were mapped in the newspapers in their respective subdivisions, which became gradually more widespread.

Such a sales system was new in the mid-century and the Parade of Homes was an expansion of the groundbreaking model home method. A landscaped, furnished house with the hottest conveniences was advertised as an example of a new subdivision's offerings. Once a family made the trip to look it over then returned home, the comparison served to make them see their current house as rather scruffy. The earlier Kingwood addition of Little Rock had used that sales practice in 1951 as soon as a complete home could be built.⁸⁷ Home building shows such as the "Comparearama" at the Barton Coliseum in Little Rock featured home building vendors. The need for replacement housing was hammered into the public's mind through the mid-century via the parades and various trade shows despite the end of the housing shortage. The building of enthusiasm and the presentation of a perceived need was used efficiently by Arkansas' developers.

The most widely publicized developments containing Ranch and Modern examples in the early 1950s were Coolwood, Cloverdale, Meadowcliff and Broadmoor in Little Rock and Lakewood in North Little Rock. These were not the earliest of such neighborhoods, but they were planned and promoted by astute businessmen who managed to get attention-grabbing articles and advertisements in the local newspapers.

Mid-century builders began to plan entire neighborhoods. They built the homes rather than selling the lots and leaving the design up to the customer. This was considered a plus because it removed the possibility that someone would build a home next door that would detract from the neighborhood and lower property values.⁸⁸ The inclusion of churches, schools, playgrounds and shopping centers became expected resources within developments. Community planning took on new meaning as cities became divided into small villages linked by high-speed roadways.

You Can Really Live in Coolwood

Some Arkansas developers got their names in the paper on a regular basis, but none more often than Elbert Lion Fausett. Fausett had started out as a Ford dealer and was a car collector and racer, legislator, publisher-printer and used car salesman before becoming a nationally known builder. Fausett was the first realtor to

utilize extensive advertising in the form of print, radio, bus benches and billboards. Among the state's most prolific developers, by 1954 he had built twelve subdivisions and had branched into Faulkner and Saline counties.⁸⁹

Fausett was best known for the early 1950s Little Rock subdivisions Coolwood and Broadmoor. Both were built to attract middle-income customers, which was another first for Fausett, since low-income families had long been the target of Arkansas builders. Fausett and Company advertised Coolwood in 1951, its name probably attributed to its location at the base of a hill that allowed breezes from the nearby Arkansas River to circulate. Arkansas Highway 10 or Cantrell Road made it a five-minute car ride from Main Street to the addition.⁹⁰

Coolwood was a small development of forty-seven houses with room for a business section. Unlike Fausett's later Broadmoor and College Terrace divisions, Coolwood did not include related resources like parks and schools but it was comprised of the latest in the small Ranch style. Coolwood homes were veneered in combinations of brick and horizontal or vertical siding. Some were all-brick with vertical siding underneath the carport. Only a few of the houses were built with enclosed garages. Fausett's advertisements stated that every home was different. He also appealed to the woman of the house by stating, "There are scores of features that women like..."⁹¹

The random placement and size of windows was not used by Fausett in this addition; he stuck with two-over-two horizontal double-hung openings. Some of the houses were built with picture windows flanked by double-hungs or pairs of windows emulating the picture window form. Front porches were small and wrought-iron was a common support for porches and carports. While the Kingwood and Queen Manor subdivisions to the west of Coolwood held what could be considered true Ranches by 1951, Coolwood houses were more transitional Ranches. They had the long and low profile of a Ranch, hipped roofs and carports, but they were more compact than the "high-style" Ranch. They had not strayed very far from the Minimal-Traditional WWII cottage.

Light-hearted Living in Broadmoor

Fausett's most ambitious residential development was Broadmoor in Little Rock. Fausett purchased the property on Hayes Street for the addition in 1953. Prior to development it had been the hunting land of Raymond Rebsamen and it included a small lake and a log lodge. Originally outside the city limits, it was annexed into Little Rock in 1957. When Fausett was through with it, Broadmoor covered 190 acres, had seven miles of paved road and contained 553 homes. He also installed a swimming beach for the lake and a shopping center with a "buffer zone" for church construction. By 1955, a

kindergarten was dedicated. An elementary school was built south of Broadmoor and an associated junior high school opened in 1956.⁹²

Broadmoor was ideally situated because it was across Hayes Street from Little Rock Junior College (University of Arkansas at Little Rock), was just east of Boyle Park and was a short distance to US Highway 70, the "Broadway of America." Hayes Street at the time was considered to be a scenic route as it was lined with wooded expanses and very little development. This was a subdivision that could hardly fail with all it had going for it.

The Broadmoor neighborhood was publicized as the largest subdivision in the state from 1953 to 1955. It was also advertised as the only subdivision with "year-'round air-conditioned homes" and central heating. What made it unique and all the more relevant to mid-century home buyers was that Fausett offered eighteen plans, later expanded to twenty-four, to accommodate the terrain and all were built in the new Ranch style.⁹³

Fausett used assembly-line construction processes at Broadmoor, which he said made customers eligible for immediate GI, FHA and conventional loans. The interior amenities he included also made them more attractive to lenders. Broadmoor was built utilizing on-site prefabrication methods in shops set up at the addition. Specialized workmen operated a metal shop and a cabinet shop where all woodwork was completed then applied in complete sections. A mill on Broadmoor Drive allowed workmen to pre-cut sections then take them to lots for construction. Broadmoor also had its own roofing supply and decking yard. Using this process, crews could complete a house within one or two weeks, saving Fausett money. By 1955, over 350 homes in Broadmoor were finished, which surpassed Fausett's expectations. In the end, initial projection of 700 homes total ended up being 553 when the last home was built in 1957.⁹⁴

Before Broadmoor was finished, Fausett began construction of College Terrace to the south on Hayes. Ninety-six houses were available in a choice of ten plans. These homes were to be larger than those in Broadmoor because of fewer plan options, use of the new Masonite Shadowvent siding rather than brick and fewer "frills." College Terrace homes did mimic some aspects of the popular Ranch homes of Broadmoor in the use of features such as low, hipped roofs with 30-inch roof overhangs, high windows, picture windows and carports.⁹⁵

Abundant Living in Lakewood

Lakewood subdivision was built up around six lakes and dams in North Little Rock. The lakes were built by the Lakewood Development Company in 1931 and were the opening efforts toward a new subdivision established by Justin Matthews. Matthews had platted adjacent Park Hill in 1921 but the Depression and WWII inter-

rupted progress. In 1946, Park Hill was annexed into North Little Rock and the first Lakewood lots were sold the next year.⁹⁶



Figure 10: Lakewood Subdivision Brochure

The subdivision was a totally planned community and a 1948 sales brochure for Lakewood outlined many of the principles that Fausett followed in community planning. Recreational areas were foremost and lots for future schools were placed next to existing parks. Shopping centers were to be built at major intersections with off-street parking. Buffer areas, like those utilized by Fausett, were to be composed of churches, duplexes and community buildings. Wide avenues were planned to move traffic quickly through Lakewood but narrower residential streets would stymie through-traffic and make for a calmer environment.

The addition was planned for expansion within "units" consisting of roughly 1,000 families. Schools to accommodate the projected 400 to 500 students within each unit would be centrally located. New construction would not occur until streets and utilities were available for those areas and until demand warranted further growth. Restrictive covenants, which kept the neighborhood all-white until the 1970s and restricted any unacceptable architecture, were established. Matthews' philosophy of planning reflects attempts to prevent depreciation of land values and spread of blight.⁹⁷ The Lakewood Property Owners Association kept an eye on improper development, settled disputes and maintained order in the recreation areas. These community features seemed to encourage growth as development continued in Lakewood through the 1960s under the leadership of his son John Matthews.⁹⁸

Matthews was as ambitious as Fausett and Lakewood was reported to include 600 families in 1955. A total of 1,300 homes were built by 1961. Much of the success of Lakewood could be attributed to the proximity of the

Little Rock Air Force Base and the influx of airmen and their families. In contrast to the homes in Broadmoor and Fausett's many other developments, Lakewood features a great variety of architecture with more examples of upper-income Ranch and Modern homes. The 1953 Parade of Homes featured twelve houses on Lochridge Road in Lakewood. A telling clue to the architectural diversity was that all the homes were built by different companies by their own architects. All were in the Ranch style or were overtly modern, but some had traditional flavors with double-hung windows and constrained styling, while others featured flat and low shed roofs, awning windows and carports placed at the front door. One Lakewood home designed by S.E. Pettifer was the definition of ultra-modern with cantilevered porch overhangs, prow decks and banks of window walls. A 1955 brochure for Lakewood listed twenty-three builders approved by the Arkansas Home Builders Association. A drive through Lakewood today reveals an eclectic collection of homes that are anything but the typical tract fare.⁹⁹

Beautiful Meadowcliff

The neighborhood of Meadowcliff was formed by Bralei Corporation in 1952. Bralei had been formed by Buford Bracy in North Little Rock in 1946 and the company contributed several homes to the Park Hill neighborhood after WWII. In 1952, General Manager Jack Bracy reached great success with the Miramar subdivision in Pine Bluff and hoped to emulate his earlier efforts in Little Rock. Following the path of Hayes and the New Benton Highway, he planned for 450 homes in the Meadowcliff addition. Development began in 1954 and 68 houses were sold before the model home had even been completed. The first family moved to the neighborhood in 1955. By 1959, the addition contained 515 finished homes and Bracy had plans for 34 more. Meadowcliff was built in separate phases and included small Ranch homes with Modern styling categorized as contemporary in 1950s newspapers.

Yandell Johnson collaborated with Bracy on Meadowcliff in designing homes similar to those he had provided at Miramar. More than just Ranch, they were termed "Premiere" and "DeLuxe" houses and were larger than those previously built in the neighborhood. Bracy stated that many styles were available in Meadowcliff and he could "satisfy virtually any architectural taste. We can provide a traditional gable roof house, ranch style or the new contemporary style." Most homes found in Meadowcliff are more Modern than traditional. Bracy planned for completion in 1957 and, like Fausett and Matthews, he provided residents with park facilities and a school. Bralei later became known as Bracy Realty and the firm went on to construct Kavanaugh Place, South Road Terrace and Sheraton Park, all in Little Rock, by 1959.¹⁰⁰

Planned-for-Future Cloverdale

Cloverdale was a planned community in southwest Little Rock that received great attention in the mid-1950s. Gus and Leonard Ottenheimer of Little Rock wanted to bring the architectural influence of "Florida architecture" to their projected development. Features that seemed to satisfy that description were slab foundations, tile roofs, terrazzo floors and sliding glass doors to a patio for the continuing trend of outdoor living. Homes followed the Ranch lines with hipped roofs, carports, combinations of double-hung and high sliding windows. Eighteen floor plans with 40 home styles were available.¹⁰¹

The dream of Cloverdale began when the Ottenheimers purchased 145 acres of flat land at the intersection of Hayes and Baseline roads in 1954. The brothers' newly formed corporation, OBG (Ottenheimer, Block, Grundfest) planned for 425 homes in Cloverdale. This was about two miles south of Meadowcliff and Sunnysdale and was considered the vanguard of residential development in that area. The first installment of the subdivision was formally opened in 1956. In the late 1950s, there was much optimism about the potential of southwest Little Rock. The formerly rural area was taking shape as a metropolitan area while remaining "country" enough to attract people looking for tranquility. Publicity of the 1950s further expressed confidence in the area's development by the listing of future facilities like airports, lakes, ice skating, race tracks, skyscrapers and super highways.¹⁰²

Like Lakewood, the development included two schools, community shopping and a park (Ottenheimer Park) with a lake. Convenience was built in as it was ten minutes from downtown after I-30 was constructed, four minutes from Town and Country shopping center and just around the corner from the industrial center. The Ottenheimers also borrowed from Fausett's lead and manufactured lumber and concrete roof tiles for the homes in their own on-site fabricating mill. Other groundbreaking features that made Cloverdale stand out was that the addition had its own sewage treatment plant and each home had "adequate" wiring certified by the Arkansas Adequate Wiring Bureau. This was important as it provided for the modern demands of mid-century electrical technology including air-conditioning.¹⁰³ Cloverdale was at the head of ongoing development in the southwest area of the city through the 1960s with more shopping centers and residential additions.

The Hansel and Gretel

In 1959, Storybook Village was opened in southwest Little Rock. The subdivision featured Ranch homes influenced by "provincial German sources." This was the first such subdivision in Arkansas and was situated on two streets called Cinderella Circle and Gingerbread Lane. Four styles, designated "The Thunderbird," "Snow White,"

"Hansel and Gretel" and "Cinderella," were offered by Putnam-Mobley Realtors. [Figure 5]

The homes included belcast bays with what can only be described as faux bird houses in the pediment of the gable, which was further embellished with scalloped bargeboards. Windows displayed diamond pane (called "criss-cross" in advertising) muntins. Small integral front porches were set beneath an exaggerated length of gabled eels. Porch supports were often slanted, oversized turned spindles. The gable ends of the homes featured either a flamboyant jerkinhead or upswept hip, both with "bird house." Storybook Village homes had enclosed garages with an applied cross-bracing design. The veneer of the houses was a combination of brick with board and batten. Some windows had oversized scalloped surrounds.¹⁰⁴

Only about eleven German-influenced homes can be found there today but they are architecturally intact. Most of the homes on those two streets are traditional brick Ranches with wrought-iron porches, some with the Colonial Revival look. These were primarily built in the late 1950s and early 1960s. An occasional Hansel and Gretel-type home shows up in other subdivisions and a small collection can be found on Evergreen Road in West Little Rock. A few such homes are situated along US 167 in Jacksonville. Overall, this style was not as popular in Little Rock as the typical Ranch or Modern home.



Figure 11: German-influenced architecture in Arkansas

The Ranch Wanes

By 1959, the *Arkansas Gazette* women's pages started profiling the Split-level and they began to dot the state's subdivisions; however, the Ranch continued in spades as the house of choice. In the 1960s, the usual brick veneer branched into different color palettes like white, yellow, blue and different shades of red. Wrought-iron was still popular through the decade and aluminum windows steadily replaced wood. Modern elements were utilized but the Colonial Revival, Gallic or French influ-

ence slowly became a safer bet for tract housing. It was a stretch to say that these homes could be influenced by historic styles in those forms—Storybook Village did a more adequate job—but realtors managed to justify the designations. Colonial Revival homes were recognized by the use of brick, referred to as “old brick” (stating that it was old was likely a liberty on the part of the realtor), dentils, shutters and Tuscan columns. Gallic and French styles displayed diamond pane windows, applied pediments over front doors and wrought-iron.

As the 1960s wore on, new subdivisions in Little Rock tended to be built in West Little Rock and the progression in that area continues today. Additions like Ellis Acres, Briarwood and Brookfield contained the ubiquitous Ranch. By the late 1960s, two-story houses became more popular and the Split-level continued its rise in popularity. Uncut stone in combination with vinyl or aluminum horizontal siding appeared as well as stationary slit windows. Eventually, the two-story Neo-Colonial Revival, Neo-Classical Revival form with full height porch and the Neo-Tudor ended the true Ranch era. Modernism has continued to trail into the 21st century since it is an accommodating style descended from Internationalism, recognized by anybody, anywhere.

The original enthusiasm of the post-WWII era translated into an exciting architectural period that was the result of higher incomes, blue-collar jobs, transformations in society and new opportunities. Historically, Arkansas lagged behind the rest of the nation in instituting popular styles, but the Ranch and Modernism appeared in the state as quickly as it did nationally. Although Arkansas was considered a rural state into the 1970s, the central regions kept pace with the rest of the country as far as suburban development was concerned. The mid-century home was a symbol of all things to all people, as that was what it was meant to express. This could be perceived as a continuation of the influence of Modern Internationalism and the function as a multi-purpose home. The influence of the Modern movement's philosophy was manifested in the Arkansas Ranch and also independently articulated. Both forms contributed to the mid-century landscape of the state's subdivisions and commercial areas and both continue to relate the story of Arkansas's thrust into a new age.

Endnotes

- 1 Although the 1940s and 1950s were known as the baby boom years, there were fewer children born in those decades per 1,000 people than in the early 20th century, Infoplease, “Live births and Birth Rates, By Year, 1910-2005,” <http://www.infoplease.com/ipa/A0005067.html>, (accessed July 26, 2011).
- 2 Clifford, C, *The American Family Home, 1800-1960*, The University of North Carolina Press: Chapel Hill and London, 1986, 132, 135, 144, 146-147, 157, 173, 179, 197.
- 3 Gelernter M, *A History of American Architecture: Buildings in Their Cultural and Technological Context*, University Press of New England, Hanover and London, 1999, 211, 226-227, 237; *Modernism: How the Principles Developed—A Brief History*, Modern San Diego, www.modernsandiego.com/Modern, (accessed July 26, 2011).
- 4 Jandl W, *Yesterday's Houses of Tomorrow: Innovative American Homes, 1850 to 1950*, The Preservation Press, Washington, DC, 1991, 12, 18.
- 5 *Ibid*, 20, 141-142, 148.
- 6 *Ibid*, 183-199; Fetter T, *The Lustron Home; The History of a Postwar Prefabricated Housing Experiment*, McFarland & Company, Inc., North Carolina, London., 2002, 141.
- 7 Gelernter, 242-243, 249-250; Raunekk, “What is Modern?” <http://www.brighthub.com/engineering/civil/articles/59583>, (accessed May 30, 2012).
- 8 Arkansas Democrat, August 15, 1954.
- 9 Little Rock City Planning Commission, *City Planning Commission: Little Rock, Arkansas, 1950*, Little Rock City Planning Commission, AR, 1950, 2; Information on construction dates obtained from Zillow.com, http://www.zillow.com/homes/High-Drive,-Little-Rock,-AR_rb/#/homes/for_sale/Pulaski-County-AR-72206/89444_rid/34.714465_-92.288072,34.711052,-92.291607_rect/17_zm/1_fr/, (accessed February 03, 2014).
- 10 Zillow. com, http://www.zillow.com/homes/402-Sierra-Madre,-North-Little-Rock,-AR_rb/#/homedetails/434-Sierra-Madre-Dr-North-Little-Rock-AR-72118/82849708_zpid/, Accessed 02/03/2014; Google Streetview, (accessed February 03, 2014).
- 11 PAGis, “Mapping Monuments,” http://www.pagis.pulaski.ar.us/webapps/index.html?config=Monument_config.xml, (accessed November 15, 2013).
- 12 Adamson P & Arbunich M, *Eichler: Modernism Rebuilds the American Dream*, Gibbs Smith, UT, 2002, 91-92.
- 13 Gillies M, et al., *Let's Plan a Peacetime Home*, Surface Combustion Corporation, OH, 1945, 14.
- 14 Federal Housing Administration, *Technical Bulletin No. 2: Modern Design*, Washington, DC: Federal Housing Administration, 1936, 8-9.
- 15 Adamson, Arbunich, 92-93.
- 16 Sorensen D, *Bachelor Modern: Mid-century Style in American Film*, Blueprints, Spring/Summer 2008, 2-4.
- 17 Aladdin Readicut Homes, 1961-1962, <http://www.flickr.com/photos/daily-bungalow/sets/72157615595463143/>, (accessed December 26, 2013); Interestingly, even when the exterior of the home was a total break from the standard subdivision fare many of the featured families in *American Homes* held onto their early American and antique furnishings.

- 18 Goodstein-Murphree E, In Memoriam: Edward Durrell Stone's Carlson Terrace, 1957-2007, *Preservation, Education & Research* 3, 2010, 23-24.
- 19 North Carolina Modernist Houses, <http://trianglemodernisthouses.com/stone.htm>, (accessed October 01, 2013) ; Stone's 1936 Collier's Model Home was an example of his textbook International style homes.
- 20 Wilcox R, Pine Bluff Civic Center, National Register nomination on file at Arkansas Historic Preservation Program, AR, 2005, Section 7, p. 9, Section 8, p. 5, 7.
- 21 Lawrence D & Ousterhaus K, Hantz House, National Register nomination on file at Arkansas Historic Preservation Program, AR, 2001; Department of Arkansas Heritage, *Outside the Pale: The Architecture of Fay Jones*, The University of Arkansas Press, AR, 1999, xi.
- 22 Department of Arkansas Heritage, 26.
- 23 Arkansas Gazette, January 07, 1951 in Yandell Johnson papers, on file at Butler Center, Little Rock, AR, Series 1, Box 4, File 17.
- 24 Toms J, Modern Arkansas: International Style in the Capital City: Part 3, <http://modernarkansas.blogspot.com/2013/07/international-style-in-capital-city.html>, (accessed November 26, 2013).
- 25 Yandell Johnson Papers, Series II, Box 5, photographs; The Johnson's take on Modernism was applied to historic buildings like Johnson's Little Rock office and the Red Crown Cleaners when he added jarringly Modern entries to late 19th- and early 20th-century structures.
- 26 Bricker D, *Ranch Houses Are Not All the Same, Preserving the Recent Past 2*, edited by h Staton D and Foulk W, 2000.
- 27 Foley M, *The American House*, Harper Colophon Books, New York, Cambridge, Philadelphia, San Francisco, London, Mexico City, Sao Paulo, Sydney, 1980, 88-89; New South Associates, *The Ranch House in Georgia: Guidelines for Evaluation*, New South Associates, GA, 2010, 7.
- 28 Gregory D, *Cliff May and the Modern Ranch House*, Rizzoli International Publications, New York, 2000, 32; May later changed the name of his homes from Haciendas to Rancherias.
- 29 Hess A, *The Ranch House*, Harry N. Abrams, New York, 2004, 13; *Ranch Style House Seems Here to Stay*, Arkansas Gazette, August 5, 1956; other headlines included "Ranch Style Established as Favorite," "Ranch Type Gaining in Popularity," Arkansas Gazette, 1953 and "Ranch House Tradition Really Comes to Town," Arkansas Gazette, June 2, 1957.
- 30 Arkansas Gazette, July through September 1962 women's sections; The "transitional" form alluded to use of "old brick" or "antique brick," classic columns, dentils, shutters and bay windows.
- 31 Ross C, *Better Homes in America, 1931: Report of White County, Arkansas, Better Homes in America, Records, 1923-1935*, Box 30, folder 9, on file at the Herbert Hoover Institute, Stanford University, Stanford, CA; *Better Homes In America, Inc.*, promoted zoning, construction standards and good citizenship as well as stemming racism and communism through homeownership. Special sermons in local churches during Better Homes Week and placards placed in store windows helped promote the activities of Arkansas committees.
- 32 Pettis E, et al., NCHRP Report 723: *A Model for Identifying and Evaluating the Historic Significance of Post-World War II Housing*, Transportation Research Board, Washington, DC, 2012; Winton A G, *A Man's House is his Art: the Walker Art Center's Idea House Project and the Marketing of Domestic Design 1941-1947*, *Journal of Design History* 17 no. 4 2004, 381.
- 33 Wright G, *Building the Dream: A Social History of Housing in America*, The MIT Press, MA, London, England, 1981, 197, 200, 241-243, 246, 248; Committee on Banking and Currency United States Senate, *Housing Act of 1949: Summary of Provisions of the National Housing Act of 1949*, Government Printing Office, Washington, D.C., 1949, 1; The Housing Act also provided for slum clearance and urban redevelopment; Federal Housing Administration, *Subdivision Standards*, Circular No. 5, Federal Housing Administration, Washington, D.C., 1939; Pettis, et al., 56-57; Remington W, *The Veterans Emergency Housing Program*, 12, *Law and Contemporary Problems*, Winter, 1947, 143; *Is Housing Rule Confusion to End in '58?*, Arkansas Gazette, January 12, 1958; Malnar J M, *Sensory Design*, University of Minnesota Press, MN, 2004, 37; Kennedy R W, *The House and the Art of its Design*, Reinhold Publishing Corporation, New York, 1953, 17.
- 34 Southworth M and Ben-Joseph E, *Street Standards and the Shaping of Suburbia*, APA Journal, Winter 1995, 71, 74; Federal Housing Administration, *Subdivision Development: Standards for the Insurance of Mortgages on Properties Located in Undeveloped Subdivisions*, Circular No. 5, Federal Housing Administration, Washington, DC, 1935, 8.
- 35 Nichols C G, *Hillcrest: The History and Architectural Heritage of Little Rock's Streetcar Suburb*, Arkansas Historic Preservation Program, Little Rock, AR, ND, 3.
- 36 Colean M, *American Housing: Problems and Prospects, the Factual Findings, The Twentieth Century Fund*, New York, 1944, 19.

- 37 PAgis, Mapping Monuments, <http://www.pagis.pulaski.ar.us/WebDocuments/ScannedPlats/2955.PDF> <http://www.pagis.pulaski.ar.us/WebDocuments/ScannedPlats/2955.PDF>; *Ibid*, <http://www.pagis.pulaski.ar.us/WebDocuments/ScannedPlats/216.PDF>; *Ibid*, <http://www.pagis.org/WebDocuments/ScannedPlats/215.PDF>, (accessed June 26, 2013); City Planning Commission, Land Subdivision Regulations, Little Rock, Ark., City Planning Commission, AR, 1950, 9.
- 38 Wachs M, Cranford M, eds., *The Car and the City: The Automobile, The Built Environment and Daily Urban Life*, The University of Michigan Press, MI, 1992, 138.
- 39 Arkansas State Highway and Transportation Department, *Historical Review: Arkansas State Highway Commission and Arkansas State Highway and Transportation Department, 1913-1992*, Arkansas State Highway and Transportation Department, AR, 1992, 54, 61, 64, 76, 86, 90; Ben Johnson, *Arkansas in Modern America, 1930-1999*, The University of Arkansas Press, AR, 2000, 95; McLaren C, *Arkansas Highway History and Architecture, 1910-1965*, Arkansas Historic Preservation Program, AR, 1999, 10-11.
- 40 Chamber of Commerce of the United States, *The Dynamic American City, 1956*, www.archive.org/details/0524_dynamic_american_city_the, (accessed April 30, 2013).
- 41 Redbook Magazine, *In the Suburbs, 1957*, www.archive.org/details/inthesub1957, (accessed April 30, 2013).
- 42 National Planners Open Little Rock Session Today, *Arkansas Gazette*, June 10, 1957; Traffic-choked Main Street Outmoded, Cars Must Go, National Planners Told, *Arkansas Gazette*, June 11, 1957; Gruen's other progressive predictions that the car would compete unfairly with pedestrians on Main Street unless the cities experience a renaissance encouraging residential development downtown with parks and green space have happily come to pass in Little Rock.
- 43 A New Dimension in Downtown Parking: Newrock, *Arkansas Gazette*, June 2, 1957; New Parking Deck For Little Rock Plans Office Space, *Arkansas Gazette*, July 14, 1957.
- 44 New Center at Geyer Springs Set, *Arkansas Democrat*, August 28, 1955; New Shopping Center Planned, *Arkansas Democrat*, August 28, 1955.
- 45 Roy F H, Sr., Witsell C, Jr., and Nichols C G, *How We Lived: Little Rock as an American City*, August House, AR, 1984, 215; Town and County shopping center included plans for a playground, but it was not included in the final center.
- 46 Blass Going Into Pine Bluff With Big Department Store, *Arkansas Gazette*, December 27, 1959; The end was actually temporary as downtown Little Rock experienced a renaissance in the 1990s that is ongoing.
- 47 Hayes Street: A New Town is Booming, *Arkansas Gazette*, September 14, 1958.
- 48 Plaza Takes Sprawl Out of Center, Brings Togetherness, *Arkansas Gazette*, December 1, 1960.
- 49 Peeler K, et al, *Housing an Air Force and a Navy: The Wherry and Capehart Era Solutions to the Postwar Family Housing Shortage (1949-1962)*, Christopher Goodwin & Associates, MA, 2007, 50; *Women in the Labor Force*, www.infoplease.com/ipa/A0104673.html, (accessed January 08, 2013); *Mothers in the Labor Force, 1955-2010*, www.infoplease.com/ipa/A0104670.html, (accessed January 08, 2013).
- 50 Gillies M, *What Women Want in Their Bedrooms of Tomorrow, A Report From the Bedroom of Tomorrow Contest*, McCall's Corporation, New York, 1944, 17, 27; Gillies' report stated that the 10,848 voters participating in the bedroom contest were "almost all women." The contest categories did not specify whether modern referred to a textbook example of the style or whether they were considering ranch as modern. As previously stated, ranch was often referred to as modern.
- 51
- 52 Open Women's Congress Homes, *The Hammond Times*, Hammond, Indiana, December 16, 1956; 59 Basic Features Are Included, *The Salisbury Times*, Salisbury, Maryland, December 8, 1956; 3,500 See Congress Homes, *The Hammond Times*, Hammond, Indiana, December 23, 1956.
- 53 Women Blunt about Homes, *St. Petersburg Independent*, St. Petersburg, Florida, December 27, 1959; Better Living Congress Seeks Wife's Home View, *Pittsburgh Post-Gazette*, Pittsburgh, Pennsylvania, August 17, 1957; McGovern House Cited, *Express and News*, San Antonio, Texas, April 25, 1959.
- 54 Mankiller W P, ed., *The Reader's Companion to US Women's History*, Houghton Mifflin Company, New York, 1998, 37.
- 55 Cole A M, *Women's Congress on Housing*, US Government Printing Office, Washington, D.C., 1956, 37.
- 56 Gregory, 23.
- 57 House Builders Please Note: Women are Lazy, *Arkansas Democrat*, March 9, 1952.
- 58 Gillies, 14.
- 59 Marcus G H, *Design in the Fifties: When Everyone Went Modern*, Prestel-Verlag Munich, New York, 1998, 40-41.
- 60 Nelson G, Wright H, *Tomorrow's House; A Complete Guide for the Home Builder*, Simon and Schuster New York, 1946, 22.
- 61 Kennedy, 253.
- 62 Stires A M, *Home Life and House Architecture*, *Architectural Record*, April 1949, 105.
- 63 Langewiesche W, *The Next American House; By a Man who's Going to Build One*, *House Beautiful*, April 1953, 145.

- 64 Kennedy, 87; Cole, 80; Wright, 255.
- 65 Roy, et al., 213.
- 66 Architecture Style Changes Result From Trend in Air Conditioning, *Arkansas Democrat*, May 9, 1954.
- 67 Nelson and Wright, 168.
- 68 Air-Conditioned Families Spend More Time at Home, *Arkansas Democrat*, May 9, 1954; The *Arkansas Gazette* in the May 31, 1959 edition stated that air conditioning provided health benefits. Artificial cooling was said to be useful for removing "radioactive materials and other contaminants."
- 69 Television is the Architects' Headache, *Arkansas Gazette*, April 16, 1950.
- 70 First TV Station Due Here Next Year, *Arkansas Democrat*, September 25, 1952; Helpful Hints on TV Arranging, *Arkansas Democrat*, March 15, 1953; The television also offered healthy advantages. The *Arkansas Democrat*, September 25, 1952, reported that TV was responsible for straightening crossed eyes. TV viewing was said to strengthen weak eye muscles.
- 71 TV Stands for Theater Vacant In Little Rock Movie Trade, *Arkansas Gazette*, June 2, 1957.
- 72 A House to Set the Pace, *House Beautiful* 90 no. 2, February 1948, 89, 132.
- 73 Langeweische, 139.
- 74 *Ibid*, 209; Mead and Hunt, 120.
- 75 A House to Set the Pace, 64-65.
- 76 Turning House Around to Get View of Yard Can Pose Problems, *Arkansas Democrat*, July 2, 1950.
- 77 Roy, Sr., Witsell, Jr., Nichols, 207; Nate Bell, Little Rock (Pulaski County), *The Encyclopedia of Arkansas History and Culture*, <http://www.encyclopediaofarkansas.net/encyclopedia/entry-detail.aspx?search=1&entryID=970>, (accessed February 04, 2014).
- 78 Roy, et al., 207-210.
- 79 More than 400 Miles Paved: Campbell Cites 8-Year Mark, *Arkansas Gazette*, March 22, 1959; Edge of City Planning Mandatory, *Arkansas Democrat*, February 17, 1952.
- 80 Getting GI Loans Now Easier, *Arkansas Democrat*, December 4, 1949; War Vet Important To Arkansas Market, *Arkansas Democrat*, October 16, 1949; Building Boom Erases Spring Slump, *Arkansas Democrat*, September 25, 1949.
- 81 Building Tops \$7 Million in Five Months, *Arkansas Democrat*, July 2, 1950; State Home Construction Up 92 Pct., *Arkansas Democrat*, December 12, 1954.
- 82 U.S. Department of Commerce, 1970 Census of Population and Housing: Final Report. General Demographic Trends for Metropolitan Areas, 1960-1970, Vols. 1-18, U.S. Department of Commerce, Bureau of the Census, Washington, DC, 1971, 4-6.
- 83 Wright, 248.
- 84 6 Bridges, Expressways Will Lead Into Future, *Arkansas Gazette*, June 21, 1959; Little Rock City Planning Commission, City of Little Rock Annual Report, 1959, Little Rock City Planning Commission, AR, 1959, 2, 9.
- 85 1955 Boom in New Housing Construction In Pulaski County Could Break All Precedents, *Arkansas Democrat*, July 3, 1955.
- 86 Arkansas Home Builders Association, Parade of Homes Plan Book ... Presenting a Preview of 1953 Homes, promotional brochure, 1953, 4; Parade of Homes Hit Since '52, *Arkansas Democrat*, September 11, 1955; Home Purchase \$ Goes Long Way, *Arkansas Gazette*, September 21, 1958; Other techniques to draw in customers to open houses were a talking Nash Air Flyte car parked in the drive of homes to greet customers, quote prices and inform them of the modern features they would soon see and an "X-ray" house. A hole would be opened in the exterior of the house to demonstrate the construction method, insulation and heating systems.
- 87 New Sales Technique Adds To Demand for New Housing, *Arkansas Gazette*, December 11, 1949.
- 88 Planning Now Best in History, *Arkansas Democrat*, September 19, 1954.
- 89 Broadmoor Latest Step in 'Fabulous' Career, *Arkansas Democrat*, September 19, 1954.
- 90 Plat maps indicate that a small business section was planned for the eastern edge of the Coolwood, but an apartment building stands at that location now. Conversations with former tenants of Coolwood reveal that there was never a commercial center on that lot.
- 91 Advertisement for Coolwood, *Arkansas Gazette*, May 27, 1951.
- 92 New Views and Home Plans Set in Broadmoor, *Arkansas Democrat*, September 11, 1955; There was a lot of publicity in the local newspapers regarding the number of homes for Broadmoor and the fact that this was the largest subdivision to date in the state. Conflicting information is available in various articles about Lakewood, however, that indicate about 500 homes had already been built in that neighborhood by 1953. It's not clear, though, whether that included the Park Hill area, which Lakewood was considered an extension of. Fausett was a prolific builder and attention-grabber. He was very adept at getting the press to cover his developments while Matthews seemed to be less interested in publicizing his houses and more in touting the community planning and restrictive covenant aspects.
- 93 Broadmoor Displays Air-conditioned Home Plan to Public, *Arkansas Democrat*, September 20, 1953; This is Fausett's Broadmoor, Information provided by Lanita Reynolds to author, Little Rock, July 25, 2012; Fausett Sees Completion of Broadmoor by 1956, *Arkansas Democrat*, September 19, 1954.
- 94 Reynolds.

- 95 Fast-Growing Broadmoor to Be Completed Year Ahead of Schedule, *Arkansas Democrat*, July 3, 1955; Luxury Homes Provided for the Average Man, *Arkansas Democrat*, September 20, 1953; College Terrace Finishes Fast, *Arkansas Democrat*, September 11, 1955.
- 96 Silva R, Lakewood Park, Sandwiching in History tour script, October 4, 2013, On file at Arkansas Historic Preservation Program, Little Rock, AR.
- 97 Metropolitan Trust Company, *You Can Live in Lakewood*, Brochure, 1948.
- 98 Lakewood Stresses Recreation, Appearance, Community Living, *Arkansas Democrat*, July 3, 1955.
- 99 Arkansas Homebuilders Association.
- 100 Meadowcliff Grows Fast, *Arkansas Democrat*, April 22, 1956; Two Ultra Modern Model Homes to Be Unveiled This Afternoon at Open House in Meadowcliff, *Arkansas Democrat*, April 25, 1956; Bracy Realty Plans 200 Homes in 4 Years at Sheraton Park, *Arkansas Gazette*, November 22, 1959; The Sunnydale addition to the east of Meadowcliff across US 70 developed by Paul H. Spikes in 1954, contains a small collection of ranch homes that could be considered to be heavily influenced by modernism like those that Johnson designed for Bracy.
- 101 No homes retain their tiles roofs in Cloverdale today.
- 102 Suburban Fever and the Great Southwest City, information found in Gus Ottenheimer Collection on file at the Butler Center, Little Rock, AR, Box 1; Lemaster C G, *The Ottenheimers of Arkansas*, Self-published, AR, 1995, 43; The ice skating, race tracks and skyscrapers never materialized in the immediate area; however, the 10-story Arkansas Highway and Transportation Building on I-30, built in 1966, could be considered to be the first (and only) skyscraper in the southwest Little Rock vicinity.
- 103 Planned-For-Future Cloverdale Offers Convenient Living, *Arkansas Gazette*, May 20, 1956; Knighton P, *The Ottenheimers Are Optimists*, *Southwest Arc*, May 9, 1957, 4.
- 104 Long-Bell is Introducing a New Trend in Home Construction, *Arkansas Gazette*, March 22, 1959; Unusual Subdivision Will Be Previewed, *Arkansas Gazette*, October 26, 1958; Storybook Village Medallion Homes, *Arkansas Gazette*, November 2, 1958.

IDENTIFYING THE 1950S RANCH HOUSE INTERIOR AS A CULTURAL RESOURCE: EVALUATION AND PRESERVATION

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Abstract

The ranch is among the most ubiquitous residential housing types in the United States. It is currently receiving recognition from the preservation community as a valuable cultural resource. Although the ranch as a housing type has been evaluated and analyzed, no study exists on the use of space or materials on the interiors of the ranches of the time. This paper identifies the key defining elements of the 1950s ranch house interior, the context and significance of the interior, a component of a newly identified resource, and the challenges associated with its preservation. Suggestions for the practical approach to the preservation of these specific interior spaces are also offered.

Introduction

The ranch is among the most prolific residential housing types in the United States; it was the home of the American 20th-century nuclear family. The building boom associated with the post-World War II period produced a record number of housing starts: over 1.65 million in 1955, and approximately 1.5 million annually for the remainder of the decade.¹ The ranch house peaked in popularity in the 1950s, when it accounted for nine out of ten new houses built.²

Mid-century ranch houses are again gaining popularity with the public. Their modest size and single-floor living are attractive to a new generation of potential home buyers. Decades of neglect and alterations, however, compromise the number of extant intact 1950s ranch houses. As millions of ranches are meeting and surpassing the National Register for Historic Places' fifty year threshold for listing, this house type is deservedly receiving recognition from the preservation community as a resource worthy of preservation. Currently, no published academic sources have evaluated the significance of the ranch house interior or have identified its key defining elements. The evaluation of the interior as a primary source for the post-war era can provide a research framework for more

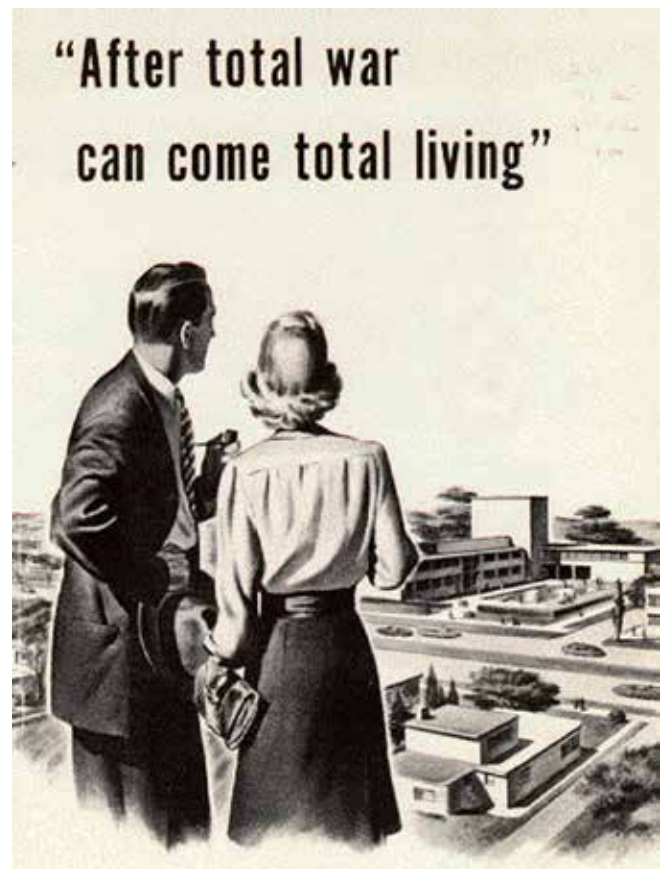


Figure 1: Post- World War II Ranch House Advertisement

detailed documentation of American suburbanization and neighborhood growth in the mid-20th century. This paper identifies the elements of the 1950s ranch house interior, the context and significance of the interior as a newly identified resource and the challenges associated with its preservation.

Preservation organizations and local governments nationwide have been examining the ranch house as a historic resource since the early 2000s. In 2010, a comprehensive study was undertaken as a collaborative effort by the Georgia Transmission Corporation (GTC),

the Georgia Department of Transportation (GDOT) and the Georgia Department of Natural Resources, Historic Preservation Division (HPD) to develop an “evaluative framework for the ranch house, establishing a period of significance for the character-defining features of the Georgia ranch house and its subtypes.”³ *The Ranch House in Georgia: Guidelines for Evaluation* traces the history of the ranch in the United States and provides an in-depth account of this resource’s development in the state. This report contains extensive evaluation and description of ranch house types, covering variations in house shape, explanation and identification of architectural styles and defining architectural elements of each subtype. The study is primarily for preservation and planning professionals and provides pictorial examples of each ranch house type as well as guidelines for efficient and proper methods of ranch house documentation. This study identifies the exterior details of the mid-century ranch, but does not address the interior plan in detail, or as a contributing element to the significance of this resource type. As the ranch house is considered a cultural resource by preservationists and policy makers, the interior deserves exploration to understand its role in the overall historic significance of this type.

During the post-war period, publishing houses printed magazines and books of potential house floor plans to serve as guidance for prospective home builders.⁴ Data collected from published ranch house plan books from 1950 to 1959 offer a statistical representation of common architectural traits through the decade and social themes expressed through idealized residential floor plans. Floor plans from nineteen historic plan books were documented for this study, resulting in data from 467 individually proposed homes.⁵ These plan books were also examined for implicit data such as room placement, plan shape, dining areas and outdoor living spaces. This data, paired with the statistics clearly presented in the books, allowed for an interpretation and analysis of prospective ranch interiors available for construction during the 1950s. These books do not identify the popularity of specific designs or the number of houses built per plan; rather, they showcase what was available to homebuyers, what was emphasized with the plan and similarities among plans over the decade.

Articles and advertisements from popular 1950s women’s housekeeping, decorating and leisure magazines also showcase information as to the “desirable” or “correct” method for living in, and choosing, a particular ranch house interior. These periodicals provide pictorial data such as existing ranch interiors, household materials and advice for successful ranch house livability. Many articles focused on contemporary housewives, their use of space within their homes, work habits, family patterns and preferences for particular color schemes and decorating motifs. By presenting trends in interior decoration and design, publishers created a template for women to emulate. Through floor plans and period articles, an image of the ideal-

ized ranch house interior from the 1950s emerges, as does an understanding of how its planning and use of space is an embodiment and answer to cultural dictates of the period.

Elements of the Interior

Floor Plans

Regardless of exterior architectural styles or form, ranch house interiors exhibited a remarkable number of similarities in spatial configuration. The most crucial and common characteristic of the ranch interior was zoning in living spaces. Of the 467 plans sampled, all exhibited some form of spatial zoning. Zoning within the ranch house placed rooms together based on function, either public or private. The public zone consisted of rooms devoted to entertaining, dining, cooking and work—the living room, kitchen and dining area. Private rooms focused on personal development and privacy—bedrooms and bathrooms,⁶ and occasionally an office or den.

Two forms of the ranch house interior emerged in this period: the open floor plan and the closed floor plan. Instances of the open floor plan exhibited a more distinct use of zoning than the closed floor plan, yet both emphasized the distinction between individual spaces and communal spaces.

The open floor plan in 1950s ranch houses was characterized by large communal areas for group or familial activities with few wall partitions. Free-flowing, unobstructed traffic patterns between the living areas, kitchen and dining areas were significant indicators of the open floor plan. Often, this plan employed half walls or a pass-through to accentuate the openness between spaces. This floor plan emphasized the separation between public and private spaces, with public spaces flowing into one another and private spaces as closed individual rooms. This openness created flexibility in room use, allowing activities in the public realm to move from space to space without hesitation.

The other possible floor plan, the closed floor plan, can be identified by singularly enclosed spaces, each with its own purpose. A greater sense of privacy is emphasized in the closed plan than the open plan, as all rooms are separated by fixed wall partitions and provide a greater sense of enclosure.⁷ This plan maintained a rigid traffic pattern between rooms, but utilized zoning between public and private spaces through room placement.

Overwhelmingly, the open floor plan was the more popular of the two in the ranch houses sampled. Of the sam-

pled houses, 68% percent used this form, showing the acceptance of the new interior type and the demand for adaptable homes for growing families. The flexibility offered by the open plan was crucial to the livability of the ranch house interior because size limitations of the ranch demanded multiple uses for each room. Based on the sample, the average size of the ranch house interior grew from 1,114 square feet in 1950 to 1,272 square feet in 1955, reaching 1,356 square feet by 1959.

Entryways

Regardless of plan type, the zoning exhibited in all ranch house interiors created public spaces and private spaces. The most rudimentary of these was the entrance into the home, which was achieved by one of four distinct designs: foyer, hall, living room or vestibule. A foyer is defined as entry into an antechamber; a small area, not completely partitioned on four sides by fixed walls, separating two significant public living spaces, i.e., the living room and the dining room. A hall is defined as a corridor leading directly from the front door to another space, either an enclosed room or another hall. The living room entry was a front entrance that opened directly into the living room, and a vestibule is an area enclosed on four sides by fixed walls with doorways leading to other spaces, directly off the entry.

Slightly more frequent in house plans than direct entry into the living room, the vestibule plan comprised 35% of plans surveyed; living room entry was present in 34%. This data shows that, although the closed vestibule and the open entry into the living room are on opposite spectrums of accessibility in terms of entry into the home, both experienced relative popularity and serve as an example of plan flexibility based on preference. This data is supported by a 1956 Department of Housing and Urban Development study, *Women's Congress on Housing*, which found female home buyers' preference was a modified or "screened-off area where guests and family could remove wet clothing and dripping umbrellas"⁸ before entering the house. A vestibule entrance was the result of a functional necessity for both house-keeping and living.



Figure 2: Floor Plans for Ranch House

Public Space

The most important public space in the home, the living room, embodied a number of shapes and sizes as well as flexibility in use. No single example can fully define the "standard" living room, as its purpose was to encompass all activities for family use and guests which dictated its size, shape and location. The living room was an area that could incorporate all functions of daily life; it was an area for leisure, personal development and for various work related activities. In short, "the living room was actually the heart of the home."⁹

The living room was the most important room in terms of placement in the ranch house, because an improper location could result in awkward room arrangements and an interruption of traffic patterns, negating the benefits of single-floor living. Regardless of its location or shape, the living room played an important role in the livability of the home and, because of its importance in design, flexibility and use, often controlled the location of the other rooms in the home.

The sample of ranch house interiors resulted in twelve separate possible locations for the living room. The asymmetry of the ranch house in plan and form meant that there were many possible locations for the living room

but, because it was the most utilized and flexible space in the home, it received the most attention in terms of placement. No standard location for the living room existed, nor did any location receive an overwhelming majority in the sample. The location of the living room in the ranch house was crucial to the effective traffic pattern of the home and, especially when paired with a dining room, constituted a large portion of the floor plan.

The wide use of the open floor plan in the 1950s ranch house decreased the number of separate formal dining rooms over the decade. In lieu of a formal dining room, a dining area could be integrated into the living room. The living room and dining room borrowed space from each other and accentuated the openness of the home. Occasionally, iron trellises or half-walls were used to suggest room separation without actively enclosing the space. The integration of these two spaces often resulted in a unique L-shape for the dining and living areas, encompassing the majority of space in the public area of the home.

Integrating the dining room into the living room was a result of the informality associated with residential living in the 1950s and the unnecessary nature of a formal dining space. Many homeowners in the 1950s found a formal dining room unused, as the popularity of eat-in style kitchens became dominant in house plans. One ranch house owner interviewed in the 1950s claimed, "I'd never build another house with a regular dining room."¹⁰

An integrated dining area also had financial benefits for the home owner. By minimizing the number of interior walls in a home, the open plan meant that the ranch house was cheaper for consumers.¹¹ This is especially important in terms of the devaluation of a separate formal dining room, because "few families [could] afford a separate dining room."¹² The inexpensive nature of the integrated dining room and the trends towards more casual dining and entertaining contributed to the decline of formal dining rooms.

Although the open plan often incorporated and integrated living room and dining area, examples from the period exist where separate formal dining rooms exist. But, because of the overwhelming use of the open plan in 1950s interiors, a typical ranch house would not have a formal dining space but would have an area for dining in the living room, and an area for family dining in the kitchen.

The kitchen was another space which received a great amount of scrutiny from perspective ranch house buyers. Historically known as a utilitarian space, the kitchen in the 1950s ranch house interior was blended into the main house as a response to social trends.¹³

Over the decade, kitchens became less utilitarian and work focused, and more viewed as a place for family interaction. The primary reason for this shift was the integration of an eat-in area in the kitchen when families could dine informally. Atlanta architect Leila Ross Wilburn noted that these spaces could be used for "all but the most formal of meals."¹⁴ Of the sampled floor plans, 59% incorporated some type of dining area in the kitchen; such areas included breakfast alcoves, breakfast nooks, dinettes, dining alcoves, snack bars and snack spaces.

Several kitchen arrangements were possible in the 1950s ranch house. Shaped by homeowners to fit individual needs, the kitchen was an area where the design and layout was crucial to its efficiency and functionality. As the kitchen was an important facet of the overall success of the interior's plan, a number of kitchen types were presented to buyers in an attempt to address any planning concerns. The U-shaped kitchen had counters of three sides of the room with the sink placed at the bottom of the layout and the range and refrigerator on opposite sides. The L-shaped kitchen was arranged with the range and refrigerator on one wall and the sink on the other, or the sink and range on one wall and the refrigerator on the other. The corridor, or strip, kitchen was arranged with all work areas—the sink, stove and refrigerator—arranged along parallel walls. The location of the work areas was often left to the discretion of the home buyer. The benefit of the corridor kitchen was the open space on the two remaining walls left for windows, door openings or dining areas. Finally, the least efficient kitchen present in ranch house plans was the pullman kitchen.¹⁵ In this arrangement, all work areas were aligned on one wall. The inefficiency of this model is based on the traffic pattern it creates; an individual has to take more steps to reach appliances and work spaces because of the linear configuration. As it required the least amount of space, the pullman kitchen was utilized in homes which were limited in size.

Despite the trend towards a more informal approach to kitchens, utilitarian spaces were still a necessity in the ranch house. These areas were often integrated into or adjacent to, the kitchen. Utilitarian spaces included areas for laundry preparation and for heating and cooling devices, as well as areas for other basic household activities. Of women surveyed in 1956, "the majority [preferred] the laundry near the kitchen, usually in a separate small utility room."¹⁶ The location of the utility space near the kitchen contributed to the overall household efficiency because household tasks could be completed quicker in a more compact space. Depending on the architect or the homebuyer, utilitarian spaces could be located in other areas of the home. Some ranch houses included basements, which were often used for the utilitarian tasks, freeing up space on the main floor. Although placement near the kitchen meant quicker access to the home's laundry facilities, Lane Publishing Company placed its laundry units in the "bedroom-bath-

room wing, close to the source of most soiled linens."¹⁷ Again, it was the desires of the home buyer which dictated room location based on individual preference.

Private Space

Removed from the communal living spaces, the bedroom in the 1950s ranch house was a space for individual expression, development and respite. The most common number of bedrooms in the ranch house was three, providing adequate space for individual reflection. All floor plans sampled included one bedroom larger than the others, which by mid-decade was referred to as the master bedroom. The versatility of room use within the ranch house interior was exhibited through the bedrooms; many floor plans expressly dictated two rooms as bedrooms, with the third labeled as den or bedroom. Regardless of its use as a bedroom or a den, this third room was in the private area of the house, separated from communal family activities. In addition to the placement of these rooms in the private section of the home, privacy and individual development were expressed through built-in room accessories. Vanities and desks were often incorporated into the bedroom's architecture as a space-saving technique and as another provision of individual space.

The ranch house floor plans sampled indicated that 61% had one full bathroom. This full bath included, at a minimum, a shower/tub, toilet and sink. If the plan warranted a second bathroom, a separate half-bath was used, usually consisting of a toilet and a sink. A half-bath was present in 17% of sampled floor plans. Of sampled floor plans, 19% offered two full bathrooms. In the instance of two bathrooms, one was located adjacent to the master bedroom, while the other was located near the other bedrooms and living areas. Bathrooms varied in design and functionality; variance in bathroom design prevented one standard type of bathroom.

Interior Details

Materials

The ranch house floor plan is the principle organizing device of the resource and provides a building block for the identification of the interior. However, the ranch house interior is more than room location zoning and use. Interior details cannot be systematically identified like the floor plan because of their variation; rather, anecdotal identifications of popular materials from the period can be made through the analysis of artistic renderings of interiors, historic photographs and advertisements. No materials from the 1950s were created specifically for use in the ranch house; however, through pictorial and anecdotal evidence, commonly used materials can be determined.

The ranch house gained popularity in a period when the building industry was experimenting with new materials. New materials arose from the war effort, and plastics and aluminums were incorporated into building materials.¹⁸ Industrial materials included decorative laminates like Formica, melamine-coated paper like Arborite and vinyl products, which were used in bright colors and intricate patterns. Living areas often used natural materials like wood paneling to replace paint and wall papers to bring warmth into a home.¹⁹ Wall-to-wall carpeting used in living areas was a relatively new feature of the mid-century home and was available in a number of textures and patterns. The prevalence of one material over another in terms of brand, color or finish in the ranch house interior is unknown; however, colors and designs were integral to creating the ambiance of the overall ranch house interior.

One mechanism builders and architects employed to counteract the problems of storage space within the confined ranch house interior were built-in cabinets and shelving. Innumerable examples of built-ins exist in floor plan descriptions from this period. Built-ins could be incorporated in any room, but the most frequently used placement for these features was in the living and dining areas.

Like interior materials, a feature which was integral to the overall presence of the ranch house interior was the relationship to exterior spaces. While fenestration of the 1950s ranch house is a notable contributor to the overall exterior character, the fenestration plays a crucial role to the interior as well. Window placement and design dictated room layout and contributed to the overall character of the interior. Often used on the facade, picture windows were a popular feature for the 1950s ranch house. Large picture windows "let in plenty of light and afford[ed] picturesque, intriguing views."²⁰ The large expanse of glass both on the facade of the home and through sliding glass doors on the rear contributed to the integration of the interior and the exterior and allowed the small interior of the ranch house to appear larger.

The variation in plan and materials used in the innumerable ranch houses built between

1950 and 1959 prevented one absolute single form of the ranch house interior. Ranch house plans varied the location and number of rooms, the traffic patterns of interiors and openness of the home. Based on the data provided by the sampled ranch house interiors, the most

commonly represented ranch house had three bedrooms, one bathroom and an open floor plan; the kitchen contained a dining area, the living room was integrated with dining room and large amounts of glass which brought the outdoors into the interior.

Changing Times

The ranch house interior showcased the change in perception of acceptable and desirable living standards in the 1950s. In comparison to previous forms of American housing, the minimalist qualities expressed by the interior of the ranch house came to be associated with the image of efficient, sensible, modern living that was the overwhelming choice of Americans buying new homes after World War II.²¹ The design of the ranch house interior expressed four cultural ideals presented to middle-class suburban Americans in the 1950s: a focus on casualness within the home, individuality expressed through residential architecture, a family-centric space and flexibility in floor plan. The ranch house became the representation of the casual and practical lifestyle and was considered more than an architectural style; it embodied a new approach to living.²²

A break with historically defined living standards and a focus on casualness within the home is best represented in the ranch house interior by the omission of formal rooms and the acceptance of the open floor plan. The emphasis on the relaxed appeal of the ranch house in publications and plan books was a reaction against the rigidity of previous generations and at the same time an embrace of the perceived informality of post-war America; the ranch house was designed to facilitate a more comfortable existence.²³

The emphasis on informality in the home necessitated more opportunities for casual entertaining and leisure activities. The integration of the outdoors into interior spaces through large windows and sliding glass doors furthered the illusion of informality by allowing the interior of the home to organically blend with nature. Many published floor plans explicitly identified spaces for outdoor patios, terraces and decks, implying the period's interest in outdoor activities. The appeal of the easy-going lifestyle that was identified with the ranch house's origins on the west coast perpetuated the connection between the home and the American enthusiasm for relaxed outdoor pastimes such as cooking and eating.²⁴

Changes in mid-century ideas about hospitality and entertaining shaped the interior of the ranch house by removing formal spaces with specific uses in favor of free-flowing, flexible public areas. The ranch house, as explained by the editors of *Modern Ranch Homes: Designed for Town or Country Living*, embraced "informal, gracious living," as demonstrated through its floor plan.²⁵

In an era that valued conformity on a political and social level, the ranch house allowed owners to express individuality through plan selection, material use and decoration.²⁶ Although some architectural critics condemned the ranch house for its perceived uniformity²⁷ ranch houses were often individualized for the particular buyer and adjusted to meet the owner's specifications.

Ranch house owners exhibited individuality by incorporating distinct features based on personal tastes. Some customized their homes by making major alterations such as porches or additions, while others individualized their houses through surface alterations including paint colors and interior decorations.²⁸ Builders and homeowners would sometimes customize these plans by using local construction materials to create a sense of individuality or variety in their appearance. Variations in interior and exterior elements meant that a housing form that was mass-produced could be altered to create a unique structure.

Women in the Home

A component of the individuality expressed in the ranch house interior was an emphasis on a family-centric home; one which was personalized for individual families. The ranch house of the 1950s was enthusiastically promoted by popular home magazines as representing this ideal of the family. The character-defining feature of single-story living resulted in less separation of family members and the open floor plan was conducive to frequent family interactions. Another common theme presented in 1950s periodicals and journals was an emphasis on the woman's role in the home, usually depicted as wife and mother. As women were associated with the role of wife and mother, ranch house floor plans and interior materials were shaped to increase their effectiveness as housekeepers and caregivers. Industrial interior materials such as laminates, wood paneling and plastics ensured quicker completion of household chores. The incorporation of new technologies into the home, namely washers and dryers and automatic dishwashers, aimed to increase the woman's efficiency in the home and create more leisure time. These interior features served to expedite the mundane tasks associated with running a household, while promoting the casualness and leisure the overall ranch house interior represented.

The expectation that the mother be omnipresent in the house was resolved by the open floor plan, particularly in the integration of the kitchen into the public realm. The typical ranch house plan, with all public rooms easily viewed from the kitchen and large expanses of glass between the indoor and outdoor, made it possible for the mother to supervise children while completing her household work. This supervision and interaction would have been impossible if cooking and playing took place in separate areas.²⁹ Not only was a mother able to watch her children as she worked, but children were more present in all areas of the house. The focus on informality and casualness in living ideals allowed children to have greater rights to entirety of the house. No longer were spaces secluded only to adults; the most important spaces belonged to all.³⁰

Flexibility

The open floor plan did not always mean a constant barrage of family togetherness. Zoned living through separating public and private areas meant that parents could “banish children to the [outdoors], or retire themselves to the study.”³¹ The changing definition of acceptable housing standards by the 1950s sought to encourage family togetherness, but recognized the necessity for “a separate play space or quiet study area.”³² As zoning is the most consistent characteristic of the ranch house interior in terms of planning and spatial organization, its use to control familial interaction illustrates how architecture responded to cultural demands.

The central role of children in the family combined with their changing needs as they grew prompted a need for flexibility in the ranch house interior. From its infancy, ranch house architecture was malleable and acceptable of change.³³ Many designers and home owners felt that “housing should be designed to be built in stages, as the means and needs of the family grew.”³⁴ This is seen in multiple additions added to 1950s ranches in subsequent decades; original buyers hoped that if their original house was not all they wanted “they would be able to make further modifications in the future that would make it more acceptable.”³⁵ Although homeowners changed the ways in which they used their interior spaces and plan books touted the benefits of additions, they rarely, if ever, expressed a need for disrupting the physical layout of the interior. The open floor plan itself expressed flexibility in room organization, use and placement.

Preservation Challenges

The ranch house interior was more than an amalgamation of room placements and manmade materials: it physically expressed ideals emblematic to a period of sweeping social and economic change in America. The manifestation of cultural influences through architecture show that the ranch house as a cultural resource is significant for more than its revolutionary architecture; it was the embodiment of the postwar cultural standards in the United States.

The preservation challenges associated with the ranch house interior are encompassed by two overarching common preservation issues: those associated with recent-past resources, and those associated with the preservation of privately owned interiors. Because the ranch house interior is a newly identified resource, the practical challenges and recommendations occur where these two topics overlap. In this overlap, a series of preservation challenges arise unique to 1950s ranch houses interiors.

A threat to the ranch house interior in terms of recent-past challenges is the overall lack of appreciation as a potential and significant cultural resource. This lack of appreciation stems from the misconception that ranches are too recently-constructed to be considered historic, from changes in architectural styles and tastes over the last fifty years, and from the ubiquitous nature of ranches, which decreases individual value. Buildings that do not fit the current norm for favored architectural style are often marginalized, ignored or questioned.³⁶ This overall dismissal of the previous generation's architecture is dangerous in terms of 20th-century residential architecture, because many examples experienced a period of acceptance, then rejection, followed by resurgence in popularity.

The pervasive nature of the ranch house may lead some to believe that they will exist in perpetuity. In actuality, the threat of demolition of 1950s ranch houses is widespread; approximately 75,000 houses are razed each year to make room for larger houses.³⁷ In 2004, The Brookings Institution, an independent research organization, undertook a study on housing in the United States. The result, “Towards a New Metropolis: the Opportunity to Rebuild America,” found that by 2030, half of all existing building stock will have been built after 2000.³⁸ The study also concluded that the area with largest growth will be the residential sector and that, “growth-related and replacement development will be more than two-thirds of all development existing in 2000.”³⁹ The public devaluation of ranch houses because of their ubiquitous nature and the general lack of appreciation of them as a resource lead some potential home buyers to purchase them with the sole intention of demolition.⁴⁰ This, coupled with the predicted building boom of the next three decades, indicates that ranch houses will not maintain their current numbers and will lose value as a group of resources.

More readily available resources that pose a threat to ranch house interior preservation are renovation publications. Published materials, including renovation books and interior design magazines, provide ideas for home owners looking to alter their interiors, often at the expense of existing historic fabric. These publications show an inconsideration towards historic ranch house interiors and a general unknowing about its significance to the overall integrity of the ranch house. Heralded as “the remodeler's dream” in architects M. Caren Connolly and Louis Wasserman's *Updating Classic America: Ranches*, little regard is given to maintaining or preserving the interior in favor of excessive modification.⁴¹ Another current example of the promotion of interior destruction is an article in the home magazine *Before & After*, entitled, “Personalizing an Everyday Ranch.” This article advocates the complete demolition of a ranch house interior because, “demolition can work as a reorganizing tool.”⁴² Articles of this nature are frequently published and, because of their availability, can increase the credibility of interior alterations with the public. Preservationists,

however, can use these publications to gauge the atmosphere of current interior design trends and attempt to predict future challenges associated with interior alterations in order to actively and accurately educate the public.

The common acceptance of interior spaces as temporary, and therefore expendable, can create problems for preservationists because interiors are viewed with lesser importance than exteriors. This assumption is a fallacy because interior spaces can often present a more accurate representation of a building's development, use and history than can exterior architectural details. The preservation challenges associated with residential ranch house interiors include the ephemeral nature of the home and changes in individual tastes, the breakdown of original interior materials and the inability to regulate interiors. The home as an entity is meant to adapt over time to suit the needs of the inhabitant. Changes in familial demands and standards of living alter the overall perception of an acceptable home interior. This does not mean that existing historic interiors should be discounted as insignificant or destroyed; rather, they should be taken into careful consideration when planning for interior alterations and sympathetically modified; the interior of a home must be malleable to meet an owner's needs.

A preservation challenge associated with both newly identified historic resources and interiors is the loss of historic materials. The 1950s saw an increase in the number of manmade products used in the interiors of ranch houses as finishes and building materials. These were complex compositions that had not been used on a large scale prior to World War II, including, plywood, fiberglass and plastics.⁴³ The large-scale industrial manufacturing processes and equipment used to make these materials are now obsolete or non-existent, making mid-century materials virtually impossible to replicate.⁴⁴ As they are difficult and expensive to reproduce and stylistic tastes change, some current ranch house owners opt to replace historic interior elements with modern materials. The challenge of material loss in the 1950s ranch house is particularly alarming because these materials cannot be recreated once removed.

Another challenge associated with material loss in the 1950s ranch house is the lack of analysis; the materials in use have not been thoroughly studied for frequency or disintegration patterns. The difficulty in assessing the frequency of a particular material in the ranch house interior stems from the variability of design based on individual family and the abundance of options available during the time period. Presumably, the regularity of one material over another varied by developer and region. Additionally, some common materials such as vinyl asbestos tile (VAT) have been noted as dangerous; their chemical compositions have been linked to health problems.⁴⁵ Despite the health risks, historic materials can be appropriately retained through standard conservation

techniques such as encapsulation. As these materials are components of recent-past resources, preservationists cannot be certain how they will preserve over time; therefore, an accurate plan for preservation cannot be established. Preservationists run the risk of destroying materials if a thorough analysis and study are not completed before attempting conservation.

The best method preservationists can employ for the protection of these components is massive public awareness building. Since there is little recourse for interior preservation in general, allowing the public to make informed decisions about their interiors can ensure the longevity of these components. Presenting accurate information and compatible alterations in a comprehensible manner on a large scale, via the internet or mass publication, may introduce homeowners to interior changes perhaps not before recognized. Educating the public to the significance of ranch house interior spaces may make them relatable to the individual homeowner and perhaps prevent irreversible damage and alteration.

Preservationists are at the threshold of a new era in their field. Ranch houses are frequently devalued because of their ubiquity and relative recentness. But by careful examination and analysis of the ranch house interior, preservationists have the ability to be active in their preservation rather than reactive to their destruction. Only through calculated attempts at educating the public to the significance of these resources will interiors be valued and preserved.



Figures 3, 4, 5: 1950's Ranch Houses

Endnotes

- 1 Clifford Edward Clark, Jr. *The American Family Home, 1800-1960* (Chapel Hill: the University of North Carolina Press, 1986), 23-24.
- 2 Witold Rybczynski, *Last Harvest: From Cornfield to New Town: Real Estate Development from George Washington to the Builders of the Twenty-First Century, and Why We live in Houses Anyway* (New York: Scribner, 2008) 207.
- 3 Richard Clouse. *The Ranch House in Georgia: Guidelines for Evaluation* Historic Preservation Division; available at http://georgiashpo.org/sites/uploads/hpd/pdf/Ranch_House_Evaluation_revSept2010.pdf (accessed March 25, 2015).
- 4 Alan Hess. *The Ranch House*. (New York: Henry N. Abrams, 2004), 51.
- 5 The base criteria for consideration for usable data included having a publication date between 1950 and 1959, containing description, square footage or dimensions and images. Published accounts from big builders, individual architects, and commercial plan companies were used to interpret a larger and more complete data group.
- 6 Ed. Staff, Lane Publishing Co. *New Homes for Western Living*. Menlo Park, California: Lane Publishing Company, 1956, 11.
- 7 Clouses, 67.
- 8 Annabelle Heath. "What Mrs. America Wants in Tomorrow's Home," *Journal of the American Institute of Architects*, July, 1956, 31.
- 9 Kate Ellen Rogers. *The Modern House: USA: Its design and Decoration*. (New York: Harper & Row Publishers) 1955, 133.
- 10 Mrs. John Struggles, in Mary Davis Gillies, "The New Ways We Eat." *McCalls*, June, 1950, 28.
- 11 Michael Kevin Chapman. "The Ranch-Type House: Evolution, Evaluation, and Preservation." MHP Thesis, University of Georgia, 2007, 12.
- 12 Mrs. Samuel Bergman, quoted in Mary Davis Gillies, "The New Ways We Eat." *McCalls*, June, 1950, 28., 111
- 13 Hess, 57.
- 14 Leila Ross Wilburn, *Ranch and Colonial Homes*, (Atlanta: Leila Ross Wilburn-Architect), 195?, 10.
- 15 Eds. Arch handi-books for better living. *Today's woman low cost homes*. (New York: Arco Pub, Co), 1954, 106.
- 16 Heath, 31
- 17 Editorial Staff of Lane Publishing Co. *New Homes for Western Living*. (Menlo Park, California: Lane Publishing Co.,) 1956, 11.
- 18 Andre L. Jaumotte, and Phillippe F. Decelle. "A Style was Born: Design During the Fifties: Or the Triumph of Curvilinear Geometry," *Leonardo*, Vol. 17, No. 3, 1984, 211
- 19 Bernard P. Spring. "Advances in House Design." *Design and the Production of Houses*. (New York: McGraw-Hill Book Company, Inc,) 1959, 65.

- 20 National Plan Service, Inc. *Eastern Home Style Trends*. Chicago: National Plan Service, Inc, 1955, 7.
- 21 Roger A Clouser, "The Ranch House in America" (Master of Arts, University of Kansas, 1984), 4.
- 22 Gary G. Peterson. "Home off the Range: The Origins and Evolution of Ranch Style Architecture in the United States," *Design Methods and Theories*, Vol 23, iss 3, 1989, 1054.
- 23 Clark, 216.
- 24 Clark, 211.
- 25 The F.A. Reguarth Co. *Modern Ranch Homes: Designed for Town or Country Living*. Dayton: National Plan Service, Inc, 1951.24.
- 26 Avi Friedman. "The Evolution of Design Characteristics During the Post-Second World War Housing Boom: The US Experience." *Journal of Design History*, Vol. 8, No. 2 (1995) , 144
- 27 Lawrence A Beneson, "The Standardization of Low-Cost Homes-I," *The American Institute of Architects*, Vol. XIV, No. 2 (August, 1950), 62.
- 28 Clark, 229
- 29 Adams, Annmarie. "The Eichler Home: Intention and Experience in Postwar Suburbia." *Perspectives in Vernacular Architecture*, Vol. 5, Gender, Class, and Shelter (1995), pp 164-78, 170
- 30 Miller, Laura J. "Family Togetherness and the Suburban Ideal." *Sociological Forum* Vol. 10, No. 3 (Sep, 1995), 401-402.
- 31 Twitchell and Rudolph, "Four houses." *Progressive architecture* 31, (August 1950): 51-69. Avery Index to Architectural Periodicals, EBSCOhost (accessed March 25, 2015). 76.
- 32 Spring 650
- 33 Gary G. Peterson. "Home off the Range: The Origins and Evolution of Ranch Style Architecture in the United States," *Design Methods and Theories*, (Vol. 23, Iss 3, 1989), 1054.
- 34 Clark, 142
- 35 Clark, 230.
- 36 Christine Madrid French, "Introduction, Modernism + Recent Past," *Forum Journal*, Vol. 24, No. 4 (Summer 2010), 6.
- 37 Patrik Jonsson. "McMansions migrate from suburb to city." *The Christian Science Monitor*, 2 January 2007.
- 38 Arthur C. Nelson, "Towards a New Metropolis: The Opportunity to Rebuild America," *The Brookings Institution Metropolitan Policy Program*, 2, download available at: <http://www.brookings.edu/research/reports/2004/12/metropolitanpolicy-nelson> (accessed 25 March 2015).
- 39 Ibid, 1-2.
- 40 Chapman, 89.
- 41 M.Caren Connolly, and, Louis Wasserman. *Updating Classic American Ranches: Design Ideas for Renovating, Remodeling, and Building New*. Newtown, Ct: The Taunton Press, 2003, 24.
- 42 Nancy McCoy. "Personalizing an Everyday Ranch," *Before & After*, Winter 2011, 109.
- 43 H. Ward Jandl. "Preserving the Recent Past: An Introduction." *Cultural Resource Management* 18 (1995): 5.
- 44 Shiffer, Rebecca A. "The Recent Past," *Cultural Resource Management*, Vol 18. No. 8, (1995), 3.
- 45 National Trust for Historic Preservation, "Your Post War House Inspection Checklist," http://www.preservationnation.org/issues/modernism-recent-past/additional-resources/Ranch-HouseInspection-Checklist_update_FORM_071808_v2.doc, (accessed March 25, 2015).

FREE FORM CONCRETE: ESTABLISHING A COMMON GROUND

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Abstract

A topic which has frequently stumped contemporary preservation professionals, as we strive to identify and document Mid-Century Modern concrete structures, is: how do we classify and describe free form concrete buildings? A hurdle for preservationists and architectural historians alike, as these buildings become part of the historic fabric, is developing a common vocabulary to bridge the gap between engineers who designed these mathematically based structures and preservationists aimed at building recordation, restoration, and retention. The aim of this paper is to begin to establish a *lingua franca* for terminology used in identifying and discussing free forms for the preservation community.

Early Concrete History and the Introduction of Thin-Shell Concrete

Since the invention of concrete over two thousand years ago and the development of reinforcing in the mid-1800s, concrete has been used by architects, engineers, and artists alike to create innovative, efficient, and sometimes elegant buildings the world over.¹ Concrete began to be implemented in construction of free form buildings in the early 1900s with the Organic architecture movement. As concrete technology progressed, engineers developed thin-shell monolithic buildings in the 1930s.² These highly versatile and relatively economical buildings rose to become iconic features in the built environment.

The first reinforced concrete building was constructed in 1854 by William Wilkinson, but it was not until 1892, when Francois Hennebique patented the first reinforced concrete system, that people began to believe large concrete structures were safe.³ As concrete was an affordable and versatile construction material, it became more popular and architects began to use the material in new ways. At the turn of the twentieth century, architects like Antoni Gaudi and Rudolf Steiner used concrete to create sculptural architecture using it to create distinc-

tive organic structures.⁴ Gaudi was a world-renowned Spanish architect that worked in organically formed concrete. Gaudi designed by implementing funicular models, which utilize chains and cloth hanging from the ceiling, allowing him to design the structures upside down. The designs were then inverted which turned the tensile systems into a compression systems. This method of construction was an inspiration for future architects and engineers working with free forms.⁵

Thin-shell concrete technology and free forms allowed engineers to become increasingly significant in the design process and the reconstruction of Europe after World War II.⁶ The popularity of free form structures was fueled by their ability to span a large area in an economic and esthetically pleasing manner.⁷ In addition, these buildings are structurally efficient, carry loads perpendicular to their surface, and can bend in moments to create or sustain equilibrium.⁸ Engineers such as Pier-Luigi Nervi, Heinz Isler, and Felix Candela rose from the mire to create beautiful new architecture which, in some cases, rivaled the beauty of the centuries old masterpieces they neighbor.⁹ The spread of the thin-shell concrete in the United States was fueled by the work of Anton Tedesco, an engineer, who designed iconic buildings like the Hersheypark Arena and St. Louis Lambert Airport.¹⁰

Construction Techniques

The original, most prominent, and time-tested practice for constructing free forms in concrete involves making a wooden form and installing rebar over it as seen in Figure 1.¹¹ Then, concrete is poured onto the wooden form covering the rebar.¹² This method of creating free form concrete structures is highly effective but labor-intensive. While after 80 years, this is still a popular method for constructing thin-shell concrete buildings, their con-

struction tapered off in the 1960s due to rising material and labor costs.¹³



Figure 1: Standard formwork

In the mid-twentieth century advances in Shotcrete technology, a method by which liquid concrete is sprayed onto buildings, helped to reduce the labor costs associated with free form buildings. This method involved constructing a grid-work of rebar and steel mesh reinforcing and then coating the framework in concrete (Figure 2).¹⁴ While this method is less material and labor-intensive it also requires skilled craftsman to construct the rebar framework.



Figure 2: Brennenman School. Chicago, IL. Bertrand Goldberg 1960-1963

The post-World War II housing shortage lead to California architect Wallace Neff creating a new construction technique which implemented pneumatics and Shotcrete to create Bubble Houses (Figure 3).¹⁵ While his efforts were not popular, and only one representative of his work remains in America; his work inspired the Bunishells and Airform Monolithic Domes which are still in production today.¹⁶ Airform buildings are created by first laying a concrete foundation, then attaching and inflating a dome shaped balloon and spraying the interior with polyurethane foam, next pre-shaped rebar hoops are installed, and finally Shotcrete is sprayed onto the rebar.¹⁷



Figure 3: Bubble House by Wallace Neff.

Free form buildings date to the early twentieth century but it was not until the invention of thin-shell concrete buildings in the 1930s that these structures were easily constructed and economical. The popularity of free form concrete buildings grew in the post-World War II period which led to the development of diverse construction technologies. Due to high labor costs the 1960s and 70s, these buildings became less economically feasible; however, engineers are still developing techniques in hopes of finding more economically feasible ways to construct free form buildings.¹⁸

Interpreting Free Forms 1930s-1960s

When approaching this topic, it quickly becomes clear that there is a lack of understanding about these forms in the preservation community. After reviewing documentation, it becomes clearer still that there are a few areas where the dissemination of information has not filtered down to the preservation community. This is because of three reasons: first, these structures were typically designed by engineers instead of architects, second, much of the documentation is not written in English, and most importantly third, most papers on the topic are written by engineers for engineers and involve lots of mathematics.

The first area of separation occurs on the design level. It was the shift in traditionally architect designed buildings to those designed by engineers, implementing the art of mathematical principles to create designs, that likely led to the breakdown in understanding of these forms by preservation professionals today. The progression of information from architect to built environment to preservationist changed and the format in which information has traditionally disseminated altered. We read plans and construction drawings, we understand massing, ratios, and proportion, but when it comes to geometric principles many preservations are at a loss.

Free form buildings are created not only on the drafting board, as we are accustomed, but with many mathematical theorems and calculations. For the majority of the twentieth century, engineers were imperative to the design of free form buildings, as the advanced mathematics required was beyond all but those studied in the art.¹⁹ Although in the last twenty years, the advancement of computers and CAD has made the intricacies behind free forms understandable and accessible to the larger population of architects.²⁰

After the mathematical divide, another reason for the breakdown in understanding these resources is language. While these forms were popular in the United States, thin-shell free form concrete was developed and most popular in Europe. As such many of its best

practitioners were not native English speakers. When researching this topic, it has been a constant struggle to find papers, books, and histories which are not written in equations and are also written in English. Many resources and texts are not readily accessible and many that are available are written in German or Dutch. Of the works translated to English, other barriers exist. Where the body of the text has been translated often times the critical diagrams are not translated (Figure 4).

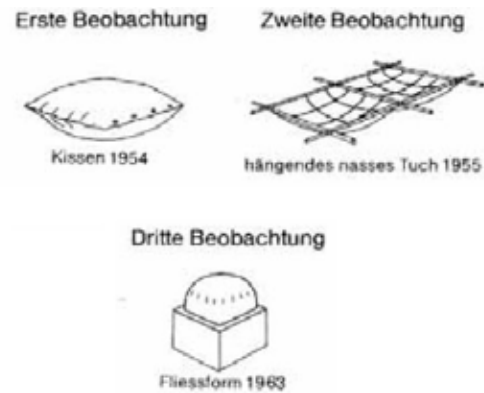


Figure 4: Untranslated diagram of Experimental forms from Free Forms in Concrete: The Fabrication of Free-Form Concrete Segments using Fabric Framework by Rob Verhaegh. 2010

The primary barrier between the preservation community and understanding free form design is the mathematical theory and terminology used by the engineers who design the structures. Articles written for the engineering community talk about free forms in mathematical formulas and often do not discuss topics in terms easily understandable by the non-engineer. In order to adequately document and interpret the built environment for these groups of buildings, we must overcome the language barrier of mathematics.

There are three types of free form shapes which designers use to create thin-shell concrete structures: Gaussian, Analytical, and Experimental.²¹ Gaussian and Analytical curves are closely related and were the earliest and most prolific shapes in free form concrete construction.²² However, it wasn't until the work of Swiss engineer, Hintz Isler, in the 1950s and 60s that simple, mathematically complex, and naturally balanced forms were created.²³

After discovering the names of the shapes and what the mathematics translated into, in the terms of shapes the functions created, the only thing left was to discover how those theories, functions, and principles translated into the built environment.

The first and most common type of shapes used in free form concrete is based on Gaussian curvature. According to Math World, Gaussian Curvature "is an intrinsic property of a space independent of the coordinate system used to describe it", or in simpler terms it can be

described as a shape formed by deforming portions of a flat plane. Typical shapes include cylinder, sphere/dome, hyperbolic paraboloid, or groined vault hyperbolic paraboloid.²⁴ But what exactly does that mean? Where you read flat plane substitute sheet of paper and imagine the following. A cylinder is created by rolling the paper in on its self, spyglass style (Figure 5). A dome can be created by deflecting the middle of the paper (Figure 6). For hyperbolic paraboloid, think of saddle or a Pringles potato chip, which is created by applying opposing force to the corners of the paper, and in some cases, force is applied to the center giving it a bend (Figure 7). The last, and perhaps most visually complicated, are the groin vaulted hyperbolic paraboloids. Which are created when the piece of paper is crumped and is akin to a circular series of waves connected in the center by a groin vault (Figure 8).



Cylinder



Bakery by Mark Ketchum

Figure 5: Double-Curved Cylindrical Roof

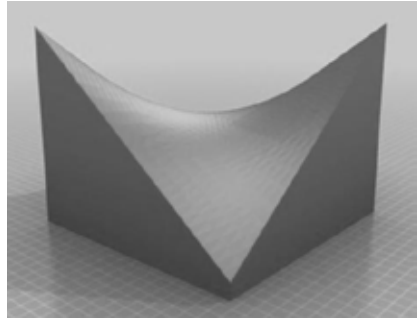


Sphere/Dome



Office Building, West Plains, MO

Figure 6: Sphere/ Dome

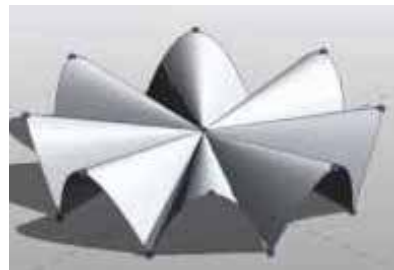


Hyperbolic Paraboloid



Union Memorial Methodist Church, 1961, St. Louis, MO

Figure 7: Hyperbolic Paraboloid



Groin Vaulted Hyperbolic Paraboloid



St. Louis Abbey, 1962, Creve Coeur, MO

Figure 8: Groin Vaulted Hyperbolic Paraboloid

The second group of forms, Analytical Forms, are shapes derived from closed mathematical formulas and can be calculated and perfected by mathematical processes. They became popular free forms due to advances in computing and the desire of architects to use more ar-

tistic forms.²⁵ These forms began to appear in the built environment in the 1930s and their popularity continued into the 1960s.²⁶ The most common shapes constructed were revolution forms and ruled helicoids.

Analytical forms are those based on basic principles of geometry and include Gaussian curves; however, there are two types of Analytical free forms that do not fall in the Gaussian subtype: revolution surfaces and ruled surfaces. According to Math World, "a surface of revolution is a surface generated by rotating a two-dimensional curve about an axis." In order to better understand revolution surfaces, think of a potter throwing a pot on a wheel. A cross-section of the pot will reveal a curvy line. That line has essentially been revolved around the center of gravity (axis) to create the walls of the pot (Figure 9). Buildings created using this method can use a complete circle of the revolution, nuclear cooling towers for example, or partial revolutions implemented in parts of buildings to create artistic details.



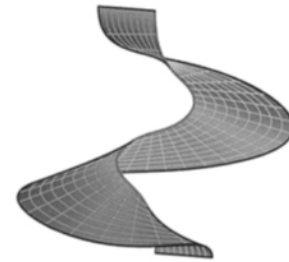
Revolution Surfaces



St. Louis Science Center, James S. McDonnell Planetarium, St. Louis, MO, 1963

Figure 9: Revolution Surfaces.

A Ruled Surface is one that can have a straight line through every point of the surface and a line can be drawn in the surface.²⁷ While many of the shapes previously discussed will fall under this category, the one shape which cannot be divided into these other sub-sections is the ruled helicoid. The helicoid can be described as a helix or unwinding spring (Figure 10). While this type is less frequently implemented in the built environment, a good example is the Guggenheim in New York.



Ruled Helicoid



The Guggenheim, New York, 1959

Figure 10: Ruled Helicoid

The third type of forms came out of the work of Swiss engineer, Hintz Isler, who experimented with how natural forces like gravity, pressure, and flow could be used to our advantage to create more structurally stable, water tight, buildings.²⁸ The experimental nature of Isler's work lead to his forms being called the Experimental forms. These shapes are completely different from other free forms as these forms do not start with mathematical principle, nor do they derive from traditional architectural or artistic practices, but from experiments using water, cloth, plastic, resin, and pneumatic forms to create organic structures.²⁹ The forms produced by these processes created water-tight, leak-proof, unprecedentedly thin roofs that obey the laws of nature rather than existing in spite of them.³⁰ As these shapes were organic in form, they were not easy to calculate or construct.

Isler presented these ideas at the first International Association for Shell Structures Conference in 1959, and completely revolutionized free-form movement by introducing designs never before imagined (Figure 11).³¹ Isler's experiments led to a seemingly endless number of free form shapes which could be created. The first groups of shapes he identified were based on the concepts of a freely shaped hill where molded earth was used to make a form, a membrane-shaped hill where an inflated rubber membrane was used to make shape, and hanging cloth bowl.³² This last type was based on similar principles

that Antoni Gaudi implemented with his funicular models turning tension systems into compression systems.

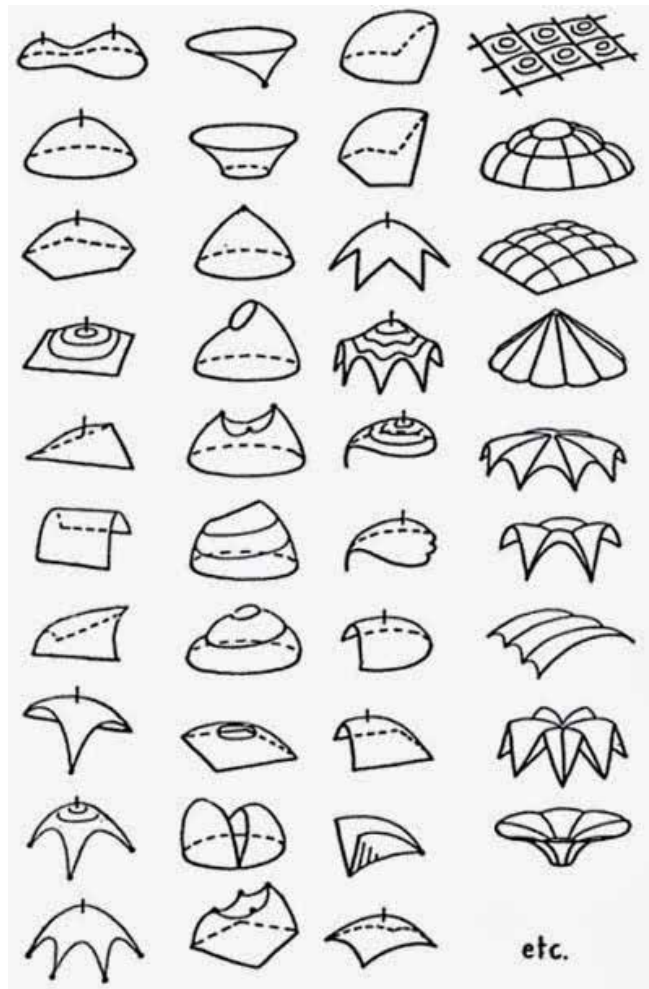
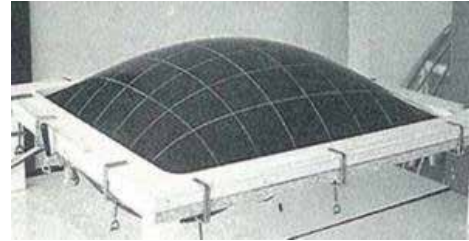


Figure 11: Shapes proposed by Hintz Isler at the 1959 International Association for Shell Structures Conference

The Experimental forms were developed in three phases: Pneumatic in 1954, Hanging in 1955, and Flowing in 1963.³³ In order to experiment with Pneumatic forms, Isler invented a rectangular pneumatic structure to create a pillowed shell using a wood frame and rubber balloon.³⁴ Roofs designed using the Pneumatic systems look a lot like a large pillow or a group of pillows spanning a large space and were popular for factory roofs (Figure 12).³⁵



Pneumatic Form



Hasle dei Burgdorf, Berne, Switzerland, 1972

Figure 12: Pneumatic Form

Hanging forms were developed by hanging a wet piece of fabric by its corners, creating tension, out in cold temperatures and allowing it to freeze.³⁶ The frozen cloth was then overturned to create a compression form (Figure 13).³⁷ While buildings constructed implementing the Hanging forms were more effective than the Pneumatic forms, they were also more expensive to construct.³⁸ These forms proved to be very durable and watertight to the point where Isler was able to remove portions of the roof to create open, airy atriums in the middle of his buildings and still obtain a watertight resilient space with no interior supports.³⁹ Another important discovery Isler made at this time was creating the first reusable forming system which allowed multiple bays of hanging forms to be constructed in rows leading to long, open spaces (Figure 14).⁴⁰ These spaces were often utilized for sports complexes, swimming pools, and airplane hangars.



Hanging Form



Deitingen BP Station, 1968

Figure 13: Hanging Form



Hanging Form



Heimberg Tennis Center 1979

Figure 14: example of reusable formwork for hanging forms

The last type of Experimental form is the Flowing form created by flowing, pouring, and extrusion.⁴¹ These experiments lead to the creation of structures with integral, stable, cantilevered awnings incorporated into the designs (Figure 15).⁴² As with his work on hanging forms, structures based on these principles lead to airy, interior spaces with elongated supports, no interior columns, and often implemented skylights.



Flowing Form



Wyss Garden Center – Solothurn, Switzerland, 1961

Figure 15: Flowing Form

Conclusion

The influence of engineers and reliance on mathematical precision created many elegant free form concrete buildings in the mid-twentieth century. Language barriers, the shift in design from architect to engineer, and the mathematical principles behind these structures have led to some misunderstandings and gaps in the collective knowledge of free form concrete. This paper has endeavored to bridge some of these barriers and establish a platform by which preservation professionals can interpret free form concrete buildings. Establishing a lingua franca allowing preservationist to continue to recognize, interpret, and ultimately preserve these unique resources by understanding the design and constructed methods related to these historic properties.

Bibliography

- Auburn University, Historical Timeline of Concrete, n.d.
<http://www.auburn.edu/academic/architecture/bsc/classes/bsc314/timeline/timeline.htm>
 (accessed March 30, 2015).
- Billington D, The Art of Structural Design: A Swiss Legacy, Princeton University Art Museum, 2003.

- Chilton J, 39 etc....: Heinz Isler's Infinite Spectrum of New Shapes for Shells, The International Association for Shell and Spacial Structures (IASS) Symposium, Universidad Politecnica de Valencia, Spain, 2009. 51-62.
- G. Goldberg & Associates. Bertrand Goldberg Chicago Architect 1913-1997. n.d. <http://bertrandgoldberg.org/projects/brenneman-school/> (accessed September 20, 2014).
- Head J, No Nails, No Lumber: The Bubble Houses of Wallace Neff. New York: Princeton Architectural Press, 2011.
- Huijben F, Van Herwijnen F, and Nijse R, Concrete Shell Structures Revisited: Introducing a New 'Low-Tech' Construction Method Using Vacuumatics Formwork, International Conference on Textile Composites and Inflatable Structures. 2011. 409-420.
- Meriam-Webster. Ruled Surface. n.d. <http://www.merriam-webster.com/dictionary/ruled%20surface> (accessed March 30, 2015).
- Monolythic Dome Institue, The Monolythic Dome. n.d. <http://www.monolithic.org/domes> (accessed September 18, 2014).
- Pyburn J, "The Role of Architectural Precast Concrete Technology in the Internationalization of Postwar Modernism." *Te VIIIth International COCOMOMO Confrance: Postwar Modernism in an expanding World 1945-1975*. New York, 2004. 113-120.
- Veltkamp M, *Free Form Structural Design: Schemes, Systems & Prototypes of Structures for Irregular Shaped Buildings*. Delft University Press, 2007.
- Verhaegh R. *Free Forms in Concrete: The Fabrication of Free-Form Concrete Segments Using Fabric Framework*. Eindhoven University Press, 2010.
- Weisstein E W Math World A Wolfam Web Source 'Surface of Revolution'. n.d. <http://mathworld.wolfram.com/SurfaceofRevolution.html> (accessed March 30, 2015).
- Pyburn, Jack. "The Role of Architectural Precast Concrete Technology in the Internationalization of Postwar Modernism." *Te VIIIth International COCOMOMO Confrance: Postwar Modernism in an expanding World 1945-1975*. New York, 2004. 113-120.
- Huijben, Van Herwijnen, and Nijse. 409.
- Ibid. 409.
- Verhaegh, Rob. *Free Forms in Concrete: The Fabrication of Free-Form Concrete Segments Using Fabric Framework*. Eindhoven University Press, 2010.
- Ibid. 5-10.
- Ibid. 24.
- Ibid. 24.
- Huijben, Van Herwijnen, and Nijse. 409.
- Veltkamp. 20-25.
- Head, Jeffrey. *No Nails, No Lumber: The Bubble Houses of Wallace Neff*. New York: Princeton Architectural Press, 2011.
- Ibid. 8-12.
- Monolythic Dome Institue. *The Monolythic Dome*. <http://www.monolithic.org/domes> (accessed September 18, 2014).
- Huijben, Van Herwijnen, and Nijse. and Verhaegh.
- Ibid. 2011.
- Ibid. 2011.
- Ibid. 410-412.
- Ibid. 410.
- Ibid. 411.
- Verhaegh. 20-24.
- Huijben, Van Herwijnen, and Nijse. 410.
- Ibid. 409-410.
- Meriam-Webster. *Ruled Surface*. <http://www.merriam-webster.com/dictionary/ruled%20surface> (accessed March 30, 2015).
- Huijben, Van Herwijnen, and Nijse. 412.
- Ibid. 412.
- Billington. 131.
- Ibid. 130.
- Ibid. 130-131.
- Ibid. 130-131.
- Ibid. 133.
- Ibid. 134.
- Ibid. 134.
- Ibid. 134.
- Ibid. 134.
- Ibid. 135-163.
- Ibid. 135-163.
- Huijben, Van Herwijnen, and Nijse, 2011.
- Billington. 135-163.

Endnotes

- 1 Auburn University. *Historical Timeline of Concrete*. <http://www.auburn.edu/academic/architecture/bsc/classes/bsc314/timeline/timeline.htm> (accessed March 30, 2015).
- 2 Huijben, Frank, Frans Van Herwijnen, and Ron Nijse. "Concrete Shell Structures Revisited: Introducing a New 'Low-Tech' Construction Method Using Vacuumatics Formwork." *International Conference on Textile Composites and Inflatable Structures*. 2011. 409-420.
- 3 Auburn University.
- 4 Veltkamp, Martijn. *Free Form Structural Design: Schemes, Systems & Prototypes of Structures for Irregular Shaped Buildings*. Delft University Press, 2007.
- 5 Billington, David. *The Art of Structural Design: A Swiss Legacy*. Princeton University Art Museum, 2003.

STRUCTURAL AND MATERIAL EVALUATION OF THIN SHELL CONCRETE (HYPERBOLIC PARABOLOID) STRUCTURES IN THE PACIFIC NORTHWEST

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Abstract

The Pacific Northwest is home to a large collection of mid-century thin shell concrete buildings. The popularity of this construction method was due in large part to the prolific creative work of John V. “Jack” Christiansen, who designed over 60 free-standing structures throughout Washington State.[1] His work included the now-demolished Seattle Kingdome, formerly the largest concrete dome in the world. The most common structural form used by Christiansen (and others) was the hyperbolic paraboloid – a warped surface generated by the rotation of straight-lines. This surface was used in a variety of structural configurations, creating many different types of architectural spaces.

The majority of these structures are now over 50 years old, and demonstrating various states of material degradation and structural integrity. They collectively present a particularly challenging set of preservation issues.[2,3] Located throughout the region, these buildings were designed for many different programmatic functions, in a variety of geographic locations. This presentation surveys the current state of several extant thin shell concrete structures in the Pacific Northwest, comparing their structural design (configuration, shell thickness) and climatic condition (rainfall, temperature range), with their current concrete quality, waterproofing strategies and issues, maintenance history and overall condition.

While Western Washington is known for heavy rainfall, the annual temperature changes are relatively modest. Conversely, Eastern Washington has far less rainfall, but significantly larger temperature changes. The comparison of these two climatic zones – and their effect on thin shell concrete construction – will provide valuable information for other preservation practitioners. In addition, by focusing on the specific structural configuration of the shells (inverted umbrella, gable, etc.), the structural forces of tension, compression and shear can be identified and compared to the current building condition. For example, vertical cracks in areas of tension or

diagonal cracks in areas of shear would indicate structural capacity concerns – a very different condition from those arising from water intrusion. These specific inquiries compliment a more general assessment of the buildings’ overall condition, and indicate where more in depth evaluations techniques are needed.

While this paper focuses on the Pacific Northwest, hyperbolic paraboloid structures of thin shell concrete were commonly built throughout the United States.[4] Building off earlier scholarship, this research will be especially useful in other conservation efforts, and help suggest, if needed, remediation and repair strategies. [5,6]

Introduction

Thin shell concrete structures were a signature building method of the post-war era. Valued for their efficiency and expressive forms, these buildings used thin structural sections in complex geometries to shape architectural space. These shells have a unity of structural form and architectural appearance – making them iconic representations of their time, while presenting significant preservation challenges.

The material and structural integrity of these shells are highly dependent on several factors, including the quality of the original concrete work, the edge condition of the shell, the waterproofing strategy as well as the structural geometry of the original design. Given the various configurations of warped planes (or modules) that are possible, it is essential to understand the particular structural action of each thin concrete shell structure in order to facilitate their maintenance and preservation. This paper introduces the thin shell building type within the context of the post war era in the Pacific Northwest, and then discusses three different case studies. Each case study examines a hyperbolic paraboloid, thin concrete shell structure built between 1959 and 1963, in varying locations, with differing climatic conditions, functional roles, and maintenance

conditions. Finally, the paper concludes with general observations on the challenges facing the effective preservation of thin shell structures.

History of Thin Shell Concrete in the Pacific Northwest

In the early 1950s, the Puget Sound area was booming with construction, due to over thirty years of pent up demand for schools, municipal facilities and residences. The resulting buildings began to reflect a cohesive, regional approach to modern architecture rooted in the geography of the Pacific Northwest and material resources most readily available. Large stands of timber on the Olympic peninsula and North Cascades provided ample, inexpensive wood for construction. The geological, glacial history of the Northwest left large deposits of hard aggregate rock and limestone/ clay deposits good for cement production. Steel production facilities were fewer. Wood and concrete became the least expensive construction means, and soon shaped the majority of post-war buildings. Thin shell concrete – formed with timber, reinforced with only small amounts of steel – was primed to flourish.

Early explorations with folded plates and barrel-vaulted forms soon gave way to a distinctive shape: the hyperbolic paraboloid. Pioneered by Felix Candela in Mexico, the hyperbolic paraboloid is a warped surface, with curvature in two-directions similar to a saddle-shape. This double curvature allows the use of extremely thin sections to be used, without concern for buckling in compression. More importantly, the geometry can be generated through the rotation of straight-lines along an axis - allowing forming with linear pieces of lumber. These forms propagated across the United States and the world.¹

This particular type of thin shell construction increased dramatically in the Pacific Northwest with the arrival of John V. "Jack" Christiansen.² Christiansen was educated at the University of Illinois, Champagne-Urbana in architectural engineering. Christiansen found inspiration in his history courses, and the early modern work of Eduardo Torroja, Robert Maillart and Pier Luigi Nervi. He received a Masters degree at Northwestern University before coming out to Seattle. He soon became aware of the work of Felix Candela, and began using the hyperbolic paraboloid in a variety of structural configurations, creating many different types of architectural spaces. His work included the now-demolished Seattle Kingdome, formerly the largest concrete dome in the world. With Christiansen leading the way, the Pacific Northwest soon became home to a large collection of mid-century thin shell concrete buildings.

Thin Shell, Hyperbolic Paraboloid Preservation Challenges

The majority of the thin-shell, hyperbolic paraboloid structures in the Pacific Northwest are now over 50 years old, and they demonstrate various states of material degradation and structural integrity. Located throughout the region, these buildings were adapted for many different programmatic functions yet maintain a similarity of design, and construction method. While Western Washington is known for heavy rainfall, the annual temperature changes are relatively modest. Conversely, Eastern Washington has far less rainfall, but significantly larger temperature changes. The comparison of these two climatic zones – and their effect on thin shell concrete construction - provides valuable information on the long-life potential of thin-shell structures. In addition, by focusing on the specific structural configuration of the shells (inverted umbrella, gable, etc.), the structural forces of tension, compression and shear can be identified and compared to the current building condition. These factors influence the quality of concrete, waterproofing strategies and issues, maintenance condition.^{3,4} These specific inquiries – through the following case study buildings – help generate a more general assessment of the thin-shell construction, and indicate where more in depth evaluations techniques are needed.

Thin Shell Case Studies

Shannon & Wilson Office Building, Seattle, Washington (1959)

The first case study is a roughly 9,000 square foot, single story office building located in Seattle, designed by Naramore, Bain, Brady & Johanson architects with the engineers Worthington, Skilling, Helle & Jackson (with Jack Christiansen in the office). The building has been continually occupied as an office building. For this particular project, initial construction documents had survived and provided sample specifications and details, ones that are then applicable to other shell structures built at a similar time. The entire roof is made up of 16, hyperbolic paraboloid modules. Each one is a series of four warped planes covering an area of 15' x 29', in a gable configuration between two columns. The columns drop 4'-0" below the ridges of the roof, creating an undulating roof plane. The shell cantilevers beyond perimeter columns roughly 4'-0" in all directions. A central core of masonry provides all the lateral resistance for the building.



Figure 1: Shannon & Wilson Office Building, Aerial View
Map data ©2015 Google Imagery ©2015 , DigitalGlobe, U.S.
Geological Survey

The concrete for the shell was specified with a 28-day compressive stress (f'_c) = 3750 psi, from 6 ½ "sacks" of high-early strength cement. The maximum aggregate size was limited to ¾", with a 3" slump needed for workability. The reinforcing steel was specified as f_s = 20,000 psi. Because of the gabled arrangement, tension tie-bars are required to keep the columns from spreading apart. 1 ½" diameter steel bars were tensioned into sockets in each column, at 8'-9" above the finished floor. The building has a typical 2 ½" thick concrete shell over the entire area, thickened ribs within the valleys of the shells. The valleys have a tapered thickness, increasing to 1'-0" over the supports. The shell cantilevers from the perimeter columns, tapering from 1'-0" to 4". The shell was reinforced by a 4" X 4" spaced, #8 gage x #8 gage (0.129" diameter) welded wire fabric, laid in flat sheets over the entire area, placed towards the bottom of the shell. The shell has additional reinforcing steel along the ridges and valleys (placed towards the top), and around the perimeter (placed towards the bottom).

The overall condition of the structure is good. The concrete shell has no evidence of spalling concrete, and only small isolated cases of exposed reinforcing steel. The reinforced shell and tension rods have proved to be a durable means to resist the forces of tension and compression – with good integrity.

The edges of the concrete shell have been left unprotected, and show some discoloration from the rain and weathering demands of Western Washington, but noth-

ing that could not be cleaned off. Most significantly, the water-shedding solution of the roof was significantly altered. The original design called for drains at each valley (low point), connecting to a pipe running down the center of the column to a sub-foundation drainage system. Over the years, these drains became clogged with the organic material and debris from the surrounding trees. A lack of maintenance attention, meant some shells began filling with water. New drains were drilled through the concrete shells, and new water drainpipes routed through the building.

The offices that occupy the interior of the space have had to make other penetrations through the overhead shell – vents, conduits for antennas, roof instrumentation. These small holes in the roof, though, do not jeopardize the integrity of the shell. With substantial redundancy within the large warped panel, holes that avoid the ridges and valleys do not disrupt the fundamental action of the shell.



Figure 2: Shannon & Wilson Office Building, Exterior. Photo by the author, 2014



Figure 3: Shannon & Wilson Office Building, Interior. Photo by the author, 2014



Figure 4: Shannon & Wilson Office Building, Edge Condition.
Photo by the author, 2014

Grant County Grandstand, Moses Lake, Washington (1963)

The second case study project is an open-air grandstand, covering roughly 6,000 feet, located in Moses Lake, in Eastern Washington, designed by Cowan, Paddock & Hollingbery architects with the engineers Worthington, Skilling, Helle & Jackson (with again Jack Christiansen in the office). This region of the state has significantly less rainfall than structures in Seattle. A series of free-standing hyperbolic paraboloid umbrellas – a module of four warped panels arranged around a central column. This particular structure uses a combination of four full shells (36'x36' in plan) and four half shells (36'x18') on the backside. The full umbrellas are self-contained, with a perimeter of concrete in tension and the valleys of the shell in compression. The half shells connect along one edge to the full shells, and are supported by a single column at the valley. The valleys of the shells act in compression, with the top perimeter in tension. The panel of the shell (made to a minimum thickness) distributes loads through shear – as a diaphragm. A series of diagonal braces along the backside of the grandstand brace the grandstand against wind and earthquake forces. While no construction documents were available, the general specifications and reinforcing strategies were likely identical to the earlier Shannon & Wilson office building, as they were designed by the same engineering firm.



Figure 5: Grant County Fairground Grandstand, Aerial view.
Map data ©2015 Google Imagery ©2015 , DigitalGlobe, U.S. Geological Survey



Figure 6: Grant County Fairground Grandstand, Perspective.
Photo by the author, 2014

Again, the concrete shell is in good condition. Without a large amount rainfall, the grandstand shows the effects of aging and weathering of these structures without the influence of water intrusion. Also, as unconditioned space, the grandstand has not been continuously painted or maintained. As a result, the underside of the shell displays a pattern of discoloration that directly matches the structural behavior of the shell. The valley portions (areas of thickened concrete) remain a clean, gray concrete, while the panel portions of the shell (areas of thinner concrete) display diagonal cracks that come from shear. These microcracks are typical of any concrete construction, with little effect on structural integrity. Without the risk of water intrusion, no significant rusting or efflorescence is visible.

The grandstand continues to protect spectators from the hot sun of eastern Washington. As open unconditioned space, there is no need for electrical or mechanical systems. The thin-shell remains operative and effective as a durable overhead structure.



Figure 7: Grant County Fairground Grandstand, Underside of Shell. Photo by the author, 2014



Figure 8: Grant County Fairground Grandstand, Shell discoloration. Photo by the author, 2014

Mercer Island Junior High Gymnasium (1960)

The final case study building provides a different arrangement of warped panels to create a significantly different type of space. The shells enclose a Junior High School gymnasium and auditorium space on Mercer Island, an island in Lake Washington (Western Washington), designed by Bassetti & Morse architects with the engineers Worthington, Skilling, Helle & Jackson (with again Jack Christiansen in the office). A series of hyperbolic paraboloid gables are supported by four columns, and then extend a cantilevered portion towards a centerline of the building. The building is composed of a cantilevered gable module, measuring 24'-0" x 67'-0" in plan. Four warped planes are supported by four columns, with two serving as a back span (35'8"), and two cantilevering (31'-4") towards a center ridge of the building. The shells are pitched in two directions, creating structural depth at the cantilever support that reduces towards the edges. The shell peaks 9'-0" above the tops of the columns, then rises to 15'-8" at the center. 16 modules enclose roughly 26,500 sq. ft. Buttresses on the ends of the building brace the shell to the ground to resist lateral loads.



Figure 9: Mercer Island Junior High Gymnasium
Map data ©2015 Google Imagery ©2015, DigitalGlobe, U.S. Geological Survey



Figure 10: Mercer Island Junior High Gymnasium, Exterior view. Photo by the author, 2014

As with the previous two case studies, the shells consist of a roughly 2 1/2" concrete slab, reinforced with welded wire mesh, with thickened portions in the valleys and edges. Similar concrete specifications of strength and mix design were followed.

Again, the overall quality of the shell is good. The shells show some discoloration on the top surface in the low-points of the shell – visible in the aerial view. The edge condition and underside of the shell had been continuously cleaned and repainted; yet deterioration was visible in some locations. A lack of capping/ waterproofing on the edge had allowed some rusting of the reinforcing – requiring limited remediation or repair.

With large open spaces formed by the regular column grid and long cantilever, the gymnasium had been repurposed by a children's theater for offices and performances. The space had been successfully adapted to a new use, with no impact to the shell structure.



Figure 11: Mercer Island Junior High Gymnasium, Edge Condition. Photo by the author, 2014

Current State of Thin Shell Concrete Preservation in the Northwest

The different climatic conditions across the state vary the effects of water intrusion on thin shells. In Western Washington, waterproofing strategies and water shedding mechanisms become the primary threats to the integrity of the structures. In Eastern Washington's more arid locations, these threats are less prominent. And yet, despite this diversity of climatic conditions, the overall condition of the remaining thin shell concrete structures is good. This is likely due to the fact that the Northwest maintained a high quality of concrete workmanship throughout the region. The structures show a careful placement of reinforcing steel and moderation of thickness, making them largely durable. Other publications address potential repair strategies when the shell integrity is in question.⁵

The material proportions and configuration of the shell dictate a specific structural action – a combination of tension, compression and shear that is tied to the modular nature of their construction. When the reinforcing is protected to avoid rusting or spalling, the structural integrity of the shells is maintained.

Further assessment of these shells is needed to investigate their behavior in seismic events. As earthquake codes have increased the lateral force resistance requirements, these structures have both beneficial attributes and characteristics that may present challenges. While thin sections of concrete have low shear resistance as diaphragms, and may require reinforcement through an additional membrane, their overall accelerated mass is small – creating low overall forces. Also, insulation issues of the thermal envelope also need to be addressed. Thin sections of concrete often require added insulation, but the thickness and weight are highly variable based on occupancy.⁶

Conclusions

Thin shell structures are an iconic representation of the post-war era in the Pacific Northwest, and yet these types of buildings are continually threatened by new developments. Their thinness and efficiency of material is commonly misconstrued as cheap or insubstantial. Their spaces – shaped by structural forms – are seen as restrictive to new programmatic uses. The Shannon & Wilson office building is currently up for sale, advertised as empty land. In January 2015, the Mercer Island Junior High Gymnasium was *demolished* without any realistic consideration of saving it. No structural assessment was performed. Though these particular preservation challenges remain, none intrinsically prohibit their conservation. The need remains to increase awareness of these geometrically complex structures, and their importance as representations of the post-war era. The primary goal is to shift discussion from questions of structural integrity to the re-use and adaptation of space - essential dialogue to ensure that thin-shell structures remain a part of our built environment.

References

1. Sprague T, Beauty, Versatility, Practicality: The rise of hyperbolic paraboloids in post-war America (1950-1962), *Journal of Construction History*. 2013, 28:1, 165-184.
2. Sprague T, Sculpture on a Grand Scale: The Structural Geometry of Jack Christiansen's Thin Shell Structures. *Biannual Conference of the Construction History Society of America*, Minneapolis, MN. November 12, 2014.
3. Boothby T E and Rosson T, Preservation of Historic Thin-Shell Concrete Structures. *Journal of Architectural Engineering*. 1998, 4:1, 4-11.
4. Boothby T E and Roise C K, Soaring or Crashing? The Challenges of Preserving Thin-Shell Concrete Structures, Historic Preservation Education Foundation, National Council for Preservation Education.
5. Boothby T E, Parfitt M K, and Roise C K, Case Studies in Diagnosis and Repair of Historic Thin-Shell Concrete Structures. *APT Bulletin*. 2005, 36:2/3, 3-11.
6. Sprague T, Conservation Metrics for Thin Shell Structures in the Pacific Northwest, *Proceedings of Structural Analysis of Historic Constructions Conference*, Mexico City, October 2014.

MATERIAL, BUILDING TYPE OR BEAUTY-WHAT MAKES PRESERVING BRUTALIST ARCHITECTURE IN BUFFALO SO HARD?

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Abstract

Why is Brutalism one of the most difficult eras to preserve? Questions of authenticity, the use of materials such as concrete, the construction of new building types like public housing and the maintenance of some of the most energy inefficient buildings ever built are some of the aspects that impact its preservation. This paper will look at Brutalist icons in Buffalo, New York, which demonstrate the pros and cons of saving these buildings.

Buffalo Modernism

Buffalo has a rich modernist heritage, which is now under siege. Not surprisingly, concrete Brutalist style buildings are at the forefront of this battle. As a way to counteract misconceptions about modernism, this author taught a seminar in the spring of 2014 at the University at Buffalo School of Architecture and Planning. The goal of the semester-long project was to document Buffalo modern structures for the DOCOMOMO US Registry. Four buildings represent the Brutalist era, and their appreciation or lack thereof seems to be related to ownership, building type, site plan, maintenance of material and perception of beauty. Those buildings remaining in the ownership of the original owners have fared much better than those that have not.

The Buffalo Evening News Building, Edward Durell Stone

The Buffalo Evening News Building was designed in 1973 by Edward Durell Stone using both site-cast and precast concrete. The project melded the influences of Buffalo's heavy Gothic architecture with the purity and minimalism of the International style. The complex has remained in use as the paper's headquarters and is in fair condition, although its concrete flat roof requires constant maintenance. There is no current threat, but a better level of appreciation of this restrained yet significant structure is desirable.

Temple Beth Zion, Max Abramovitz

The Temple Beth Zion, designed by Max Abramovitz in 1967, is representative of the Brutalist movement with symbolic intent and material use. Monolithic, rough-face concrete walls with exposed aggregate and fastener holes reference a simplistic and unadorned approach. It received both national and local praise for its beauty and progressive aesthetic stature when it opened. The complex remains a beloved symbol of the congregation and is not threatened.

One Seneca Tower (former HSBC Center), SOM

SOM designed this precast concrete building in 1972 as a bank's headquarters. At forty stories, it remains the tallest privately owned building outside of New York City. It has a conflicted relationship with Main Street, which is articulated through a barren tunnel and windswept plazas at the base of the building. Its most recent primary tenant, HSBC, moved out in 2013, leaving the building 95% vacant with its owners in bankruptcy. It is one of the least liked buildings in Buffalo.

The Shoreline Apartments, Paul Rudolph

The Shoreline Apartments, a public housing development, was commissioned in 1969. What was ultimately completed in 1974 was considerably reduced in scale from Rudolph's original scheme. Featuring corduroy concrete block, projecting balconies and enclosed garden courts, the project's serpentine site plan was meant to create active communal green spaces, but the spaces went unused and the high crime rate over the years has often been attributed to the design rather than poor management.

Still low-income housing, Shoreline is now threatened by the current owners who are proposing demolition of five of the original thirty-two buildings, which would be

replaced with "nouveau Victorian fiber cement board suburban rowhouses." Their reason: the buildings are "ugly," energy inefficient and encourage crime.

Buffalo Modernism



Figure 1: The Richardson Olmsted Complex, formerly the Buffalo State Asylum for the Insane, September 2013. Photo by Barbara Campagna

Buffalo has some of the best and most groundbreaking architecture in America and, indeed, in the world. As one of the few cities with masterpieces by Richardson, Sullivan and Wright, it has long been a destination for students and lovers of architecture. In recent years, a renaissance of sorts is reviving its landmarks and reactivating the neighborhoods and downtown. Grain elevators and daylight factories that influenced Le Corbusier, Erich Mendelsohn and Reynier Banham are finding new life while Richardson and Olmsted's long-vacant Buffalo State Asylum for the Insane became a boutique hotel, conference center and architecture center. [Figure 1] Wright's Darwin D. Martin House has been restored and reconstructed and Sullivan's Guaranty building—often called the first real skyscraper—has been rehabilitated for a second time in twenty-five years. Buildings by Richard Upjohn, Daniel Burnham and the Saarins fill in the landscape.

What is less recognized is that Buffalo's architectural innovation continued through the modern era, and that the traditional icons of Buffalo can be found across the street from buildings by Yamasaki, Edward Durell Stone, SOM, IM Pei and Paul Rudolph. Buffalo has an incredibly rich modernist heritage, yet some of that heritage is now under siege. As is the case in much of the rest of the country, Buffalo's preservationists are now finding themselves in the midst of battles to save its modern architecture.

Not surprisingly, concrete Brutalist style buildings from the late 1960s and early 1970s are at the forefront of this

battle. Why is Brutalism one of the most difficult types of architecture to preserve? Questions of authenticity, the use of materials such as concrete, the construction of new building types like public housing, subjective opinions of beauty and aesthetics, perceived relationship to urban renewal and the maintenance of some of the most energy inefficient buildings ever built are some of the aspects that impact the preservation of Brutalist buildings.



Figure 2: Shoreline Apartments, designed by Paul Rudolph, November 2013. Photo by Barbara Campagna

This paper will look at Brutalist icons in Buffalo, New York, which demonstrate the various aspects of trying to save these buildings. As a way to counteract misconceptions about modernism, this author taught a graduate seminar, "Preserving Modern Heritage," in the spring of 2014 at the University at Buffalo School of Architecture and Planning. The students' semester-long project was to document a Buffalo modern building for the DOCOMOMO US Registry. Until this year, only two buildings in Buffalo were listed on the Registry, and one of those had been demolished in 1950! (The New York Central Terminal Railroad Station, an Art Deco masterpiece from 1929, and Wright's 1906 Larkin Administration Building, demolished 1950, were the only two Buffalo buildings listed.) Seven modern sites were ultimately listed as part of the class. Four buildings represent the Brutalist era and their appreciation or lack thereof seems to be related to ownership, building type, site plan, maintenance of material and perception of beauty. Those buildings remaining in the ownership of the original owners have fared much better than those that have not.

According to the Department of Energy Study on Commercial Buildings in 2003, the most energy efficient commercial buildings in the country were built before 1920 and after 1990, which would lead us to surmise that the most inefficient buildings in the country were built in the years in between.¹ Given the fact that 85% of our commercial building portfolio in the United States was built after 1945, the assumption can then easily be made that buildings from the modern era are the biggest problem we have from a climate change standpoint. Many would like you to think that modern buildings are

also the biggest problem we have in terms of aesthetics. Not only culturally, but also physically, the distance between past and present has become ever shorter, making preservation efforts increasingly more urgent while at the same time appearing far more dramatic because they are often experienced within the same generation as a building's construction.² Since the Art Deco era, we have been asking ourselves, do we need more time to appreciate buildings of our own recent past?

Despising the 1970s

The *Buffalo News* published an article on March 5, 2015 entitled "Unloved, Maybe, but Standing Tall" identifying the "most unloved buildings in Buffalo."³ In the article, the journalists write, "We aren't professional architectural critics, so wherever possible we tried to relay the critiques of others rather than impose our own views."⁴ Filled with anecdotes and randomly quoted negative comments—many from as long ago as twenty or thirty years—the piece lists ten buildings in Buffalo and Niagara Falls, all except one having been built in the early 1970s in the Brutalist style. The article is useful in documenting the overused and ill-informed epithets often applied to Brutalist architecture. The article exploded online and was filled with dueling comments, both from trained professionals and citizens not in the field, with some of the most uninformed ones coming from preservationists in town, sadly.⁵

A notable example of the tone of the reporting was related to the Buffalo City Court: "Built in 1974, and designed by Buffalo architects Pfohl, Roberts & Biggie, the Buffalo City Court building looms like a monolith over Niagara Square with its facade of massive concrete panels. Defenders say the City Court Building is a classic example of Brutalist architecture, and that's certainly a good word for it. The building looks like it would be right at home in a bleak, post-apocalyptic graphic novel."⁶

Case Studies

Given that so many people find "brutalist" an appropriate description of these buildings and believe it gives them carte blanche to hate them, a variety of case studies in Buffalo have been reviewed. Five buildings in Buffalo are discussed below, four of which were submitted to the DOCOMOMO registry as part of the University at Buffalo class in 2014.

The Buffalo Evening News Building, Registry Fiche Documented and Prepared by Aaron Salva⁷



Figure 3: Exterior View of the Buffalo Evening News Building.
Source: Robert M. Metz, Buffalo Evening News Photo Collection, January 6, 1973

The Buffalo Evening News Building, on the edge of downtown Buffalo, was designed in 1973 by Edward Durell Stone. [Figure 3] Stone used both site-cast and precast concrete. The complex has remained in use as the paper's headquarters and is in good condition, although its concrete flat roof requires constant maintenance. The tenant, however, has adequate facility staff who appreciate and maintain the building appropriately.

The construction of the Buffalo Evening News Building marked a significant move for the company, as it brought back together the production and the administrative sides of business at one location, which had been separated for decades. At the time of its completion, the building was one of Stone's last works. The project was a time for Stone to reflect on his previous work and projects that he was influenced by, but there was also the large task to fit it into the context of Buffalo's rich architectural history. The project melded the influences of Buffalo's heavy Gothic architecture tradition with the purity and minimalism of the International movement. Stone reinterpreted Le Corbusier's five points in one

heavy monolithic move. At the time, it was an important piece of the modern movement in Buffalo but did not receive as much national recognition as Stone's previous works. The complex has remained in use as the Buffalo News Headquarters and remains in fairly good condition. There is no current threat to this complex, but a better level of appreciation of this restrained yet significant structure is desirable. Even the March *Buffalo News* article noted, "Some people might put the Buffalo News Headquarters building on the unloved list," although they did not.⁸

To read Aaron's full Registry fiche, visit

http://docomomo-us.org/register/fiche/buffalo_evening_news_building

Temple Beth Zion, Registry Fiche Documented and Prepared by Madelyn McClellan⁹



Figure 4: Temple Beth Zion, Delaware Avenue Entrance.
Source: Buffalo Historical Museum, 1967

The Temple Beth Zion, designed by Max Abramovitz in 1967, is representative of the Brutalist movement, although with symbolic intent and softer use of material. [Figures 4, 5] Following the destruction of the earlier synagogue from fire, the congregation, which was established in 1863, hired New York City architect Max Abramovitz to design a new temple. Opened in 1967, this building received both national and local praise for its beauty and progressive aesthetic stature. The architectural mindset at that time was focused on the need to find a modern aesthetic to represent traditional forms and cultural values. Locally, the design was not well received initially. Because the congregation had such presence within Buffalo, the new construction gained quite a bit of local press and attention. Even though the local media attention was relatively unbiased, the pub-

lic opinion, upon release of the rendering in the newspaper, was quite negative. After the building was constructed, however, people were able to experience the simplistic grandeur and the local opinion changed.



Figure 5: Temple Beth Zion, View of Ark, from upper balcony.
Source: Buffalo Historical Museum, 1967

Monolithic concrete walls with exposed aggregate and fastener holes reference a typical simplistic, unadorned Brutalist material approach, allowing the symbolism to read through the form. The ten scallops along the exterior facade represent the ten commandments and the slight outward angle represents arms raised in praise. Meanwhile, the rough face of the concrete reminds the congregation of its roots in antiquity. The complex remains a beloved symbol of the congregation and is not threatened.

To read Madelyn's full Registry fiche, visit

http://docomomo-us.org/register/fiche/temple_beth_zion

One Seneca Tower (former HSBC Center), Registry Fiche Documented and Prepared by Dillon Galvis¹⁰

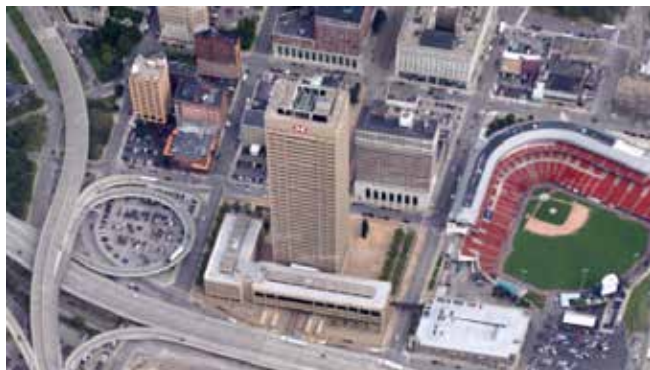


Figure 6: One Seneca Tower, aerial view. Source: Gizmodo.com, November 23, 2013

Skidmore Owings and Merrill (SOM) designed this precast concrete building in 1972 as a bank's headquarters. [Figure 6] At forty stories, it remains the tallest privately owned building outside of New York City. It has a conflicted relationship with Main Street, which is articulated through a barren tunnel and windswept plazas at the base of the building. Its most recent tenant, HSBC, moved out in 2013, leaving the building 95% vacant with its owners in bankruptcy. The building will go up for auction in October, 2015.

The precast concrete building was constructed in 1972 specifically for Marine Midland Savings Bank's Headquarters. The architects (SOM) were commissioned to erect the tallest building in Buffalo, which ultimately topped out at forty stories. Today, the building's profile defines the downtown Buffalo skyline. Its location and height allow for amazing views of Lake Erie, the Buffalo River and the entire region. The modern, unornamented Brutalist building was built to serve the purpose of a bank and did not reflect much consideration of the surrounding context of the site. It is placed perpendicular to the other buildings and acts as a barrier to the higher and lower sections of Main Street. The building's entrances are all set back from the surrounding streets, with little protection for poor weather conditions. This building's ongoing vacancy is one of the blights on Buffalo's current renaissance. It is one of the least-liked buildings in Buffalo because of its massive, unadorned exterior and its relationship to Buffalo's urban renewal era.

To read Dillon's full Registry fiche, visit

http://docomomo-us.org/register/fiche/one_seneca_tower_former_hsbc_center

Willert Park Courts, Registry Fiche Documented and Prepared by Nicholas Batson¹¹



Figure 7: Willert Park Courts, outdoor spaces. Source: Buffalo Municipal Housing Authority, Center for Urban Planning, SUNY at Buffalo, date unknown

Although not mid-century modern, Willert Park Courts was one of the earliest International style buildings in western New York and had a huge impact on Buffalo's modern designers. [Figure 7] Now officially titled the Alfred D. Price Courts, after the complex's long-time manager, the Courts were part of a housing experiment in 1939. The housing project was designed for African Americans and remained as such throughout its years of occupancy. Frederick C. Backus, a local architect, designed the project. His design called for ten buildings containing close to 175 residential units, situated mostly parallel around a central courtyard.

This was one of the first public housing developments to incorporate such an arrangement and a wide use of green space. To give the design an aesthetic other than the brick facade, Backus worked with Robert Cronbach and Harold Ambellan from the Federal Arts Program to design sculptures with the theme of work and working-class life. The tinted concrete panels, situated at the entrances of each building, added a different look to the project and made it one of the first in Buffalo to involve sculpture in housing design. The complex is significant culturally, historically, socially and architecturally as the first housing complex for African Americans in Buffalo and as an early International style design. The complex has been vacant and abandoned for a decade and is threatened with demolition. Despite receiving approval for local landmark designation by the Buffalo Preservation Board, the Common Council denied its designation because its neighbors "were opposed to it, although

they do want to see the artwork embedded in the walls preserved."

To read Nick's full Registry fiche, visit

http://docomomo-us.org/register/fiche/willert_park_courts_1

Paul Rudolph and Western New York



Figure 8: Shoreline Apartments, corner of Niagara and Carolina Streets, November 2013. Photo by Barbara Campagna

Perhaps the most hated buildings in Buffalo are Paul Rudolph's Shoreline Apartments. [Figure 8] A complex of low-income housing which occupies nine-and-a-half acres on the edge of downtown Buffalo, the Shoreline Apartments face the first of several projected phases of "upgrades," which call for demolition of currently unoccupied Rudolph-designed units and replacement with suburban like townhouses.

Paul Rudolph brought his singular brand of sculptural modernism to western New York in the early 1970s. In a span of two years, three buildings were built to his designs: the Waterfront School and Community Center (1974-1977), with design concept by Rudolph and executed by local architects Hess and Gorey; the Earl W. Brydges Public Library in Niagara Falls (1973-1974); and the Shoreline Apartments in downtown Buffalo (1971-1974). The Waterfront School and Shoreline Apartments face one another across a wide expanse of green, which has never been used or landscaped in the way it was intended.

National Recognition

Rudolph's first scheme was featured in the September 1972 edition of *Architectural Record*. It was also featured in a 1970 Museum of Modern Art exhibition entitled

Work in Progress. "With few exceptions, Paul Rudolph's buildings can be recognized by their complexity, their sculptural details, their effects of scale and their texture," wrote Arthur Drexler, the longstanding Director of MoMA's Architecture and Design Department, in 1970. Drexler exhibited Rudolph's original, much more dramatic scheme for Buffalo's Shoreline Apartments alongside pending projects by Philip Johnson and Kevin Roche in the exhibit. The projects on display were compiled to represent a commitment "to the idea that architecture, besides being technology, sociology and moral philosophy, must finally produce works of art." Drexler wrote in the exhibition brief that, despite the project's massive scale, it was "designed to suggest human use, affording both inhabitants and passersby a kaleidoscopic variety."¹²

Shoreline Apartments



Figure 9: Shoreline Apartments, Photo in *Architectural Record*, September 1972

The Shoreline Apartments, a public housing development, were commissioned by the Urban Development Corporation, a state agency, in 1969. The complex was originally part of a large waterfront development of market rate and low-income housing. The ambitious urban renewal project in the shadow of Buffalo's City Hall originally included a marina, which was never built. The Shoreline Apartments that stand today represent a scaled-down version of the original plan. Featuring shed roofs, ribbed or corduroy concrete exteriors, projecting balconies and enclosed garden courts, the project combined Rudolph's spatial radicalism with experiments in human-scaled, low-rise, high-density housing developments. The project's weaving site plan was meant to create active communal green spaces, but, like those of most of its contemporaries, the spaces went unused and the high crime rate over the years has often been attributed to the design rather than the poor management.¹³

Still low-income housing, Shoreline is currently threatened by the current owners who are proposing demolition of

five of the original thirty-two buildings, which would be replaced with "nouveau Victorian fiber cement board suburban rowhouses," as a local architect and friend has coined these uninspired replacements.¹⁴ [Figure 10]

The Demolition Plans



Figure 10: One of the several types of new brick and cement fiber board buildings to replace Rudolph's buildings. Drawing courtesy Buffalo Rising, October 8, 2014

In the sections of housing, Phase 1, which opened in 1972, was renovated in 2010; renovations included the removal of two of the original twelve buildings. Phase 2, which opened in 1974, faces Niagara Street and contains twenty-two buildings. The five furthest from downtown, at Carolina and Niagara Streets, are vacant and are the ones proposed for demolition. The buildings, both inside and out, are actually in remarkably good shape for forty-year-old concrete block buildings. Structurally, they are very sound. The current windows are replacements from an earlier renovation and were not good replacements when they were installed. The UDC and subsequent owners have not done well by Rudolph. There is no valid architectural reason to demolish the buildings other than that the owner does not like them, and has not maintained them properly. The proposal is to completely abandon Rudolph's master-planned community and planning approach and replace the buildings with three-story high faux "Victorian" row houses. There has been a lot of discussion about returning this acreage to the 19th-century streetscape for which it was torn down. However, the proposed replacements are examples of pseudo-historicism. Cities evolve. If we removed every building in America that was the result of "urban renewal" our cities would reference only traditional nostalgia.

The Shoreline Apartments Today

Norstar Development has owned the site since 2005. Like many of Shoreline's public housing contemporaries, the inventive, complex forms and admirable social aspirations of the development have been overshadowed by disrepair, crime and startling vacancy rates (30 % in 2006, according to *Buffalo Rising*).¹⁵ Originally built with over 400 units on nine-and-a-half acres, a 2007 renovation merged many of the units to a lesser count, with Norstar reportedly spending \$19 million on "sprucing up" the complex with new facades, windows and railings.

According to a report in Buffalo's *Business First*, "The Shoreline Apartments have 426 total units, although 89 have been 'off line' since 2004 because such issues as needed elevator repairs.¹⁶ Of the remaining 337 apartments, nearly 75 %, or 270 in hard numbers, are occupied." Having toured the vacant and abandoned buildings, I can attest to the fact that there is nothing wrong with them, other than years of no or little maintenance.



Figure 11: One of the several types of new brick and cement fiber board buildings to replace Rudolph's buildings. Drawing courtesy Buffalo Rising, October 8, 2014

On November 6, 2013 Norstar presented plans to the City of Buffalo's Planning Board to demolish five of the currently vacant Rudolph buildings on Niagara Street and Carolina Street, replacing them with eight suburban-style affordable residential townhouses with forty-eight units. Reportedly, this is "Phase 1" of their plan with future phases not yet identified, but likely similar. Once five buildings are removed, the rest will become even easier to remove. The Planning Board approved the draft SEQR plan and approved the plan as presented. Every attempt is being made to wipe the street and slate clean of Rudolph's innovative designs.

Since Norstar is financing the work with funding from the New York State Department of Housing and Community Renewal, as well as with an annual allocation of low-income housing tax credits, the project is required to be reviewed by the State Historic Preservation Office under Section 106 for any impacts to a potentially eligible historic site. While demolition has not yet begun, it does appear that the five buildings will be demolished and replaced with mediocre suburban-looking buildings and a site plan. (Note: the five buildings were demolished in the summer of 2015.)

Moving Forward



Figure 12: Shoreline Apartments, several of the buildings scheduled for demolition, February 2014. Photo by Barbara Campagna

It is easy to blame the buildings and grounds for the vacancy rates and crime in modern public housing developments. Yet a walk around the site today shows blocks full of buildings in various states of repair with little thought given to the expansive land on which it sits. The private balconies and garden courts are desirable features in high-end condos all over town and the nearly ten acres of mostly ill-used land would be desirable in any city. A good architect and landscape architect, with the ability to respect Rudolph's intent while recommending native and more sustainable land use approaches, could do wonders with this complex. The owner's complaint that the buildings are in poor condition and are energy inefficient reflects a lack of maintenance by ownership.

It has not gone unnoticed that another groundbreaking modern public housing complex is also under imminent threat in Buffalo. The Willert Park Courts, now called the AD Price Housing, a ten two- and three-story brick multiple dwelling complex designed by Buffalo architect Frederick C. Backus and built in 1939-1940, is owned by the Buffalo Municipal Housing Authority, which has announced plans to demolish the entire complex. The design was based on the functional, flat-roofed blocks used in German public housing projects and is ornamented with a series of cast relief sculptures on the theme of labor and family life. The buildings are vacant with windows wide open, missing doors and deteriorating sculptures despite the fact that they have been determined eligible for the National Register.

It seems ironic that both of these Buffalo public housing projects had been singled out by the Museum of Modern Art for architectural significance. Shoreline was included in the 1970 exhibition, *Work in Progress*, while Willert Park Courts was included in MoMA's 1940 guidebook, *Guide to Modern Architecture of the Northeast States* as one of only eight buildings considered significant modern architecture in Buffalo.¹⁷

Developing Local Policies for Preserving Modernism

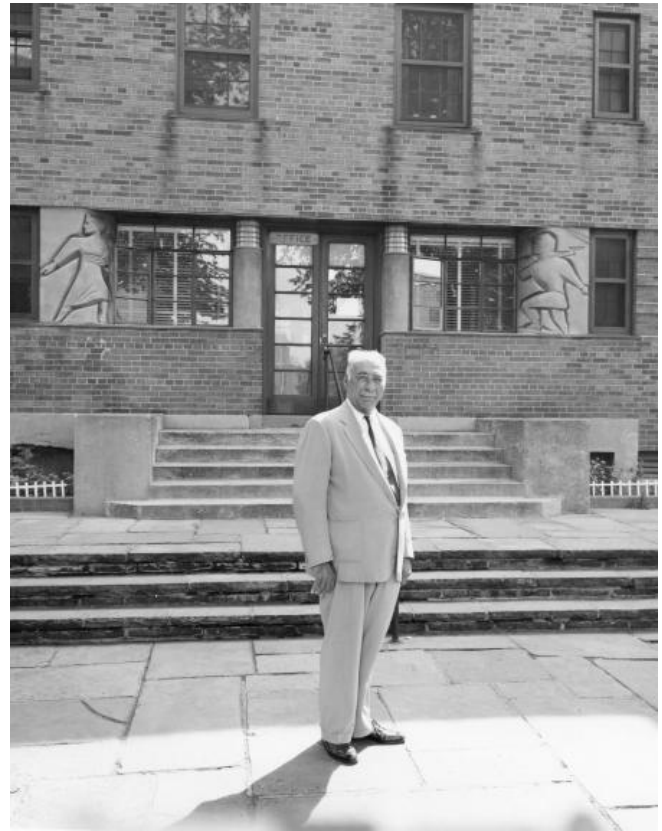


Figure 13: Willert Park Courts, Alfred D. Price standing in front of the entrance to the administration building. Source: Center for Urban Planning, SUNY at Buffalo, date unknown

Both of these housing complexes have been determined eligible for the National Register but organized neighbors and owners have managed to defeat the local landmarking of both sites. Willert Park Courts was approved for landmarking by the Buffalo Preservation Board but denied by the Common Council because neighbors "were against the designation." Shoreline received a vote of four to three in favor of landmarking; six votes were needed to pass so the complex was not landmarked. The State Historic Preservation Office is still reviewing the project, which is using state funds, and there is still a chance that this demolition could be put on hold. We are in dangerous territory in preservation law when neighbors can impact a landmark designation because they do not "like" the buildings and when preservation board members vote based on opinion of aesthetics over established criteria.

Buffalo has no non-profit dedicated to the preservation of modern architecture and there are only a handful of DOCOMOMO members west of Syracuse. The "Mid-Century Modern Buffalo" Facebook group, created by Joe Incao, has been useful in terms of sharing concerns and wins with over 450 members. Yet in the past year, advocacy efforts to save these two modernist affordable housing complexes from full or partial demolition have led to a public forum on modernism (co-sponsored with Preservation Buffalo Niagara, the Preservation League of New York State and DOCOMOMO US) and two local landmark designation submissions, both of which ultimately failed. We have a lot of work ahead of us to better inform western New York residents and even preservationists about the significance and nuances of modernism.

With these potential losses, the significance of documenting modern buildings while we still have them becomes even more important.

Looking to the Future



Figure 14: The Buffalo Evening News Building from Main Street, April 2014. Photo by Barbara Campagna

It seems that, weekly, we read of another Rudolph building becoming endangered or another Brutalist building being demolished. Would these buildings have fared better if our great critic Reyner Banham had never popularized the Anglicization of "Beton Brut" to Brutalism? These case studies in Buffalo demonstrate that certain buildings with the Brutalist label seem to be managing better than others. Temple Beth Zion and the Buffalo News Headquarters are well-maintained and still owned by the original owners who commissioned them. Of the two, Temple Beth Zion is considered by most to be beautiful. Although it is constructed of concrete, its symbolic ornamentation seems to be appreciated and understood. The Buffalo News Headquarters is both loved

and hated; its simplistic exterior may not be understood or appreciated by many but its glorious interior, which wraps around brilliant skylights, and its exterior walkway, which provides views of the waterfront and the grain elevators, provide great interest to occupants and visitors.

The public housing label on both Willert Park Courts and the Shoreline Apartments are the more challenging aspect of these two complexes. One Seneca Center's urban renewal history and site planning is likely its most difficult feature. The unornamented exteriors of all three, however, do not serve them well for the traditionalists in Buffalo. It is interesting to note that the only features at Willert Park Courts that neighbors and politicians care to save are the decorative concrete panels at the entrances.

Local planning of the Shoreline project began in 1963. That October, Buffalo's City Council approved with a vote of thirteen to one a waterfront urban renewal plan with proposed "high income and middle-income apartments, commercial developments, park areas and a marina."¹⁸ This plan was supported by statistical evidence from the 1960 US Census showing a general population decline within the city of Buffalo. Relocation of residents began in 1964 and by 1968 planning for the demolition of the "dilapidated or decaying homes in [the] rapidly deteriorating" neighborhood had begun."¹⁹ The two blocks that would become the Shoreline Apartments had contained numerous single- and multi-family houses, warehouses and a public school up until the demolition. The Rudolph complex was created to replace dilapidated blocks of streetscape in the 1960s and now, forty years later, we have come full circle.

References

- Campagna, Barbara. *Shoreline Apartments, Buffalo Local Landmark Nomination*, May 2014.
- Goodwin, Philip. *Museum of Modern Art, Guide to Modern Architecture: Northeast States*. New York: The Museum of Modern Art, 1940. pp. 48-49.
- Jensen, Robert. "Housing: One Government Agency Reaches for Good Architecture," *Architectural Record*, September 1972, vol. 152, no. 3, 145.
- Muschamp, Herbert. "Paul Rudolph is Dead at 78; Modernist Architect of the 60's," *New York Times*, August 9, 1997.
- Schmertz, Mildred F. "Paul Rudolph: Work in Progress," *Architectural Record*, November 1970, vol. 148, no. 5, 100.
- Stephens, Suzanne. "Standing by the Twentieth Century Brick," *Progressive Architecture*, October 1974, vol. 55.

Endnotes

1. eia, US Energy Information Administration, 2003, revised 2008, http://www.eia.gov/consumption/commercial/data/archive/cbecs/cbecs2003/detailed_tables_2003/2003set19/2003html/e02a.html, (accessed 04.01.14).
2. Prudon, Theodore. *Preservation of Modern Architecture*. Hoboken, NJ: John Wiley & sons, Inc., 2008.
3. Watson, Stephen T. "Unloved, Maybe, But Standing Tall." *The Buffalo News*, March 5, 2017.
4. Watson, *ibid*.
5. Watson, *ibid*.
6. Watson, *ibid*.
7. Silvan, Aaron. *The Buffalo Evening News*, DOCOMOMO Registry Fiche. http://docomomo-us.org/register/fiche/buffalo_evening_news_building, (accessed 04.01.14).
8. Watson, *op cit*.
9. McClellan, Madelyn. *Temple Beth Zion*, DOCOMOMO Registry Fiche. http://docomomo-us.org/register/fiche/temple_beth_zion, (accessed 04.01.14).
10. Galvis, Dillon. *One Seneca Tower*, DOCOMOMO Registry Fiche. http://docomomo-us.org/register/fiche/one_seneca_tower_former_hsbc_center, (accessed 04.01.14).
11. Batson, Nicholas. *Willert Park Courts*, DOCOMOMO Registry Fiche. http://docomomo-us.org/register/fiche/willert_park_courts_1, (accessed 04.01.14).
12. Miller, Nick. "Five Paul Rudolph Buildings Under Threat in Buffalo," November 5, 2013. <http://blog.archpaper.com/wordpress/archives/74839>, (accessed 04.01.14).
13. Miller, *ibid*.
14. Roxanne Button Kujawa, *Mid Century Modern Buffalo Facebook Group comment*, February 2014.
15. Miller, *op cit*.
16. Fink, James. "Owner Plans Improvements to Shoreline Apartments," <http://www.bizjournals.com/buffalo/news/2013/10/30/owner-plans-improvements-to-shoreline.html?page=all>, (accessed 04.01.14).
17. Goodwin, Philip. *Museum of Modern Art, Guide to Modern Architecture: Northeast States*. New York: The Museum of Modern Art, 1940. pp. 48-49.
18. Shoreline Apartments Historic American Building Survey Level II Documentation prepared by H.A.Z.Ex (Christopher M. Hazel, RPA, Principal Investigator and Jonathan Gunderlach, MA, Architectural Historian) in October 2009.
19. Shoreline Apartments Historic American Building Survey Level II Documentation prepared by H.A.Z.Ex (Christopher M. Hazel, RPA, Principal Investigator and Jonathan Gunderlach, MA, Architectural Historian) in October 2009.