RESPONSE TO CALL FOR PAPERS

Construction History Society of America

November 2, 2012: Construction History in the Americas 1850 – 1950

Title of Paper: **Theories of Organization and Assets: Innovative Delivery Approaches of Stone & Webster, The Austin Company and Chicago Bridge and Iron from the 1870s to the 1960s**

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Abstract: Burgeoning development within late 19th and early 20th century American cities was partially satisfied through the services of vertically consolidated firms that provided both professional expertise and trade/craft labor to support demand for new commercial, industrial and civil infrastructure projects. The research employs later permutations of Porter's value chain framework to compare and contrast three iconic American design and construction firms based on their differing market focuses, their organizational structures and their asset acquisition and deployment strategies.

As part of this research, firm asset categorization relies on a newer model developed for management auditing and firm valuation that includes not only traditional monetary and physical assets (which are typically the only assets captured in balance sheets and annual reports), but looks holistically at natural assets, legal/registrable assets, organizational assets, competence assets and motivational assets, as well as traditional monetary and physical assets. The model enables one to construct asset reliance diagrams containing both tangible and intangible resources. The study is intended to make a contribution by exploring a methodology for understanding how firms rely on asset groups coupled with idiosyncratic production processes to achieve operating success, corporate stock value and business continuity or sustainability.

Classical economic theory and the theory of law both describe firms as bundles of assets. The opportunity to assemble and exploit corporeal and volitional assets helps to explain why companies come into existence, and may also help to explain how some large-scale architectural – engineering – construction firms persist for over 100 years. Significantly, firms perform differently under the same conditions of technological opportunity and customer demand. Stone & Webster set out to concentrate on the market for alternating current electricity generation and distribution systems. The Austin Company pioneered a system of cast-in-place concrete industrial facilities design and construction. The Chicago Bridge and Iron Company specialized in highway bridges, oil tanks and elevated water tanks. To what factors can one attribute the differing levels of performance of large-scale design and construction firms? The research will posit some possible tendencies based on holistic factor input selections and production logic choices of three iconic American firms working in the built environment.

The Era of the Modern Timber Connector

Timber took on new importance as an engineering material in the United States with the 1933 introduction of the split ring connector. These 2.5 and 4 inch diameter steel rings greatly increased the strength at critical points in the average structural assembly changing the entire design practice and cost aspect of many types of structures including free standing wood towers spiring to 300 feet, clear span fire-retardant-treated timber trusses of over 250 feet, and the vernacular preservative treated timber trestle bridge.

Pre-framed and treated composite trestle bridge: Port Angeles, WA

The development of ring connectors started in Europe during World War I when gigantic military machines were demanding and consuming munitions and war materials in vast and increasing quantities. By the close of the war, iron and steel for structural purposes, and also the skilled labor needed for their erection, had become scarce and costly. Economical and low-cost construction became imperative and inevitably engineers turned to the natural resources of the forest.

Wood construction, although of traditional importance in Europe, had always been handicapped by the limitations of the timber native to the region, which is composed predominately of species comparable to our softer pines, eastern spruce, and the true firs. The lumber, which was cut mostly from second growth timber, was of small size and of considerably lower strength than our Douglas fir and southern yellow pine.

The economic necessity of utilizing such wood in construction compelled European engineers to seek means of improving the existing framing methods. The timber joint, long recognized as the critical link in every wood structure, was the logical point for improvement. With ring connectors, joints in timber framing could be made much stronger than with the ordinary bolt and plate fastening techniques. Coupled with this great contribution to structural efficiency, they were also simple, inexpensive, and easily installed.

These factors along with the superior structural properties of Douglas fir and southern yellow pine lumber as well as the growing use of preservative and fire retardant treatments immediately expanded the use of wood as an engineering material in the United States. By 1938, only five years after its introduction, the split ring connector had been utilized in over 10,000 structures firmly establishing its superiority over its predecessors. In 1942 the ring connector and timber construction were once again called on to relieve the pressure of war saving some 400,000 tons of steel per year.

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EXPERIENCE:

I have over 30 years of construction experience in both academia and industry. In addition to hands-on experience as a carpenter, superintendent, and project manager, I was a research scientist at Colorado State University, taught college courses in construction technology and forest products, and was a field representative for the American Plywood Association.

EDUCATION:

Ph.D., Forest Science (Wood Utilization), Colorado State University
M.S., Wood Science and Technology (Wood Engineering), Colorado State University
B.S., Industrial Construction Management, Colorado State University

SELECTED PROFESSIONAL MEMBERSHIPS:

ASTM International (ASTM)
Forest Products Society (FPS)
International Code Council (ICC)
National Fire Protection Association (NFPA)
Society of Fire Protection Engineers (SFPE)
Society for Wood Science and Technology (SWST)

RECENT PROFESSIONAL SERVICE ACTIVITES:

ASTM International
- Committee E05 on Fire Standards

Colorado Chapter International Code Council
- Code Change Committee

Forest Products Society (Elected)
- Board of Directors
- Trustee – Rocky Mountain Section
- Vice Chair – Rocky Mountain Section
- Secretary/Treasure – Rocky Mountain Section

National Fire Protection Association (Appointed)
- Technical Committee on Manufactured Housing
- Technical Committee on Fire Risk Assessment Methods
- Technical Committee on Forest and Rural Fire Protection
- Technical Committee on Hazard and Risk of Contents & Furnishings
- Building Code Technical Committee on Structures, Construction and Materials
- Building Code Technical Committee on Building Construction

The earliest iron roof structures and cast iron staircases in the U.S.

This presentation will describe the earliest iron roof structures and cast iron stairs in the U.S., dating from the second quarter of the 19th century. It arises from the discovery of wrought iron roof trusses spanning the two terminal gatehouses of Boston's 1848 Cochituate aqueduct, Boston's first public water supply system. Its design involved two important early professional engineers John Bloomfield Jervis and Ellis Sylvester Chesbrough. These appear to be the oldest extant "iron roofs" in the U.S. One of these gatehouses also has a continuous wrought iron roof deck and the oldest extant cast iron staircases in the U.S. intended for public use.

Until now the oldest known extant U.S. wrought iron roof trusses were in William Strickland's Tennessee State capital, installed 1852. The little known, long lost, roof structures of Strickland's Philadelphia Gas Works retort-houses, of 1835-37, were the only earlier recognized U.S. examples. Two other cast iron roof structures of the period have also recently been identified, although they too remain little known

In the course of this research six additional no longer extant U.S. "iron roofs," earlier than or contemporaneous with those of the aqueduct gatehouses, have been identified (or recognized as significant for the first time). Also newly recognized is the extant, and structurally remarkable, iron roof of the 1848-52 U.S. Custom House in Savannah, Ga. It too predates Strickland's Tennessee State capital trusses.

At least six of these pre-1852 roof structures were wrought iron. Two combined cast and wrought iron. Four spanned gas works retort houses. Three spanned railroad buildings. The two earliest non-industrial examples were in or near Boston — on Harvard University's 1837-40 Gore Hall Library and the 1841-42 Boston Merchants Exchange, designed by Isaiah Rogers.

Attention will be paid to the unusual accordion-pleated, self-spanning roofs of the Boston Merchants Exchange and Savannah Custom House. Both of these also incorporate trusses of unusual but differing designs. Both of these fireproof buildings had iron stairs. Both probably also had jack-arch brick vaulted ground floor ceilings supported on iron beams —early non-industrial examples in the U.S.

A handful of earlier, wholly or partially iron, U.S. staircases, identified mostly for the first time, will be touched upon. A link will be shown between the Cochituate gatehouse staircases and the Boston Athenaeum, and a circumstantial link suggested from those buildings to the first building by Ammi B. Young to significantly use iron. As Architect of the Treasury beginning in 1852, Young is often credited with fostering the wider adoption of iron building components in the U.S.

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David B. Steinman – American Bridge Designer

David B. Steinman was a pioneering and prolific bridge designer in an era of dramatic developments in the design and construction of long-span bridges. Many of his bridge projects dramatically shaped the development of American cities and their interconnecting highway systems. In the early 20th century, long, slender, steel suspension bridges were the most significant and coveted building projects for structural engineers. As America developed and the demand for new infrastructure increased, the need for long-span bridges grew as well. Steinman's background, education, professional training, and personality thoroughly prepared him for the challenges of designing record-setting bridges and getting them built.

His early abilities in math and successful college career at Columbia University, where he earned three degrees, foreshadowed a keen aptitude for structural engineering. After an apprenticeship with noted bridge designer Gustav Lindenthal, where he worked alongside his later competitor and rival, Othmar Ammann, Steinman partnered with an experienced bridge designer, Holton Robinson. Their consulting practice was well established when the fateful Tacoma Narrows Bridge collapsed in 1940. Steinman had consulted on a design for that bridge, but ultimately did not win the contact. The collapse had a profound impact on Steinman, as well as the entire engineering profession. In fact some of his own bridges, such as the Deer Isle Bridge in Maine, also had significant stability issues due to wind loads. He researched and wrote many articles and letters in the leading engineering journals of the day promoting his theories on wind effects on bridges. Steinman argued extensively on the best ways to stiffen bridge decks. He was also a strong proponent of sharing information for the greater good of the engineering profession.

Although he had built several long-span bridges before the Tacoma Narrows incident, his most important commission was the Mackinac Bridge of 1957, which spans the Straits of Mackinac in northern Michigan. "Mighty Mac" is a record setting, yet graceful, suspension bridge in a dramatic and extremely windy location. The design of this bridge was directly influenced by Steinman's own research, and his experiences on other bridge projects, both before and after the Tacoma tragedy.

David Steinman was one of the most significant contributors to developments in the design and construction of long span bridges. This paper will analyze his pioneering contributions to aerodynamic bridge design and research, and to the profession of engineering in the early 20th century.

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American Construction 1850-1950

Regional Material Investigation: 1940-50
Paul Rudolph + Ralph Twitchell

Abstract by
Christopher Domin + Joseph King

In the 1940s Sarasota, Florida was a haven for artists and writers that were drawn to the area by the sub-tropical climate and cultural life. In this engaging context, Paul Rudolph and Ralph Twitchell embarked on a series of material investigations that employed endemic materials and leveraged nascent structural and spatial concepts-- an ideal opportunity to test theory with practice. A partnership with local inventors and builders provided the necessary synergy required to bring new materials and technologies to the local building culture. Beginning with multiple iterations of houses built of “Ocala Block” and heart cypress timbers, Rudolph and Twitchell expanded their practice to include new materials and techniques developed for the defense industry during WWII from which they created building assemblies that were unimaginable at the beginning of the decade.

This presentation will investigate the design and construction of the Twitchell Residence (1941), Lamolithic Houses (1948) and Cocoon House (1950) based on newly available primary source material from the Joseph Steinmetz Photography Archive and construction documentation housed in the Paul Rudolph Archive at The Library of Congress. These buildings are indicative of the robust experimental architecture culture that developed rapidly during the 1940s along the West Coast of Florida and became the groundwork for what would be later known as the Sarasota School of Architecture.

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The World's Largest Office Building: Development of Concrete Skeleton Frame Engineering and Construction

This paper presents the development, evolution, and national dissemination of the concrete "skeleton" frame as a cost-effective and industry-wide accepted structural system for buildings. The development of the modern skeleton frame is traced from its first reported use at the Ingalls Buildings of 1903 in Cincinnati, Ohio to the Plymouth Building of 1910 in Minneapolis, Minnesota. Despite the fact that the concrete skeleton frame was patented in 1902 by Ernest L. Ransome, the system was not fully embraced or understood by the architecture and engineering professions, nor by the construction industry. The Ingalls Building was described by Carl Condit as the first reinforced concrete skyscraper, "among the major pioneer works of reinforced-concrete construction." However, the Ingalls Building did not take advantage of the frame technology at the exterior of the building; its floor beams frame into traditional load-bearing exterior masonry walls. Likewise, in Minneapolis, the Northwestern Knitting Company (1904) engineered by C.A.P. Turner, a Minneapolis-based innovator with national recognition best known for his Mushroom Flat Slab System, also used exterior load-bearing masonry walls. Industrial buildings, termed "daylit factories" by architectural historian Reyner Banham, were the first to accept the concrete skeleton frame as a complete system. The proliferation of factories and warehouses in the early Twentieth Century created a demand for large, cost-effective, and quickly constructed buildings. Skeleton frame detailing varied and developed through its use in factory construction. However, it was not until 1910 that the use of concrete skeleton framing at the exterior was accepted for an office building with a high level of finish and architectural detailing. A key feature of the Plymouth's frame construction is the spandrel beam built integrally into the exterior edge of the floor slab. The spandrel beams support the exterior decorative brick wall, allowing for the use of a curtain-wall system and large window openings. Use of a concrete skeleton frame structural system also made it possible to dramatically alter the façade in 1936. At the time of its construction, the Plymouth building was described as the "largest all reinforced concrete building in the world." Skeleton framing was made possible, in part, by the rise of an integrated design and building industry for the specialized field of concrete design and construction. The John M Ewen company of Chicago, "Engineers and Builders" were selected for construction of the Plymouth Building, despite the availability of local engineers, including C.A.P Turner, and experienced concrete contractors. While the concept of skeleton framing was well understood and used in structural steel framing well before the Twentieth Century, it was not until the development reinforced concrete engineering knowledge and the evolution of cost-effective construction delivery methods that the concrete skeleton frame could be developed at a national level in America.

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From Bridge to Tabernacle: Town Lattice Trusses in the Rocky Mountains, 1861-1867

Town lattice truss bridges were built over the Jordan and Weber Rivers in Utah in the early period of Mormon settlement. The success of the Town lattice truss for bridges encouraged builders to adapt the system for the arched trusses of the Salt Lake Tabernacle which set the North American record for an interior clear span. Not designed using numerical analysis, the structures were built with rules of thumb, experience, and limited model testing.

The White Bridge (1861) was designed by Henry Grow, prefabricated in Brigham Young's workshop, and then installed over the Jordan River with a 132 foot span. The lattice planks were held in place using wood pegs, a necessity in the Rocky Mountain valley before the arrival of the railroad and access to supplies of iron bolts. Installation of additional piers under the bridge enabled it to survive until 1908, the lattice truss design adapting to new load path configurations created by the additional piers.

The Salt Lake Tabernacle structure (1867) was designed also by Henry Grow, and has the same 132 foot clear span as his White Bridge. However, the straight trusses of the bridge were formed into arches with two sets of curvature, approximating an ellipse. The arched trusses were "analyzed" by load testing a scale model, although the model apparently did not predict the local failure of wood tension connections which permitted the trusses to deflect into a stable three-hinged arch. This truss was held in place with wood pegs like its predecessor, with a smaller number of iron bolts hauled into the valley on wagons. This National Engineering Landmark survives to this day, with most of the trusses carrying their original load.

The use of the Town Lattice truss in Utah during the 1860s represents the last stage of truss design prior to the introduction of numerical methods of analysis. While Whipple (1849) and others had published methods of numerical truss analysis, builders in the Intermountain West forged ahead building record breaking spans with scale models and builder's judgment. The adaptability of the Town lattice truss, with its multiple diagonals ready to respond to whatever load path was applied to them, provided an adaptable structural form that contributed to the success of these pre-railroad era projects in Utah.

Prefabrication and social architecture. Richard J. Neutra and the project for Latin America.

Catherine R. Ettinger

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The development of modern architecture relied, to a large degree, on industrialized building practices, that appeared first in Europe and the United States. As the modern project was exported to the developing world, the use industrialized materials and methods was often problematic. This paper engages the thought of the Austrian born American émigré architect Richard J. Neutra on the subject of how to promote modern building and the use of prefabrication in Latin America.

Neutra, known for his spectacular Southern California Houses, in particular the Lovell Health House which was the first American use of a steel frame in domestic architecture, became interested in Latin America through work he carried out in Puerto Rico in the 1940's on community schools, hospitals, clinics and community centers in which he applied prefabricated elements in designs particularly sensitive to the tropical climate.

Working from this experience as well as from housing developments he had designed in California and Texas, Neutra published *Architecture of Social Concern in Regions of Mild Climate* in 1948 in Brazil. In this book Neutra makes an interesting argument for industrialization of the building industry in Latin America, considering that the use of prefabricated elements in "the hinterlands" would erase the differences in health and educational opportunities between rural and urban areas. In this argument, the solution to Latin America's social problems lay in the application of new building methods that would guarantee the erection of cheaper schools, hospitals and housing. For Neutra, the process of industrialization is paves the road to "civilization".

This paper examines the text itself as well as Neutra's promotion of his ideas through publications and lectures given in Argentina, Peru, Mexico, Brazil, Venezuela, Cuba and Dominican Republic using archival materials. By the mid-century as Le Corbusier's influence among young Latin American architects waned, Neutra, whose presence in the region has been largely ignored, became a central figure in Latin American architecture.

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Short bio:

Catherine R. Ettinger is a full profesor in the Architecture School at the Universidad Michoacana de San Nicolás de Hidalgo where she has occupied diverse administrative positions and currently teaches architecture theory. She was trained as an architect with a Master's Degree in Preservation of Historic Sites and Buildings (1998) and a Doctorate in Architecture (2001) from the Universidad Nacional Autónoma de México.

She has authored seven books including *Arquitectura contemporánea. Arte, ciencia y teoría* (Plaza y Valdés 2008) and *La transformación de la arquitectura vernácula en Michoacán. Materialidad, espacio y representación* (UMSNH y Colegio de Michoacán, 2010) and has edited another nine including *Modernidades arquitectónicas. Morelia. 1920-1960* (Gobierno del Estado de Michoacán, H. Ayuntamiento de Morelia, Congreso del Estado de Michoacán, 2010) and *La situación actual de la historiografía de la arquitectura mexicana* (UNAM y UMSNH, 2008).

Her research interests include architectural theory and modern architecture and is currently working on the topic of the flow of ideas between the United States and Mexico in the first half of the twentieth century through the architectural press. She is a national researcher (Level II) in Mexico and was an Edmundo O'Gorman scholar at Columbia University during winter 2012.

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Elevator Shaft Construction 1880 - 1925

While the importance and impact of the elevator has been recognized in architectural history and the history of building technology, its actual placement in buildings – beyond studies of elevator-bank planning – has received limited attention. This paper will provide the first examination of elevator shaft construction and will focus on the period from approximately 1880 to 1925. Areas of investigation will include guide rail installation and placement, shaft doors and thresholds, window design, ventilation, pit and machine room design, and overall shaft construction.

The source materials used in this investigation include manufacturers' catalogs, architectural and engineering periodicals, patents, and H. Robert Cullmers' 1912 book titled *Elevator Shaft Construction*. These diverse materials provide insights into the complexity of elevator shaft construction, the gradual development of the requisite working drawings required to communicate this information, and changes in shaft design from the late 19th to the early 20th century. This investigation also serves as a case study of a unique and overlooked aspect of building design and construction history.

Abstract for a proposed talk for the CHSA Construction History in the Americas conference.

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The American barn is an important landmark structure in the history and architecture of America's landscape. Barns housed our livestock, stored our grains, and protected our farm implements from all but the most severe elements. The progression from a country of subsistence farmers to one that feeds the world could not have happened without the large spaces that the barn created. One common barn type was the Gothic Arch Barn, with its pointed Gothic arch that evokes European cathedrals of our ancestors, to the clay-tile or concrete side walls that supported the roof and enclosed the lower levels. This talk will describe the Gothic Arch Barn and the history of the construction methods that were created in the second half of the 19th century to build the barn.

This talk will introduce the Gothic Arch Barn with pictures and will describe the history of the barn type. The talk will go into some depth of one construction technique that made the shape possible – the curved glued laminated roof rafters. A history of glued laminated timbers will be given, starting with the first patented system by Otto Hetzer in Weimar, Germany in 1872. Pictures of the first notable buildings with curved glued laminated roofs will be shown, including the domed roof at the University of Zurich. The talk will describe the system's introduction by Max Hanisch in 1934, and the creation of the Rock Island Lumber Company (Rilco) in Peshtigo, Wisconsin. Rilco created kits that were produced in their factory and shipped throughout the United States. These kits were simple enough to be built by local builders and farmers but large and robust enough to meet the needs of growing farms. Close-up photos of one farm near Minneapolis will be used to describe the construction details and present the adaptive reuse of one historic barn.

Underlying Geometry and Stereotomy Studies of Three Ribbed Vaults Constructed in Mexico during the Sixteenth Century.

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Ribbed vaults find their origins mainly in European gothic cathedrals. The methods of construction applied to build this type of structures involved the implementation of practical geometry. This practical approach observes simultaneously to the part and the whole. This twofold approach to construction was necessary to achieve stable structures and required of a meticulous process that involved the detailed carving of large pieces of rock. The rib, as John Fitchen pointed out, is a constructive solution that emerged from the necessity to cover two intersecting surfaces of a vaulted structure. The use of the rib evolved to the point that complex patterns and designs emerged, converting ribbed vaults in laborious stone weavings. At this point in history Iberian master builders used the technology with exquisite refinement giving birth to renaissance churches that show elaborated vault designs. This technology was imported to the Americas; the integration of European building technology with Mexican indigenous artisanship gave origin to outstanding architectural models inspired by the spirit of the Renaissance utopia.

This paper focuses on the ribbed vaults found in the churches of *Yanhuitlán, Teposcolula*, and *Coixtlahuaca*, located in southern Mexico. The roof systems of these monumental pieces of architecture used the most advanced technology at the time: ribbed vaults constructed with geometric rigor and elegant stereotomic solutions. This investigation scrutinizes the techniques applied to the construction of these buildings under the light of stereotomy. The work is anchored in the significance of local interpretation of constructive principles by stating the symbiotic process of indigenous masonry techniques and European applied geometry.

The methodology connects digital technology with the methods introduced by sixteenth-century documents such as the manuscripts of Hernan Ruiz (1580) and Alonso Vandelvira (1560). The point clouds obtained from 3D laser scanning documentation are processed and edited trough means that make the data readable in the NURBS environment. These digital models are manipulated and reconfigured in Rhinoceros software in order to be sliced, dissected and broken into smaller pieces. The process involves the analysis at the macro and micro geometries revealing the design criteria and the stereotomic operations necessary to assemble the ribs. As this analytical process serves to reveal the constructive solutions and the underlying geometry of the three vaults, it positions these buildings in the global context of construction history and the transmission of building technology from Europe to the Americas.

Keywords: Stereotomy, Masonry, Vaults, Analytical Methods, Digital Models, Geometry

Getting the Job: How U.S. General Contractors secured building contracts, 1870-1970.

ABSTRACT: Many books and articles have been written about architects, and the buildings they designed. This paper chronicles the stories of four builders and their drive to "get the job." It examines their successes, failures, and the real profits achieved in the building process.

KEYWORDS: Builder, Contractor, General Contractor.

INTRODUCTION

I have been involved in the construction and renovation of buildings for over 40 years, and have found it difficult to research and find stories directly dealing with the most important part of a builder's livelihood, which is the ability to get work. This paper has been prepared for the sole purpose of setting forth the stories of George A. Fuller, Paul Starrett, Louis J. Horowitz and John McShain and their drive to build businesses and get jobs.

George A. Fuller

George Allon Fuller was born in 1851 in Massachusetts. He completed his education at Massachusetts Institute of Technology, and began work as an intern architect with his uncle. In 1876 he became a member of the architectural firm of Peabody & Stearns in New York. In 1880 he moved to Chicago in partnership with another architect to start building. Two years later, Fuller dissolved his partnership to start his own firm The George A. Fuller Company. One of Fuller's first commissions, in 1884, was the Chicago Opera House, designed by Henry Ives Cobb and Charles S. Frost. Fuller did something daring and original: he took full responsibility, including supervising, coordinating, administering and holding all the subcontracts involved in constructing the project, under a "single contract." He charged a fee (similar to the architect) for this service. This was called cost plus fee contracting. Fuller originated the single contract system. Hence, the term "General Contractor" was born when he built the Chicago Opera Building. Because Fuller was trained as an architect, owners and other architects preferred the cost plus contract approach because it allowed them to work more collaboratively with the builder than under a lump sum arrangement, and help develop new solutions to construction problems. William A. Starrett, a former employee of Daniel Burnham and George Fuller, wrote in his book <u>Skyscrapers and the Men who build them</u> (1928), said "Contractors until the mid to late 1880's usually had been boss carpenters or masons, men of little capital and foremanship, with little technical education, who executed sub-contracts under the supervision of the architects. As buildings grew in complexity architects were overwhelmed with the multiplicity of burdens for which many of them had little training and no aptitude. Fuller rose contracting from a limited trade to both an industry and a profession, visualizing the building problem in its entirety-promotion, finance, engineering, labor and materials; and the architect reverted to his original function of design. Fuller first was a salesman who sought out property owners and promoted new buildings; secondly, an expert who understood the income possibilities and necessities of office buildings; then a financier who arranged the capital and; next an engineer competent to oversee every phase of modern building; and lastly, a business executive, buying and assembling materials to the best advantage and commanding a staff of assistants and an army of sub-contractors and laborers". [1]

Fuller died in 1900 and his firm was carried on by his son- in- law Harry S. Black. The New York Times, in commenting upon Fuller's progress said; "Perhaps no other firm in the history of the world has done more to revolutionize the building trade." [2] Like Henry Ford in the automobile industry, Fuller didn't invent the building business but changed dramatically how it was to be run in the future. Prior to his death, in 1900 he had built: the Monadnock (both sections), Marquette, Fisher, Old Colony, Rookery, many of the Columbian Exposition buildings in 1893 and other Chicago landmarks.   The George A. Fuller Company went through many owners, until it was liquidated, - and finally closed in 1994. Its name was acquired by Louis Capelli as a subsidiary of his real estate business in 1998 and still operates in Valhalla, New York.

The Rookery Chicago Illinois

The Monadnock Chicago Illinois

The Reliance Chicago Illinois

Paul Starrett

Paul Starrett was born in Lawrence, Kansas in 1866, and later moved to Highland Park, Illinois with his family. He and his brothers Theodore, Ralph, Goldwin and William, all worked for Daniel Burnham in Chicago in the late 1800's, starting out as draftsman, eventually becoming superintendents on various jobs. Theodore went to work for Burnham and Root on the Rookery; the contractor was the George A. Fuller Company. Paul kept a journal with tables, facts, and notes pertaining to design and construction information and would study this journal constantly. Burnham took a liking to Paul and told Starrett, "Paul, let me give you some advice. This note taking about concrete, steel and window frames is all very well, but don't you know that you can hire any number of civil engineers, mechanical engineers, and electrical engineers, who will be absolutely content to spend their whole lives in doing routine? "You Starrett boys are different. You have a genius for organization and leadership. My advice to you is to drop this note taking. Study the organization side of the business."[3]

Starrett became superintendent of the Land Title and Trust building in Philadelphia. He developed a nice working relationship with the contractor on that job, and shortly after the building was completed, the contractor approached Starrett and offered him a $3,000/year salary (exactly what he was making with Burnham**) plus 25% of the profit on all business he could bring into his office.** Starrett believed this was his opportunity to get into the building part of the business and discussed this offer with Burnham. Burnham questioned Starrett's **ability to bring in business** but Starrett believed he could. According to Starrett, Burnham said "**Well, Paul, you'll have to- bring in business, if you intend to become a builder. Remember this, 75 per cent of your success will be your ability to go out and get the job."[4]** Burnham shook Starrett's hand and said "Good luck Paul. If you ever want to come back, your job is waiting for you."[5] Unfortunately Starrett's deal with the builder never materialized, so without a job and deciding not to go back to Burnham, he walked over to the George A. Fuller Company. Theodore had started working there shortly before Paul arrived, Ralph and William followed shortly after Paul. Paul met with Harry S. Black, who was the vice president (and George Fuller's son- in- law). Black hired Paul and he began work for Fuller in 1897 in Baltimore, at a salary of $2,400/year. During Starrett's early years with Fuller (1897-1903) he began to bid and negotiate work in Baltimore and Washington D.C., completing a Baltimore project on time for a small profit and the Washington Star Building, on time, but at a loss. The new 12 story Willard Hotel with Henry Hardenburgh, the architect, was his next project. It was designed, estimated and bid

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by Starrett, and Hardenburgh ‘on the back of a napkin’ at a cost of $800,000. The project was completed on time with a substantial profit.

After Fuller died in 1900, Black became President and moved the corporate headquarters to New York from Chicago. Starrett’s first project in New York was the Flatiron (Fuller) Building, which was designed by Burnham’s firm, now called D.H.Burnham & Co., and owned by Fuller. Black, representing Fuller as owner, argued repeatedly with Burnham, during the course of the design and construction, especially about the small corner of the property Black wanted to rent and Burnham thought it would detract from the design of the building. Starrett’s relationship with his old boss kept things moving along nicely, by concentrating on the construction and working amiably with Burnham’s design architect Frederick Dinkelberg. In 1899, Theodore left Fuller and became partners with Henry Thompson to form the Thompson-Starrett company. Paul’s brothers Ralph and William worked for him at the Fuller Company for a while, but eventually joined Theodore, and their other brother Goldwin at the Thompson-Starrett Company, which became Fuller’s biggest rival at the time.

Throughout Starrett’s career he was able to work within an owner’s budget, suggesting changes to the plans to reduce cost, much like the methodology used by George Fuller when he began his business. This talent helped him get work and continue to build relationships which led to other jobs. Clients and architects would also recommend him for other projects. Starrett’s relationship with Mckim, Meade and White on previous projects, led to his getting the Pennsylvania Railroad station job in New York. Starrett was able to negotiate a contract on Fuller’s behalf at cost plus- 8 percent fee on the work Fuller actually executes and cost plus 5 per cent fee on their subcontracts. The construction cost was $8,000,000 in 1910, Fuller’s largest project to date. The successful completion of the station led Fuller to obtain the contract for the main New York Post Office project which was being built adjacent to Pennsylvania station, and was also being designed by Mckim, Meade, and White.

Starrett was an employee of the Fuller Company for approximately 25 years, and president for 17 years. According to Starrett, The George A. Fuller Company executed building contracts totaling $368,000,000, and some believe, at the time, they were the largest building company in the United States.

During Starrett’s employment and oversight, Fuller and Company also built The R. H. Macy and New York Times Buildings in New York, the Frick Building in Pittsburgh, the Lincoln Memorial in Washington, D.C., the Plaza Hotel and Commodore Hotel (now the Hyatt Regency on 42nd St.) in New York, the Chateau Laurier, and Ritz Carleton hotel in Canada, and many other projects in the U.S.

In 1922 Starrett left the Fuller Company, and with his brother William formed Starrett Brothers. Shortly thereafter the name changed to Starrett Brothers and Eken, with the addition of Andrew J. Eken another former Fuller man. William was younger, aggressive, and connected with many enterprising young financiers and real estate speculators, and through those connections, the Starrett's became real estate developers, builders and third party contractors, much like their mentor George A. Fuller. According to Starrett "The greatest speeds and highest skyscrapers came after I started to build under my own name".[6] In the mid to late 1920's, they built the New York Life Insurance building, the McGraw-hill Publishing Company building both in New York, and the 70 story Bank of Manhattan Building (40 Wall Street) among others. The crowning achievement of Starrett's career was the Empire State Building.

The Empire State company asked five leading builders to appear before the directors and make proposals. It has been speculated that Starrett, Fuller, Turner, Fred T. Ley Company (who erected the Chrysler Building), and Thompson-Starrett, were the builders. Paul and his brother William attended the meeting, with Al Smith (former governor of New York and now president of the Empire State Building Company), John Raskob, and Pierre du Pont, Louis Kauffmann, and some other prominent investors in the project, as well as Richmond H. Shreve of the Shreve, Lamb, and Harmon architectural firm. Smith began the meeting by saying to Paul Starrett, "Well what have you got to say for yourself?"[7] Starrett said that they were there to prove that they were the best builders to put up the building, and they were the only firm in New York whose members had been educated as architects before going into the building business. They had just built the New York Life, Metropolitan Life, and the Bank of Manhattan buildings in record time. He emphasized speed in his presentation, since the faster a building is completed the sooner rents can be collected and loans can be paid back. Smith asked him what his fee was and Starrett said Six Hundred Thousand. Smith said "that's you're asking price" and Starrett said "No, that's our real price!"[8] This back and forth between Smith and Starrett was the beginning of a bargaining/negotiation effort between the men. The discussion turned to the amount of equipment Starrett's organization had on hand to handle a building of this size, and the amount of work they would perform with their own labor. Starrett knew this question would come up since he believed one of his competitors would boast about how much equipment they had and the abundance of work they would perform themselves. Starrett said that he believed that this building was so special that the normal equipment most builders had on hand would not be able to handle this project. He said they would buy new

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equipment and at the end of the job sell it and credit the difference back to the owner's account. Starrett also said they wouldn't perform any of the individual trade work themselves, if they could award subcontracts for less money. Smith asked "how long will it take you to do the job? Starrett said "to tear down the old Waldorf Astoria Hotel and put up the building 18 months."[9]

Shortly after Starrett and his brother got back to their office, Smith and Shreve came over. Smith said "Paul, we have decided to have you build the building for us. And we are going to give you $500,000 for it." Starrett agreed, if he could make minor changes to the contract and allow them to carry their own liability insurance.

Title to the site was acquired by the owners, on 6/1/1929; demolition commenced on 9/29/1929, and completed on 3/12/1930; the building was completely finished on 3/1/1931, 21 months after the site was acquired, 5 ½ months for demolition and 11 ½ months for construction.

Starrett Brothers and Eken filed bankruptcy in 1935, as a result of real estate failures caused by the depression. Paul Starrett retired in 1938 and died in 1957. Andrew Eken became President in 1938 and continued through 1955. Starrett continued to build and develop under different names (Starrett Housing, and Starrett Corporation) in 1977 H.R.H. Construction Company was acquired and became the general contracting arm of the Starrett Corporation. H.R.H. filed for Bankruptcy in 2011.

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The Willard Hotel Washington, D.C.

The Flatiron (Fuller) Building New York City

The Empire State Building New York City

Louis J. Horowitz

Horowitz was born in Poland in 1875, moving to New York City in 1892. Horowitz was self-taught, and got a basic understanding of the real estate and loan brokerage business from his father. During the period 1895-1900, with no money, he formed various partnerships involving loan brokerage, real estate development, and building of small apartment buildings in Brooklyn. His partners had the capital, while he provided the sweat equity for a share of the profits. Using the profits he acquired, in 1900 Horowitz planned a 12 story building in Brooklyn Heights called the Tourraine. The building was too complex for a one-man organization, so he hired the Thompson-Starrett Company. With the help of Thompson-Starrett he finished the building in 1902. The building became a successful operation and he sold it for a nice profit. The Thompson-Starrett Company started by Theodore Starrett and Henry S. Thompson in 1899, had by 1902 built a reputation as reputable builders. Horowitz joined Thompson-Starrett as assistant to the president at a salary of $2,500/year, handling all financial matters for the firm, and some sales. He was primarily hired to put their affairs in a positive cash position rather than a negative position. Horowitz discovered, through his Chicago office manager William Dinwiddie, that the Sears, Roebuck's main headquarters was being planned for the West side of Chicago. George A. Fuller Company and Thompson-Starrett were being interviewed for the project by Julius Rosenwald, head of Sears, and his attorney William Loeb. The architects were Nimmons and Fellows, and a $ 4,000,000 construction cost was established. Horowitz, during his presentation described the Thompson-Starrett organization, and the experience of William Dinwiddie who would be in charge of the project. After his presentation, Rosenwald said "Before you came in here I talked with the head of a firm competing with yours; while he talked I was persuaded that I could not do better than to give the contract to him. I really do not know what to do." Horowitz, the ultimate salesman responded as follows "Now, Mr. Rosenwald, I understand your confusion. You've never seen me before in your life, and I am asking you to give me a $4,000,000 job and a fee of $ 250,000. [10]Horowitz proposed that the Thompson-Starrett Company build the project for a fee of one dollar. After the job is finished Rosenwald alone would determine if they earned their $250,000 fee. Rosenwald consulted with his attorney and offered the job to Horowitz for a fee of $40,000, or one percent of the cost, because they felt it would make a stronger arrangement legally. Nothing in the contract would refer to any further compensation. The project went exceptionally well according to Charles Condit in his book <u>The Chicago School of Architecture,</u> "For all their unprecedented size, the five major structures and their subsidiary facilities were built in exactly twelve months, from January 24, 1905, to January 22, 1906. Only the exigencies of war have brought comparable feats of construction." [11]After completion of the project Horowitz received a letter from Rosenwald which said "Your contract has been audited and found correct. I enclose our check for $40,000, representing the fee the Thompson-Starrett Company, as provided for in the contract we signed." In addition as he read further "By a private agreement between us I was to decide, when the job was completed, whether you were to have the full fee as originally proposed by you. Because your company did what you said it would do, I enclose another check for $210,000. There was a last paragraph to the letter, because you accomplished something beyond our expectations I enclose an extra check for $50,000." [12] Paul Starrett, Will Dinwiddie's brother in law, commented in his memoir, that Rosenwald was so pleased with the project he presented Dinwiddie with $75,000 of Sears, Roebuck stock.

The Woolworth building proposed in 1910 was to be the largest skyscraper in the world and was actively being pursued by many prominent builders. The field was narrowed to the Fuller Company and the Thompson-Starrett Company. Cass Gilbert was hired to design the building, and would wield considerable influence with Woolworth in the selection of the builder. Starrett's fee for the job was $300,000, plus the cost of the work. Starrett believed he secured the contract but learned later that Thompson-Starrett had gotten the job, for

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the same fee. As far as Starrett knew it was Gilbert who influenced Woolworth in giving the job to Thompson-Starrett, which was true. Gilbert had also developed a mistrustful view of Fuller's new parent organization, the United States Realty and Construction Company. Gilbert, as architect, working for Black on an earlier building, believed he was treated unfairly; Gilbert responded by getting the job pushed in Horowitz's direction.

Woolworth, tried to renegotiate Horowitz's fee of $300,000, and pay him less, but after lengthy discussions with Horowitz, they signed the contract on April 20, 1911, and the building was dedicated by President Woodrow Wilson on April 24, 1913.

The firm became one of the largest construction firms in the United States. Some of the projects they built were the Union Station in Washington, Gimbels department store in New York, the Field Museum, and Palmer House hotel, Continental and Commercial Bank Building in Chicago, the Equitable Building, Hotel McAlpin and Waldorf Astoria in New York, among many others. Horowitz retired in 1934 and died in 1956. The Thompson-Starrett Company experienced turnover in leadership, ceased building, and in 1968 was merged with the Elgin Watch company.

The Sears, Roebuck and Company Headquarters Chicago, Illinois

The Woolworth Building New York City

THE WALDORF · ASTORIA
PARK AVENUE AT FIFTIETH STREET · NEW YORK 22 N.Y.

John McShain

John McShain was born in Philadelphia in 1898. His father was a carpenter who, at the turn of the century, became a builder, - of churches, schools, rectories, and convents for the Catholic archdiocese. McShain never finished college and took over his father's business when he died in 1919. McShain spent most of his time in the field learning the various trade disciplines. He took a drafting course at Drexel Institute of Technology in the evenings, becoming self taught in bookkeeping and estimating. Winning his first job with a low $46,000 bid on a parish school, the job went well, and he made money. His business journal indicates that he allocated $1,200 to overhead, paid himself $5,600, and still showed a profit of $5,809, or somewhat over 12 per cent. He also did the job quickly; it was completed in less than a year in 1923. Working fast helped to prevent inflation from eating into profits. McShain continued to do work for the Catholic Church and by 1923 had invested a significant portion of his profits into his business allowing him to expand and take on larger projects. In 1927 he landed his first public and secular contract, Lansdowne High School in Lansdowne Pennsylvania. McShain put his own capital at risk using it as collateral for bonding which larger jobs required. The availability of sufficient capital allowed him to have better working relationships with subcontractors since he could pay them before he himself was paid by an owner. A good capital reserve was also a buffer in lean times. McShain was a tireless worker, doing the estimating, bookkeeping and constantly searching for new work. Throughout the early and mid 1930's McShain concentrated on public projects, in which the low bidder got the work. McShain's talent as an estimator kept his bids low. In the early 1930's with the beginning of the depression he shifted to federal work as most private and some state and city work became scarce. In 1932 McShain won his first federal contract, for a 12 story Naval Hospital in South Philadelphia. His bid, $2.772 million, was only $24,000 lower than second place finisher, Turner Construction Company, one of the country's largest builders. When the job was completed in 1934, McShain's financial statement indicated a profit of 1.49 percent, or a little over $39,000, on what turned out to be a slightly smaller contract than was originally bid. In 1934, he did his first job in Washington, D.C., building the Internal Revenue Service's foundations. On that job he lost over $15,000, or 10.5 percent, on a contract worth over $148,000. Doing "Hard Money" jobs for the government had its problems; the constant inspection, paperwork, subcontractors going broke, fighting with bonding companies and legal fights in courts were time consuming and expensive, and a strain on his small organization, which he started to grow in the 1930's.

Washington D.C. was growing and he bid for the foundation of the National Archives but did not get the job; however in 1934 he won his first Washington job, the excavation and foundation for the annex to the Library of Congress, a $372,000 contract. He lost money on the project due primarily to overly complicated contract inspection procedures with which he was not familiar. He chose not to bid on the superstructure of that project and later learned that the firm that got the job lost a small fortune on it.

In 1939, the memorial to Thomas Jefferson was put out for bid. McShain was determined to build this monument, and he cut his bid to a point where he doubted that he could break even. Nineteen firms were invited to bid but only five submitted bids. McShain's bid of $2.157 million was $260,000 less than the highest bid. As a result of other minor changes McShain received $2.263 million for the project and he lost over $43,000, or 1.9 percent. The memorial started in 1939 and was completed in 1941.

McShain's life was about to change during this period. He was notified in September of 1939 that a bid he submitted for the Franklin D. Roosevelt library at Hyde Park (which was privately financed), had been accepted and the President wanted to meet him. He arrived at the President's home in Hyde Park with his superintendent, the architect and the government engineer assigned to oversee the work. During the building of the library, Roosevelt and McShain became quite close. McShain was successful in obtaining portions of the contracts for the Washington National Airport and Naval Medical Center in Bethesda. He lost nearly $109,000 (2.44 per cent) on the medical center, a $4.5 million project in 1941, though he made $47,000 (or close to 17 per cent) on the building's exterior that same year. He lost $66,000 (nearly 3 per cent) on Washington national Airport that year, too, though in 1942 he made $113,000 (5 per cent) on additional hangars at the airport. After the completion of the Roosevelt Library McShain was told that the library needed a guard house however there was no more money to pay for it. McShain offered to build it for one dollar which he did (and lost over $100,000). McShain was finishing the new War department building in Washington D.C. when Roosevelt tipped him off to what would be the largest office building in the world. The building was to be built in one year, and would cost approximately $40 million. The building would be paid on a cost plus basis guaranteeing the builder a profit, whatever the cost, rather than a set price for the entire job. The building was ultimately called the Pentagon.

An advisory committee nominated three combinations of three firms each. McShain was the first choice, with the Turner Construction Company and George A. Fuller Company, major New York-based firms, as part of the package. However General Brehon B. Somervell, commander of the Army services of supply chose two Richmond-based firms, the Wise Contracting Company, Inc, and Doyle and Russell, possibly due to political reasons as the building was being built in Virginia. McShain acted as Contractor's Representative as the majority partner in the venture, and according to McShain Wise, Doyle and Russell, "actually participated only to the extent of furnishing a few men on the job."

The building began in October 1941, and was completed in sections. By mid November the building was substantially finished, a mere 13 months after ground was broken. The building when completed had over 6.6 million square feet on five stories. Building construction costs were $28 million. McShain's fee according to an audit by congress was $614,270. McShain's portion of the partnership was 60% which would have netted him $368,000. However his records, and one of his employee's recollections, made it closer to $500,000.

McShain continued to work in Washington and became quite successful; he went on to build the National Shrine of the Immaculate Conception, the Kennedy Center, and many other projects. Not all were profitable. During the late 1960's and early 1970's he divested his other, - financial and real estate holdings eventually closing the construction company. He retired to Ireland and died in 1989.

The Franklin Delano Roosevelt Library Hyde Park New York

The Jefferson Memorial, - Washington D.C.

The Pentagon Arlington Virginia

Conclusion

The more things change the more they remain the same translated from an old French proverb, is as true today as when it was written in 1849. In the late 1880's Fuller revolutionized the contracting profession by instituting the single contract, cost plus a fee system for building contracts. In addition he was able to develop new building projects by obtaining the financing, securing the land, hiring the architects and tradesman, and managing or selling the completed buildings. He was able to collaborate with owners and architects to suggest changes, improvements and new techniques in the building process to complete buildings faster and safer. He then was able to sell these services to third parties as a contractor, builder and/or developer, and in so doing create the largest building concern of the era.

The Starrett's, Dinwiddie's, Horowitz, and to some degree McShain, in his area of government lump sum bidding, and all of us who compete today in the building game, follow techniques Fuller developed. George Fuller followed others such as John Mills Van Osdel, Daniel Burnham, and William Le Baron Jenney, in his pursuit to develop his business approach. Our search to get the jobs can be summed up by Paul Starrett, "getting the job is pretty nearly a universal human problem; a livelihood for most of us depends on it. In the business of building construction, financial deals help or hinder getting the job. Politicians help or hinder. You shrewdly size a man up, and you win; you mistake him, and you lose.

The apt and fit reply brings success and the words that miss mean failure. Genuine friends get you the job, and false “friends” cheat you out of it. Pleased clients speak a good word for you, even put on their hats to go and help you. An unfriendly architect will see that the door is closed upon you”. The stories of these men, their organizations and the generations of builders that follow have proven that,- the right timing, a good organization with top notch supervision, sharp estimating, financial savvy, technical capabilities, vision, connections, capital, hard work, luck and a passion for what you do will create success and **GET THE JOBS.**

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Pittsburgh Quarterly Steel City Spectacle Melanie Linn Gutowski Fall 2012

Abstract

Building a City in the Wilderness: Hospitals at Alabama Power Company Construction Camps

In Alabama a new phase of development began with the damming of the major rivers for the production of hydroelectric power. The major player in Alabama was the Alabama Power Company (APC). The worker housing camps may have begun as prototypical Wild West boom towns, with saloons and pool halls, but they grew into villages complete with wives and children, churches and stores. The workers were moved from one jobsite to the next as APC completed construction or expanded their operations and the workers required living quarters on the job sites in order to keep them on the job.

This presentation describes the variety of architectural provisions for a particular program, health and disease prevention, at four Alabama Power Company worker villages constructed during the 1920s in Central Alabama. Typically the first hospital was only a first-aid station, but a more suitable structure was provided as the camp population grew. Over time and as new camps were constructed, there were several different hospital iterations to meet the needs of the changing camp populations, technological advancements in disease prevention and equipment upgrades. Floor plans were improved as the APC learned from experience in the older camps.

By taking a broad view of the paperwork on file in the APC archives, it is possible to document the architectural changes at these dynamic sites and to understand them as evidence of patterns of life and work in a remote area, all supporting rapid, efficient industrial development. The hospitals served both black and white workers and sometimes non - employees; they changed in form and layout as the needs of the resident population changed, reflecting the variations in the type and numbers of the work force present at each camp.

The hospital locations are compared as to configuration, site placement and materials of construction, in an effort to illustrate the evolution of the APC's goals for the most efficient and productive designs. The majority of the input for design changes seems to have come from the director of medical services, Dr. S. R. Benedict, who oversaw a stable of company physicians and also directed the sanitary provisions at all the APC construction sites and employee villages.

376 words.

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A Local Adaptation of Balloon and Platform Frames

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Abstract: A Local Adaptation of Balloon and Platform Frames

The balloon and platform framing methods dominated the late 1800's and early 1900's as the preferred method of executing the light wood frame in America. Best practices were widely distributed in serial articles in newspapers, trade books, and homesteading guides. Carpenters in the Appalachian Mountains made a series of heretofore-undocumented adaptations to adapt to these practices to their local material and energy sources.

This paper will illustrate the adaptations carpenters in Blacksburg Virginia made to adapt the preponderance of hardwood dimension lumber which was notoriously difficult to kiln dry and subsequently place in buildings in various degrees of "dry." Working with this wet lumber required re-thinking the established practices and processes common to the balloon frame, and innovation in applying the details and processes of the platform frame.

The paper will present the adaptations in comparison to computer models of the balloon frame, in process stages as described by Solon Robinson, models of the platform frame processes as illustrated in early editions of architects and builders guides, as well as photographs and models of the conjectured process for the local adaptation.

Ultimately these adaptations offer us insight into how to build the light wood frame from "green" or non-dried lumber, dramatically reducing the total embodied energy and subsequently the related emissions produced in the kiln-drying step of the production of dimension lumber.

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Archiving a History of Construction through the Historic American Buildings Survey

Established in 1933, the Historic American Building Survey is the nation's oldest federal preservation program. The collection of measured drawings, large-format (film) photographs, and historical reports generated by HABS and maintained at the Library of Congress in Washington, DC, has become one of the largest architectural archives in the world. HABS methodology for recording is time-tested, and its architectural drawings are the standard against which others are measured, both as policy and in practice. This paper looks at the different approaches to HABS documentation, beginning with the 1930s survey style through the multi-sheet monographs of the 1980s and 1990s, to show how the evolution in what was drawn, and its presentation, responded to contemporary preservation practice and construction industry demands.

The collection as an object of study tells us about the history of construction through the technologies recorded as well as by the places selected for inclusion in the Survey. Those responsible for its contents, those who produced HABS documentation through their investigations of building forms and structural systems as well as manufacturing plants and construction industries, simultaneously shaped the emerging discipline of American vernacular architecture. As each matured during the twentieth century the underlying intent of the documentation and the discipline it helped to distill remained intact: to capture information about the plans and components of our historic buildings. That material history, drawn for the HABS collection, became a point of departure for the study of the societies our predecessors constructed for and to represent themselves. How it was drawn serves as the point of departure for this paper.

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Setting up Systems:
New Deal Housing Construction in East Tennessee

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In 1964, in *Notes on the Synthesis of Form* (image #1), Christopher Alexander described the changes involved in the move from "unselfconscious," or folk, construction system to what he called a self-conscious culture. In the first system knowledge is transmitted through gradual exposure to craft and techniques and through individual trial and error. In the self-conscious system instructors "condense the knowledge, which was once laboriously acquired in experience," which is then transmitted "academically, according to explicit rules."[1] Access to this knowledge, Alexander contends, is gained through mental and formal pictures, which are used to *fit* the abstract, general knowledge to the specific situation.

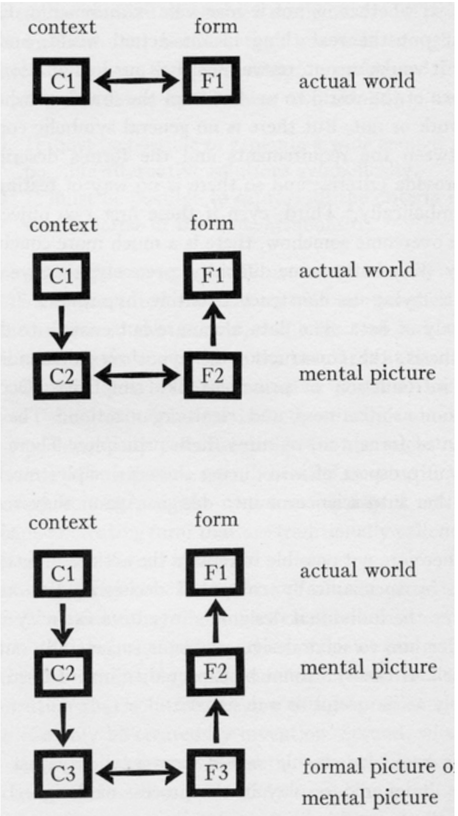

Image #1 From "Notes on the Synthesis of Form" by Christopher Alexander 1964 (Christopher Alexander. *Notes on the Synthesis of Form*. (Cambridge: Harvard University Press, 1964).

The "condensed knowledge" of Alexander's description is readily available in the building industry in the United States today: building specifications, codes and standards, are all in wide spread use across the nation. This knowledge is the product of continuous research, development and documentation by many entities, and is disseminated systematically – at least to some extent – through the industry. In our investigation, however, we were curious about the process through which this knowledge was amassed. How did people in the industry, and specifically home-builders go about creating systematic knowledge when none was there. Capturing this long and laborious change is not straightforward, of course, but the federal projects of the New Deal in the United States offer a unique a chance to examine these changes occurred in an accelerated and intensive process.

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[1] Christopher Alexander. *Notes on the Synthesis of Form*. (Cambridge: Harvard University Press, 1964). p. 36

The New Deal federal projects were enacted with the immediate objective of providing work to the many unemployed during the Great Depression. They were also motivated, however, by the long-term goals of social reform and of providing better living conditions for Americans across the nation. These improvements included the availability of modern technologies such as electricity, dependable systems of transportation for work and recreation and affordable, high quality homes. The means of building such homes were already under investigation in many cities. The Pierce Foundation in New Haven, CT, for example, experimented with substitutes for plywood and by 1933 had spent $80,000 on research. These innovations, however, were not spread evenly across the country. In some areas, such as rural East Tennessee, the “unselfconscious” system of construction still prevailed. People built homes with local materials according to traditional methods, and many lived in them with no running water or electricity (image #2).

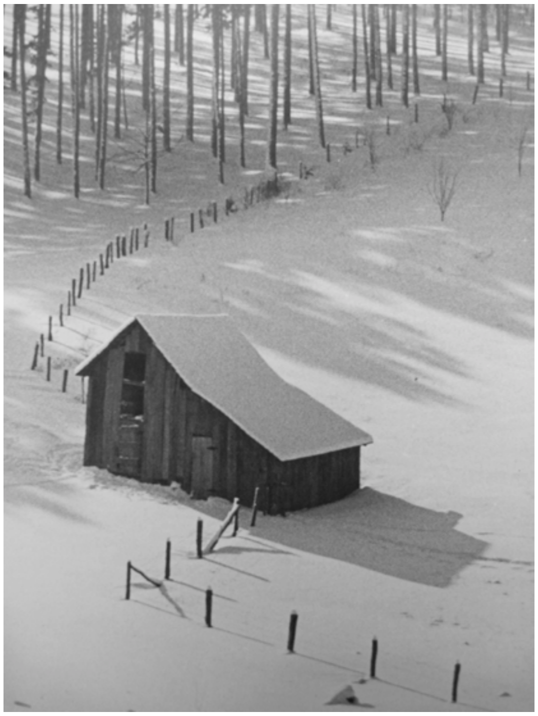


Image #2: Farmhouse in East Tennessee in the 1930's, (TVA Archive, National Archives Building, Atlanta, GA)

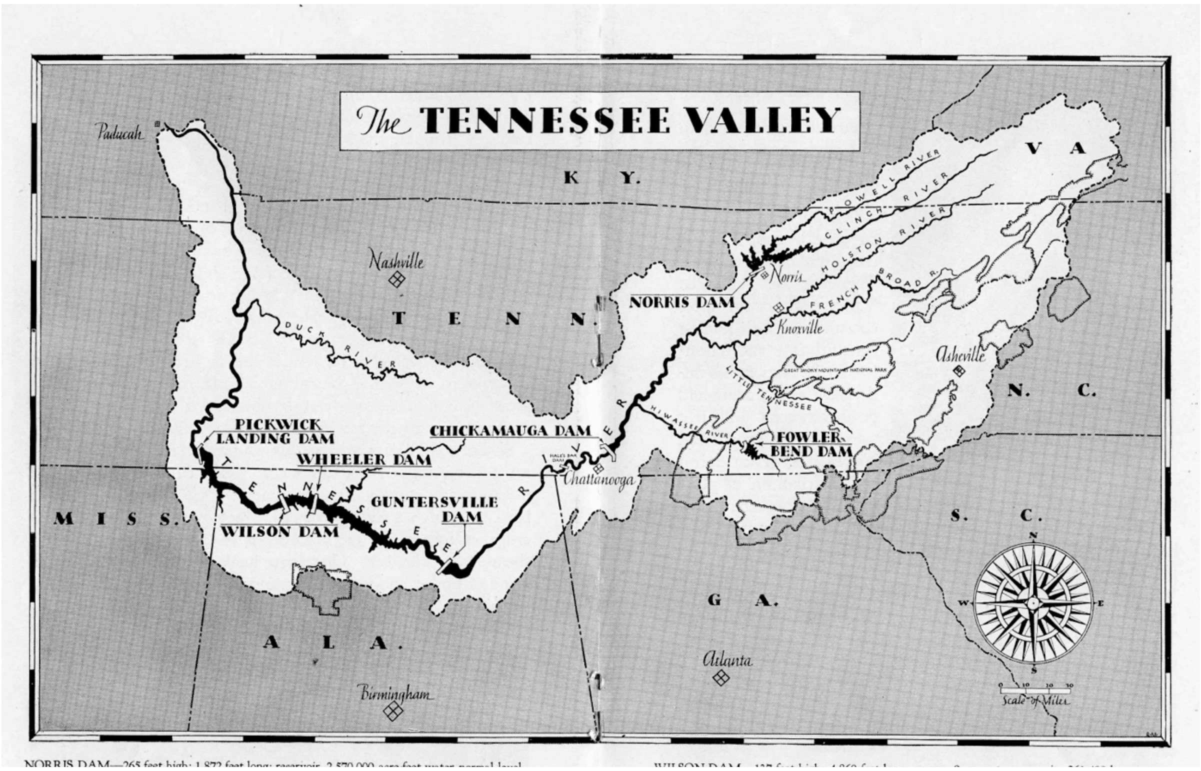


Image #3: The TVA Project in a 1930's Map (*The Development of the Tennessee Valley* (TVA, 1937))

The Tennessee Valley Authority, known as the TVA, was established as a federal agency with jurisdiction over the entire Tennessee River watershed in 1933 (image #3). The Authority's main mandate was to provide low-cost electricity to residents in the region through the construction of a series of dams and power stations along the river and its tributaries. The TVA also introduced new agricultural methods such as fertilizers, supported the region's shipping industry, and developed state parks for recreation. These projects were all devised with the goal of aiding what was then one of the poorest regions in the nation.

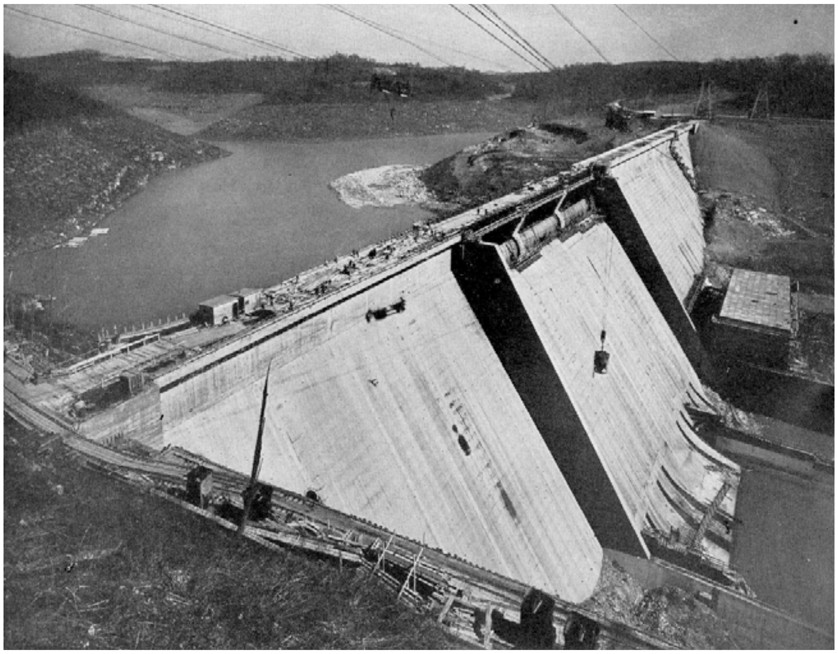
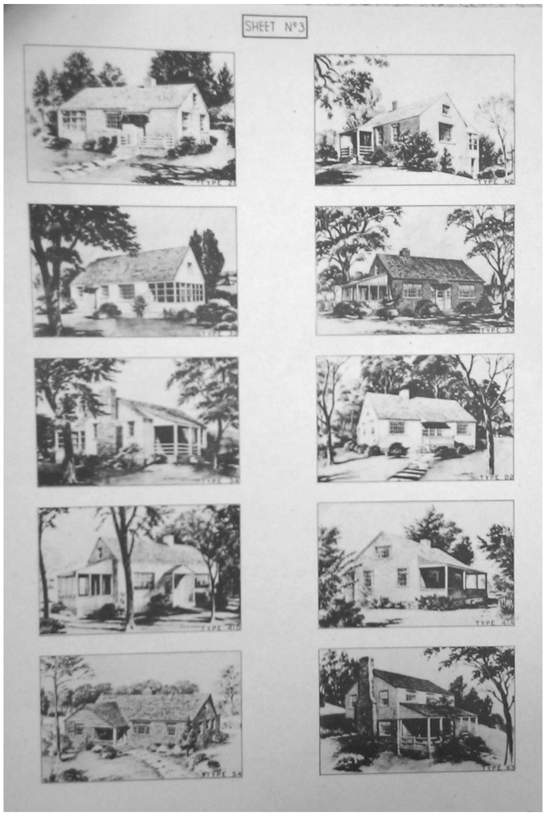


Image #4: Norris Dam in the 1930's (*The Development of the Tennessee Valley* (TVA, 1937))

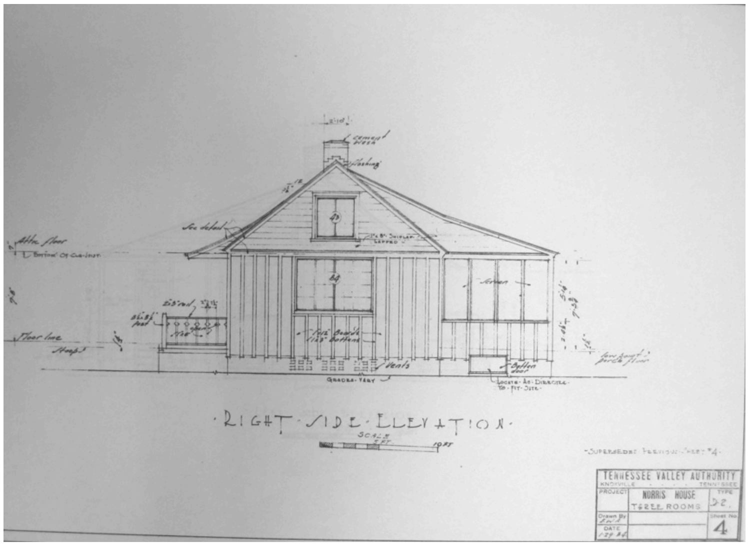
Image #5: Norris Town in the 1930's (TVA Archive, National Archives Building, Atlanta, GA)

The first TVA dam was designed to span the Clinch River, and was later named the Norris Dam in honor of the senator who had pushed for the legislation that instigated the entire project (Image #4). The location of the dam, at a distance from any existing town, prompted the need for housing for the dam builders. The TVA decided to establish a new, permanent, town rather than rely on temporary camps. Norris, as the town was named, was conceived as a model of progressive town planning for the region. Surveys and designs were begun in August 1933 and the town was occupied in spring of 1935. Norris' first residents rented directly from the TVA, but in 1948 the town was sold in a public auction, and many long time residents quickly bought their homes (image #5).



The TVA built about 200 homes in Norris, all centrally designed at the TVA headquarters in Knoxville, TN. The houses were all based on a small number of different floor- plans, but the designers changed the outward appearance of each house by altering the position of porches or the slope of the roof and by adjusting the house to the site (Image #6). The systemization of the house construction extended to the work force as well. The TVA managed the work directly, acting not only as designers but as project managers and construction supervisors as well. This centralized management facilitated rapid construction, reduced costs and also allowed for changes and alterations even when work was already underway. While many at the TVA headquarters came from afar, the skilled and unskilled labor was undertaken, for the most part, by local contractors and not by relief workers.

Image #6: Norris House Types (TVA Archive, National Archives Building, Atlanta, GA)



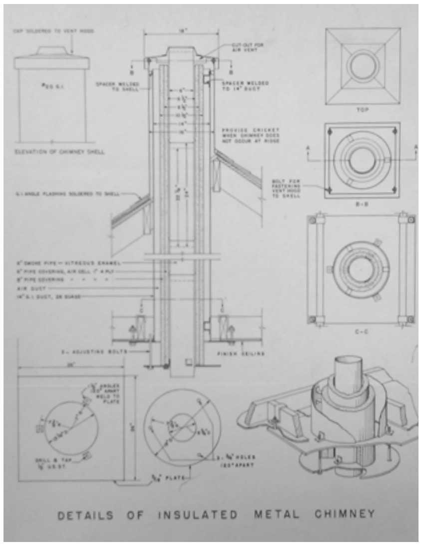
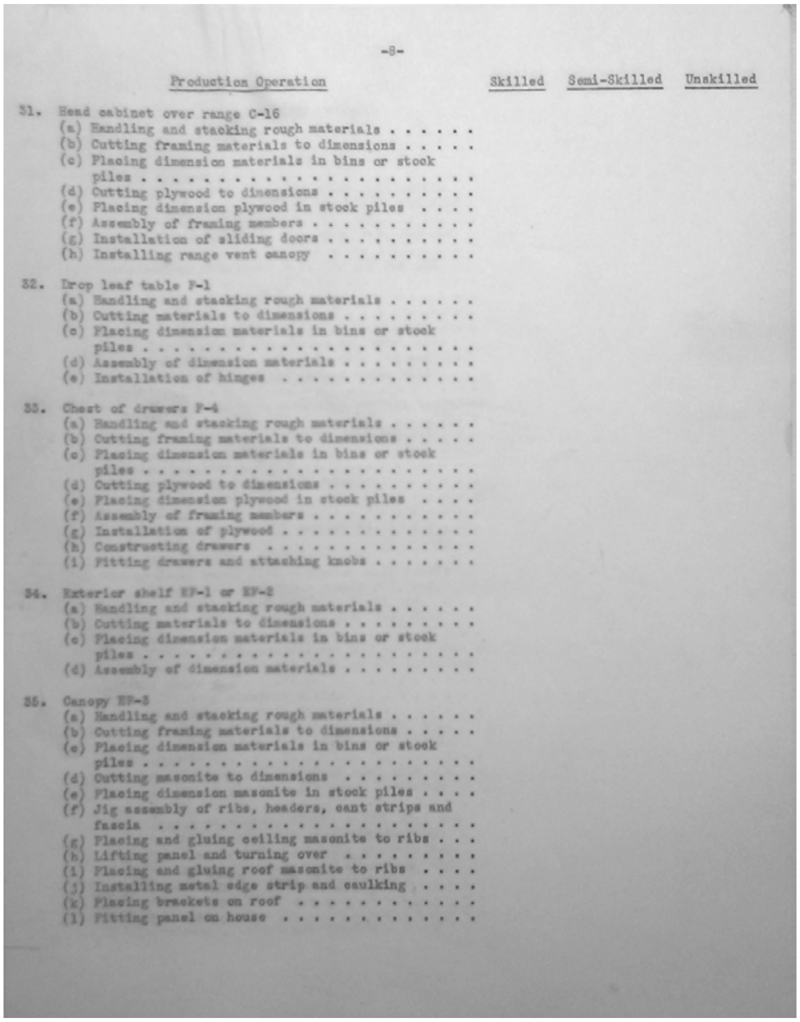


Image #7: Construction Drawing for Norris House D-1 (TVA Archive, National Archives Building, Atlanta, GA)
Image #8: Details of Insulated Metal Chimney for Houses in Norris, TN (TVA Archive, National Archives Building, Atlanta, GA)

This vertical integration required an unprecedented attention to Alexander's "mental images" – i.e. to specifications and contracts. In contrast to previous houses in the area, the houses at Norris were first detailed in annotated construction drawings (such as image #7) and meticulously drawn specification drawings for elements such as an insulated metal chimneys (image #8), all of which were carefully preserved so that the knowledge embodied in them would be available in future construction sites. With an eye towards the future and towards creating a robust self conscious system the TVA also recorded every aspect of the construction process, for example the number of skilled, semi-skilled and unskilled labor hours required for each "production operation" (image #9).

This thorough documentation required considerable extra work. The added expenses in both time and resources (which added up to as much as 20% of the over costs), however, were absorbed by the TVA administration, which saw this "theoretical inquiry" – i.e. research – as a central component of the social reform with which they were charged. The extra resources were also used for experimentation with new building materials and processes, such as the introduction of precast floor slabs and even the construction of an entire house made of steel. As construction progressed, the TVA team collected data on the performance of different materials in protecting against termites and in providing ventilation and insulation for the homes, which was added to the growing self-conscious system they were creating.



-8-

Production Operation	Skilled	Semi-Skilled	Unskilled
31. Head cabinet over range C-16			
(a) Handling and stacking rough materials			
(b) Cutting framing materials to dimensions			
(c) Placing dimension materials in bins or stock piles			
(d) Cutting plywood to dimensions			
(e) Placing dimension plywood in stock piles			
(f) Assembly of framing members			
(g) Installation of sliding doors			
(h) Installing range vent canopy			
32. Drop leaf table F-1			
(a) Handling and stacking rough materials			
(b) Cutting materials to dimensions			
(c) Placing dimension materials in bins or stock piles			
(d) Assembly of dimension materials			
(e) Installation of hinges			
33. Chest of drawers F-4			
(a) Handling and stacking rough materials			
(b) Cutting framing materials to dimensions			
(c) Placing dimension materials in bins or stock piles			
(d) Cutting plywood to dimensions			
(e) Placing dimension plywood in stock piles			
(f) Assembly of framing members			
(g) Installation of plywood			
(h) Constructing drawers			
(i) Fitting drawers and attaching knobs			
34. Exterior shelf EF-1 or EF-2			
(a) Handling and stacking rough materials			
(b) Cutting materials to dimensions			
(c) Placing dimension materials in bins or stock piles			
(d) Assembly of dimension materials			
35. Canopy EF-3			
(a) Handling and stacking rough materials			
(b) Cutting framing materials to dimensions			
(c) Placing dimension materials in bins or stock piles			
(d) Cutting masonite to dimensions			
(e) Placing dimension masonite in stock piles			
(f) Jig assembly of ribs, headers, cant strips and fascia			
(g) Placing and gluing ceiling masonite to ribs . . .			
(h) Lifting panel and turning over			
(i) Placing and gluing roof masonite to ribs			
(j) Installing metal edge strip and caulking			
(k) Placing brackets on roof			
(l) Fitting panel on house			

Image #9: List of Production Operations for Norris Houses (TVA Archive, National Archives Building, Atlanta, GA)

The main focus of the TVA's research, however, were the "electrified houses" – homes equipped with electric heating and lighting (Image #10). One hundred and fifty-two such houses were built at Norris at the cost of $1,000,000, or an average of about $6,500 for each, which was very high for the period. The TVA personnel were especially concerned with adapting the insulation and ventilation in these houses to the new technology. A TVA memo included this report:

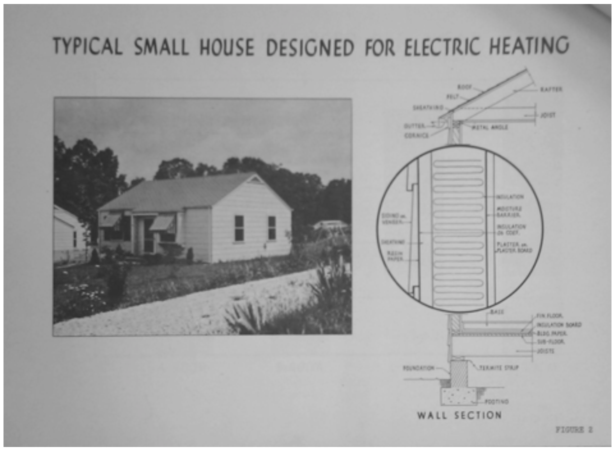


Image #10: Houses Equipped with Electric Heating, From TVA Promotional Material 1930's (TVA Archive, National Archives Building, Atlanta, GA.)

> Two houses electrically heated and occupied, one insulated and one not insulated, were carefully compared and the insulation in this case was found to effect a saving of 44.75 per cent in best. Reports of these tests, among the first of their kind, served as a valuable guide for future TVA work. The results of this work were presented to the insulation industry at a meeting sponsored by the National Mineral Wool Association and have been extensively used to further the work of the industry.[2]

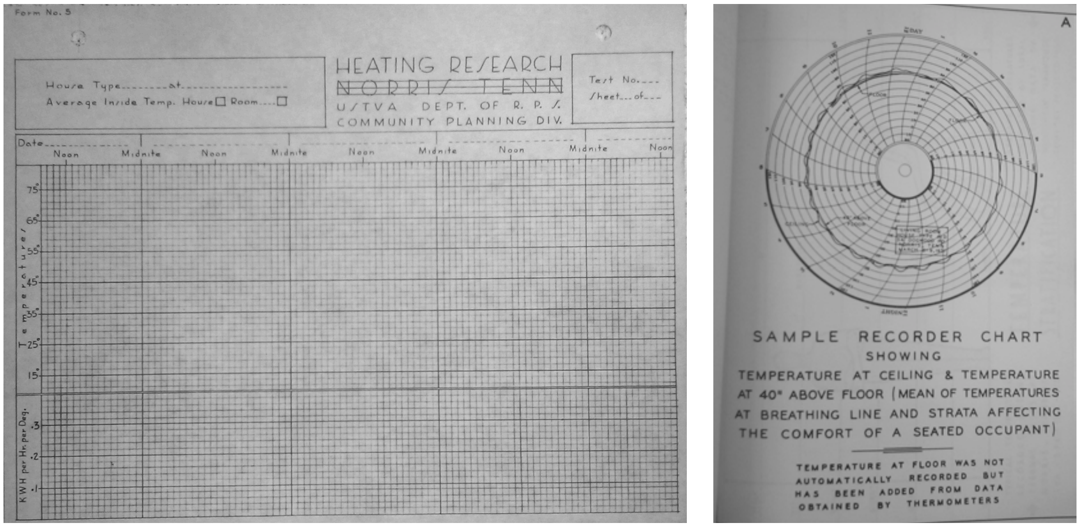


Image #11: Recording Charts for Heating Research conducted by the TVA (TVA Archive, National Archives Building, Atlanta, GA.)

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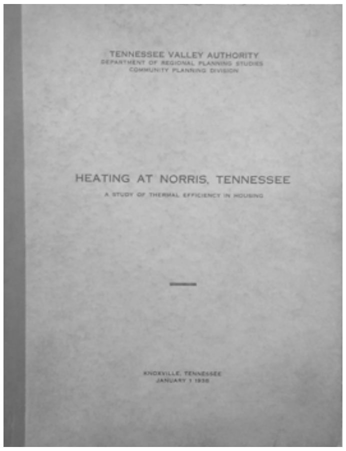
[2] *TVA Thermal Research*. RG 142 TVA Regional Studies Department, Architectural Records 1940-1948, George Richardson Files, Box 10, Folder TVA Projects, National Archives Building, Atlanta, GA.

In the process of recording data the TVA personnel developed new notation standards (image #11) and also recorded the houses inhabitants' response to the electrified homes. This knowledge was carefully compiled and an initial study compiled in 1938 as "Heating at Norris, Tennessee. A Study of Thermal Efficiency in Heating" (image #12). The findings from this and other studies informed other TVA projects and were also made available to a wider public as "Studies in the Heating of Small Houses." After World War II electric heating equipment similar to that assembled and tested by TVA was placed on the open market.[3]



TENNESSEE VALLEY AUTHORITY
DEPARTMENT OF REGIONAL PLANNING STUDIES
COMMUNITY PLANNING DIVISION

HEATING AT NORRIS, TENNESSEE
A STUDY OF THERMAL EFFICIENCY IN HOUSING

KNOXVILLE, TENNESSEE
JANUARY 1 1938

Image #12: "Heating at Norris, Tennessee" (TVA Archive, National Archives Building, Atlanta, GA.)

In one area, however, the TVA did not innovate: the exterior appearance of the houses. This was a deliberate decision on the part of TVA Chairman Arthur E. Morgan to use local traditions materials such as wood shakes, hand split wooden shingles, and stone foundations as the basis for the exterior design (image #13). Indeed, TVA architects spent considerable time studying local homes, the product of the unselfconscious construction system, for inspiration. This decision points to one of the drawbacks of the self-conscious system, as Alexander comments: "The use of logical structures to represent design problems has an important consequence. It brings with it the loss of innocence."[4] Despite the effort put into constructing a new system, at Norris the TVA designers were not yet ready to give up the innocence associated with unselfconscious construction and were prepared to use aesthetic symbols to allude to it. The willingness to do so, however, would be part of the next research projects the TVA undertook.

Image #13: Houses in Norris, TN in 1930's Photographs (TVA Archive, National Archives Building, Atlanta, GA.)

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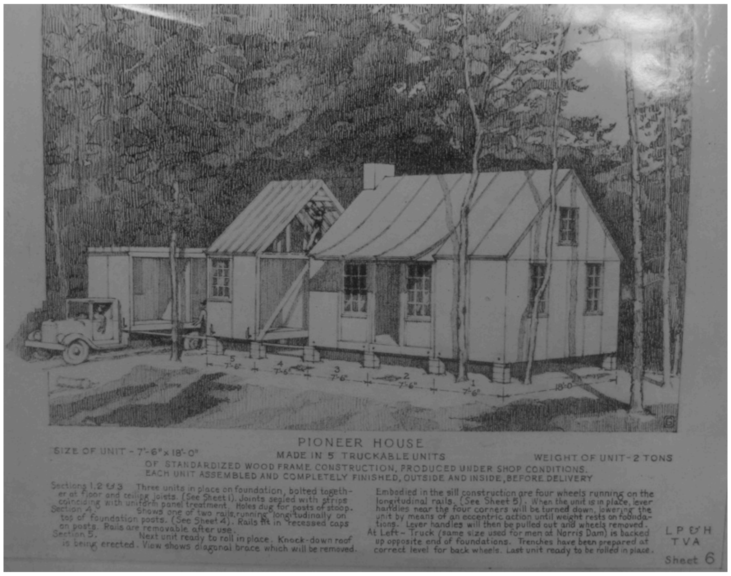
[3] *Completion Report For Activity Authorization #125, Study of Thermal Character of Tennessee Valley Houses*. RG 142 TVA, Regional Studies Department, Architectural Records, 1940-1948; George Richardson Files, Box 12 Folder Research – General, National Archives Building, Atlanta, GA.

[4] Alexander, *Notes on the Synthesis of Form*. p. 8

At Norris the TVA architects and planners introduced a new approach to house construction, but the overall system remained traditional in that materials were shipped to the site and assembled there. By the 1930’s, however, another approach – off site prefabrication – was gaining attention. The term covered a wide range of systems, as Burnham Kelly, MIT professor, reported: “There were houses of copper and of cotton; houses could be hauled down Main Street or floated down a river; and a hundred names, from "prefabs" to "motorized zipper housing” were bestowed upon these proposals.”[5] The TVA joined the craze. In the early 1930’s, even as the permanent homes were being built in Norris, Louis Grandgent, an architect working at the agency, drew plans for “Pioneer Houses“ (image #14). These houses, had they been built, would have looked like the Norris Houses, but would have been constructed so that they could be separated into four or five sections that could travel safely on public highways.



PIONEER HOUSE

SIZE OF UNIT - 7'-6" x 18'-0"

MADE IN 5 TRUCKABLE UNITS

WEIGHT OF UNIT - 2 TONS

OF STANDARDIZED WOOD FRAME CONSTRUCTION, PRODUCED UNDER SHOP CONDITIONS.
EACH UNIT ASSEMBLED AND COMPLETELY FINISHED, OUTSIDE AND INSIDE, BEFORE DELIVERY

Sections 1, 2 & 3 Three units in place on foundation, bolted together at floor and ceiling joists. (See Sheet 1). Joints sealed with strips coinciding with uniform panel treatment. Holes dug for posts of stoop.
Section 4. Shows one of two rails, running longitudinally on top of foundation posts. (See Sheet 4). Rails fit in recessed caps on posts. Rails are removable after use.
Section 5. Next unit ready to roll in place. Knock-down roof is being erected. View shows diagonal brace which will be removed.

Embodied in the sill construction are four wheels running on the longitudinal rails. (See Sheet 5). When the unit is in place, lever handles near the four corners will be turned down, lowering the unit by means of an eccentric action until weight rests on foundations. Lever handles will then be pulled out and wheels removed.
At Left – Truck (same size used for men at Norris Dam) is backed up opposite end of foundations. Trenches have been prepared at correct level for back wheels. Last unit ready to be rolled in place.

L P & H
T V A
Sheet 6

Image #14: From a Proposal for the "Pioneer House" by Louis Grandgent for TVA, 1934 (TVA Archive, National Archives Building, Atlanta, GA.)

The impetus for examining the idea of a “truckable home” in earnest, however, came in the late 1930’s when the TVA began working under more serious time constraints and in even more remote areas. Under the direction of Carroll A. Towne, chief of the Recreation Grounds Division of the TVA’s Department of Regional Studies, the agency constructed six prototypical “truckable” houses. These were made of wood and weather resistant fiberboard and were composed of several sections bolted together. The floor and roof were made of stressed skin panels, in which the plywood was both nailed and glued to the frame to increase its load bearing capacity. Each section was 7’6” long, and 9’6” high (2.1 X 2.7 m) and weighed about three tons, thus meeting highway clearance demands. Each house section had a set of wheels that allowed it to be moved along the assembly line and then be transported to the site. Unlike the Norris Houses, these prototypes left the factory with all electric, heating, and plumbing equipment

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[5] Burnham Kelly. *The Prefabrication of Houses, A Study by the Albert Farwell Bemis Foundation of the Prefabrication Industry in the United States*. (Cambridge, MA, New York, NY: The Technology Press of the Massachusetts Institute of Technology and John Wiley and Sons, Inc., 1951).

Image #15: Constructing a TVA "Truckable" House (TVA Archive, National Archives Building, Atlanta, GA.)

installed, and arrived at the site completely finished even down to light bulbs and screens. It took as little as four hours to bolt the house together (image #15).

After some “theoretical inquiry” – particularly feedback from potential inhabitants – the TVA continued to produce about one hundred and fifty “truckable” houses. These homes were much smaller and cheaper than the Norris Houses and also more “modern” – they did not include any of the local features that were part of the Norris Houses. In the spirit of the time, however, this aesthetic approach was accepted, even celebrated, as inhabitants were happy to have even these more basic accommodations (image #16).

Image #16: "Modern Kitchen in a TVA Demountable House" (TVA Archive, National Archives Building, Atlanta, GA.)

Image #17: TVA "Truckable Houses" in East Tennessee (TVA Archive, National Archives Building, Atlanta, GA.)

From this auspicious beginning the agency continued to experiment with variations and changes over the next few years, including building homes at Oak Ridge, a World War II nuclear development facility located twenty miles from Norris. By the end of the war the TVA had designed and constructed several different types of houses and prepared detailed plans for each one. In the postwar years this knowledge contributed to the development and production of mobile homes across the nation.

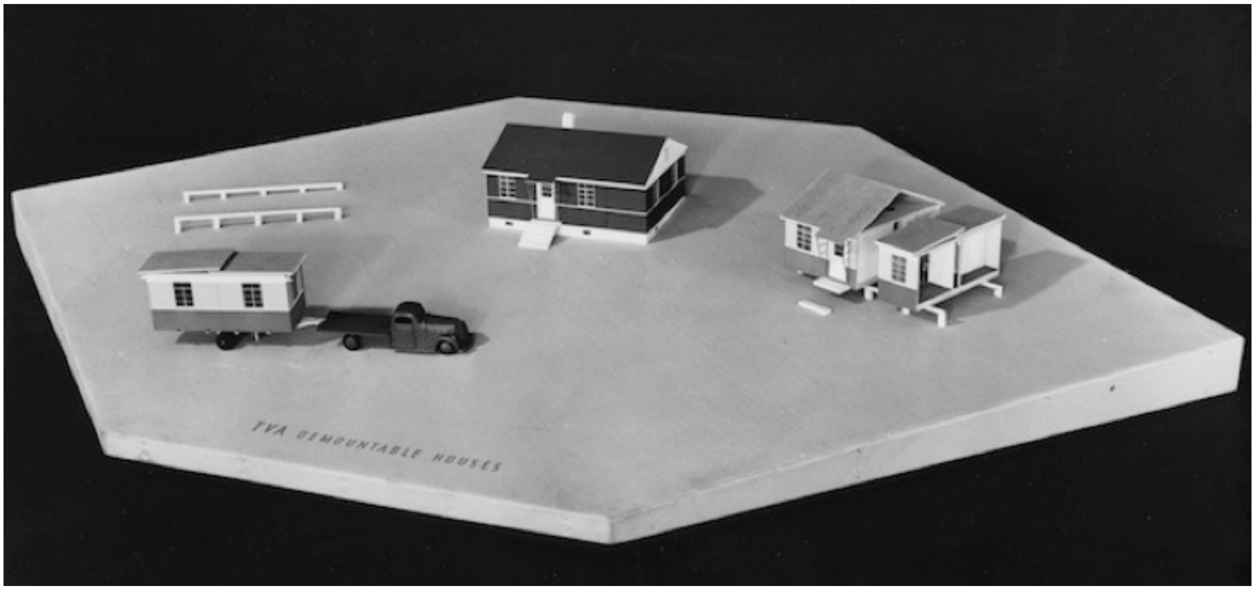

Image #18: Model for "TVA Demountable Houses" Research (TVA Archive, National Archives Building, Atlanta, GA.)

In the course of this ongoing project the TVA designers introduced hinges for the roofs that allowed them to be transported flat. They also experimented with a system for ensuring that the transported sections aligned on site as they did in the assembly line. As at Norris, these developments were considered research, and the Office of the General Manager of the TVA authorized funding for this process. TVA architects also used models to simulate processes that were hard to document (image #18).

One of the "findings" of these experiments was a preference for sections over panels or trailer homes. As Marian Moffett explains:

> There were several advantages of sectional construction. Architects were allowed much greater freedom in design when not obligated to use a standard module, no matter how small, as the basis for construction. Even though sections units had to be sized for highway transport, their joint locations were relatively independent of their interior arrangement. Furthermore, TVA architects felt that the time and expense required to create a workable standard panel system was better used creating varied sections designed so as to respond to a wider array of user requirements.[6]

Image #19: TVA Outdoor Prefabrication Site (TVA Archive, National Archives Building, Atlanta, GA.)

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[6] Marian Moffett. "Manufactured Housing: The TVA Experience." *ARRIS Journal of the Southeast Chapter of the Society of Architectural Historians* 5 (1994): 31-37.

Image #20: TVA Indoor Prefabrication Plant (TVA Archive, National Archives Building, Atlanta, GA.)

The first TVA "truckable" houses were constructed in an outdoor assembly line, beside which pre-cut lumber was stacked ready for use (image #19). The TVA team also designed and eventually built an indoor prefabrication plant with twelve stations (image #20). These factories were a manifestation of the self-conscious system that had been developed. Unlike at Norris, where the materials and the workers moved from house to house, here the houses themselves traveled from station to station, and in each a specific task, such as the installation of door and window subassemblies, was undertaken according to predetermined rules. The indoor plant allowed a reversal of the construction order; for example the roof, so crucial in on-site construction was only added towards the end of the process.

In "Notes on the Synthesis of Form" Christopher Alexander posits an inexorable move from unselfconscious construction methods to the rational methods of self-conscious systems. As is evident even in Alexander's later work, however, this process is rarely one directional. With time new methods can themselves become "unselfconscious," slipping from the status of innovative processes into accepted and unquestioned methods only to be replaced again with rational and researched construction strategies. This is in part what occurred in East Tennessee. The systems set up by the TVA – the centralized design and build method, the use of the materials they explored and the electric components they introduced – have become commonplace. The truckable house in its late 20th c. incarnation – still referred to as a mobile home though officially titled manufactured houses – have become in many ways the new unselfconscious houses in rural East Tennessee. The research and innovation attitude the TVA introduced, however, is also still with us, as is evident in a recently constructed project, the New Norris House (image #21).

Image #21 A New Norris House (Credit: Ken McKown.)

The house was designed and constructed by a project team led by faculty and students at the College of Architecture and Design at the University of Tennessee, Knoxville (UTK). Drawing on the systems set up by the TVA eighty years earlier, the scope of the project was determined by three goals: first, to make the house into a living lab for energy-efficient concepts and systems, with careful attention to the insulation and ventilation systems. Secondly, to respect the physical and historical context in which the house was built – the town of Norris, which is now listed on the United States' National Register of Historic Places. Thus, like their TVA predecessors the UTK team grappled with regional expression and the possible "loss of innocence." Finally, the team set itself the task of achieving these goals while using off site, prefabricated construction techniques, the descendants of the TVA truckable homes. Thus the move from unselfconscious to self-conscious systems that Alexander describes begins yet again.

Figure 1: Administration Building and Research Tower, aerial view from southwest

One of the most renowned works in the history of modern architecture is Frank Lloyd Wright's S.C. Johnson Co. Administration Building (1936–39) and Research Tower (1943–50), in Racine, Wisconsin (Figure 1).[1] Yet less known in modernist historiography is the novel system of heating and cooling that Wright devised for the Johnson buildings in collaboration with a series of mechanical engineers, equipment manufacturers, and the SC Johnson Co. as his client. The Johnson buildings' mechanical systems, integral with the structure, were to create an ideal environment for office work. By the 1930s, the development of air-conditioning in the United States had given rise to the concept of a "windowless office building," meaning a structure whose lighting and air handling enabled walls without windows. For Wright and his contemporaries, the Johnson buildings exemplified this novel idea. As he wrote in 1937, his Administration Building was "a highly developed synthesis of form and idea—more highly developed than has been possible in the past because it is a building without windowed walls. It consists of a great work room breathing from above through two nostrils."[2] As seen in this view, these he placed symmetrically on the roof of the penthouse north of the great workroom.

Figure 2: Administration Building, Great Workroom looking southwest, 1939

The building's renowned structural and material innovations—the lily pad columns and the Pyrex glass tubing—both had major environmental implications. The columns' 18 ft 6 in ~~(5.64 m)~~ diameter crowns form the solid areas of the building's roof, with two layers of tubing originally placed between the column crowns to create the translucent ceiling. Tubing also formed a tall clerestory above the brick walls around the mezzanine level.[3] The total tubing is about 43 miles ~~(69.2 km)~~ long, consisting of 2-inch and 1-inch diameter hollow tubes. At first, daylight coming through the tubing was to be the main room's only lighting, although soon incandescent lights were inserted between the upper and lower layers of tubing to improve lighting without marring the streamlined effect.[4] Overall the streamlined aesthetic for which the building is renowned serves as a visual metaphor for streamlining as the movement of conditioned air throughout the interior.

Figure 3: Administration Building, sectional perspective by Vernon Swaback

Environmentally, the roof had advantages and disadvantages. On the one hand, unlike an ordinary roof, "the Johnson roof, with its inserts of glass tubing in two layers, lets in light, diffuses it, saves many kilowatts of electric power."[5] Yet, on the other hand, the unique design precluded the possibility of using the ceiling for heating or air-conditioning ductwork or any other horizontal utility lines. Also, the slender shafts of the tall columns, although hollow above their lower sections, could not be used for vertical distribution of conditioned air, as Wright had done in earlier buildings like his Unity Temple of 1905–9. However, as shown in this drawing, on the upper level, there is an air space between the two bands of tubing, which acts as a thermal insulator, provided that joints between tubes could be kept sealed. As one engineer wrote, in the tubular bands, "three dead air spaces result—one in each tube and another wide section between the two layers of tubes."[6] This arrangement not only cut down on heat loss in winter and heat gain in summer, but also helped to prevent condensation in winter, often a problem in windowed buildings.[7]

Another crucial factor for environmental control was the brick wall's construction. So far as possible, the exterior and interior walls were made of the same Cherokee red color facing brick. The walls consisted of three-inch, asphalt-dipped cork for insulation in the middle, 1.5 inches of concrete on both sides, and the 2.5-inch interior and exterior brick dovetailed to bond with the concrete.[8] From an environmental viewpoint, this method of construction had both disadvantages and advantages. On the one hand, there were no cavities in the walls that could serve as spaces for running ducts or pipes, nor did interior walls have outlets or registers for moving air. Yet, on the other hand, with walls, "being insulated and having no windows, there is virtually no heat loss, which guarantees low maintenance costs," presumably meaning low operating costs.[9] Of course, the tubing's insulation value depended on its mastic joints staying completely weather-tight. Yet this proved difficult to achieve. Thus, the building's heat leakage was a problem.[10]

Figure 4: Administration Building, main floor detailed section showing steam pipes

Wright's innovative choices for the great workroom's structure and lighting led him to favor an unconventional system of radiant heating emanating up through the main floor. In the winter of 1937–38, a version of heating with hot water pipes underneath the floor slab had been successfully installed in his first Usonian house.[11] But unlike the small Usonians, the great hall for clerical staff in the Johnson building was among the largest interiors that Wright ever built. To heat such a large space with a water system would have required high pressure and much energy to pump the water through its elongated courses of supply and return. So for the Johnson building, "it was decided to use steam at sub-atmospheric pressure."[12] As first built, the room's heating came mainly from 7,500 ft ~~(2,286 m)~~ of welded galvanized wrought iron steam piping with lines laid four feet apart in a 9-inch ~~(22.86 cm)~~ layer of gravel under the main floor. The floor is a 6-inch ~~(15.24 cm)~~ slab of concrete overlaid with felt building paper and originally a ¼-inch thick layer of rubber tile. Welded sections of piping were clamped to pre-cast concrete blocks at the base of the gravel layer, in order to fix all pipes in their proper positions (Figure 4).[13]

Figure 5: Administration Building, plan diagram showing zones of steam piping.

To efficiently move the steam and even the heat, the workroom has six zones, creating relatively short piping runs, each zone of which was thermostatically controlled and synchronized with the sun's movement.[14] Each zone was equipped with two thermostats laid in the floor slab, both of which linked to an averaging instrument in the basement. This control averaged the readings of the two thermostats, and operated a steam valve to hold the zone's average floor temperature at 75 degrees F. (23.88 C.).[15] Figure 5 shows the under-floor plan of the piping laid diagonally in its six zones: two central ones on the north side, two large zones on the east side, and two on the west. The plan's lower part is a diagram of heat distribution to the upper floors atop the building's north side.[16]

Ideally, with this system of floor heating, one could feel comfortable in a room where, as Wright said, "the heat comes up as gently as the light falls from the sky above."[17] As an engineer said of the building after over a year of operation, because warm air rises, "This type of heating coupled with forced ventilation results in a material reduction of temperature differential between floor and ceiling. Another result is the complete absence of any sensation of chilliness even with air temperatures 10 F less than usual. This latter result is attributed to the fact that body heat losses by radiation are balanced by radiant heat from the floor. In addition to this, heat warms all other surfaces in the room directly so that there is a minimum of stratification and a maximum of even comfortable heat."[18] Alluding to the under-floor heating in traditional Japanese dwellings, Wright also explained: "The effect of such heating as I have observed it in the orient is more that of 'climate' than heating. You make a natural climate instead of an artificial condition."[19]

Figure 6: Administration Building, plan through nostril showing air handling

In addition to the floor heating system, the building was air-conditioned throughout. In this period, as now, the term "air conditioning" did not refer only to mechanical air cooling, but rather to total year-round powered ventilation including heating, washing, and humidifying fresh air in winter, and cooling, washing, and dehumidifying fresh air during the summer.[20] Fresh air was drawn in through two circular ten-foot-diameter ~~(3.05 m)~~ shafts, or "nostrils" as Wright called them. The term was apt since these shafts are the building's only air intakes, each nostril corresponding to one of the two halves of the air conditioning system. Each nostril had a separate compressor, cooling coils, fans, and controls. "The division of the building into East and West sections permits compensation for the relatively high sun effect encountered because of the large glass areas and the low flat construction of the roof," whose parts warmed variably over the day.[21] At Wright's insistence, likely to maintain the unity that he thought essential to the design, "the air distribution system is completely built into the structure by masonry ducts," including plenums cast integrally with the mezzanine's concrete floor around the great workroom.

Figure 7: Administration Building, view of lobby looking northeast, showing grilles

Wright's architecture signified the company's commitment to innovation. Herbert Johnson's son recalled that when it was erected, it was the only air–conditioned building in Racine. The building's environmental amenities evinced the company's legendary concern for its workers.[22] The company's program of profit sharing began in 1917 and continued annually, except for 1931 and 1932. The company also devised a working conditions program, whereby an outside firm surveyed workers' attitudes and solicited their concerns anonymously, including grievances about architectural issues, such as the lighting in a certain department.[23] Hence the lighting in Wright's interiors was keyed to both workers' comfort and to a managerial quest for efficiency. As one contemporary wrote: "there are no windows to gaze through, drafts to distract, noises to disturb, glare to bring headaches, or shadows to bring eye-strain and fatigue."[24] After the first cooling season in the summer of 1939, the company claimed: "There is no doubt in our minds that during the summer months this can be credited with a large percentage of increased production over buildings without cooling. A sealed building with washed air resulted in an easier job of maintenance and a healthier place in which to work."[25]

Figure 8: Research Tower, full section showing tubing, plate glass, and air shaft

Figure 9: Research Tower, detailed section showing floor plenums and air shafts

As Wright stressed, the tower's floors cantilevered off its central tubular shaft as the tower's sole support, as shown in a section (Figure 8), like the hollow upper shaft of the Administration Building's dendriform columns. As a similar structural experiment, the tower, at 156 feet ~~(47.55 m~~) high above the ground, would be "the tallest building ever built without foundations directly under the side walls."[26] The glass tubing would again be used, yet the tower's glass tubing walls initially also had an inner layer of plate glass. The tower's mechanical systems rise through its central main shaft. These would include air supply and return plenums for heating and cooling, plumbing, and service pipes for supplying laboratories with hot, cold, and distilled water, illuminating gas, compressed air, carbon dioxide or nitrogen, steam, and direct and alternating electric current.[27]

Wright "planned [that] several phases of the air conditioning system would become an integral and necessary part of the construction."[28] Over half of the air conditioning load came from the solar effect on the glass. The glass also largely determined heat loss in winter, although the lower angle of winter sun, and thus more direct transmission of its warmth through the glass, eased heating loads. The glass meant that the tower's four quadrants experienced peak heating and air conditioning loads at different times of the day. Heating was difficult due to the windows' height of nearly thirteen feet from the brick parapet on one main floor up to the next main floor past the recessed mezzanine. Even with the inner plate glass, low winter temperatures on the glass's inner face cooled air there, setting up down drafts just inside the windows. An area of steam heating pipes along the outer parapet walls on each mezzanine floor (a) compensated for heat lost through the glass tubing. In the basement a 400-ton-capacity compressor supplied chilled water for air conditioning. In winter, outside air was heated with coils carrying steam from nearby factory boilers. Warm or cool air was supplied under a slight pressure from the central shaft through horizontal plenums between the top and bottom of the floor slabs (b). Air was exhausted through grilles at the central core's wall into the exhaust shafts (Figure 9, c), into which vitiated air from the laboratories' fume hoods was also directed. This was then a legal practice. Few metal ducts were used, fulfilling Wright's aim at "the integration of the construction and air conditioning."[29] Yet casting hollow slabs as plenums was harder than casting solid slabs and hanging metal ducts under them.

Figure 10: Research Tower, plan of central shafts, with south toward the left;

Figure 11: Tower, construction view from south, showing central columnar shafts

In the final design, there was only one central supply plenum for warm or cool air (1), but two exhaust plenums on opposite sides (5), as seen in a structural plan for a typical floor (Figure 10), where concrete mass is cut to a minimum. In this plan, south (toward the Administration Building) is at left. Another circular shaft housed the elevator (2), while the U-shaped shaft holds the fire stair (3). Adjacent is a circular toilet room (4).

A construction view from the south shows these shafts, the tower's sole supports (Figure 11). Two exhaust fans on the tower's top floor drew used air up from occupied spaces and forced it out the tower's roof. Return air was not reused, nor was its heat recovered.

Figure 12: Research Tower, interior view showing laboratory with ceiling diffusers

Overall, the technically innovative Johnson Research Tower had its operational and climatic problems, and was closed in 1981 when the Johnson labs were moved to larger quarters nearby. Yet scientists who had worked in Wright's tower recalled that its form had inspired them.[30] Photographs of the tower's laboratories show the openness of the cantilevered floors to promote interaction (Figure 12). Air passed down to working areas through multiple ceiling diffusers that were each a combined of air inlet and light fixture, designed by Wright specially for the tower. The impression of small research groups was not fictive, as only about fifty people worked in the tower when it opened, about three on each floor, unlike the Administration Building, which is still corporate offices.[31] As one account of the Administration Building's attenuated and costly building process had noted: "The owner's attitude—most unusual—is far from that of impatience, but rather is one of delight in watching a new architectural conception evolve into reality."[32] Wright anticipated that the tower, too, would be a technical and financial challenge, but, as he wrote to Herbert Johnson at the outset: "A good building isn't like anything else. It is never a perfected thing because it is a pioneer never really completed if it is a great building. Only the petty routine job is ever finished. And that is finished because it was finished so very long before it was ever started that it is now only for dead ones."[33]

Construction History Society of America
Construction History in the Americas, 1850-1950

ABSTRACT

"Beauty, Versatility, Practicality": The Innovative Construction of Hyperbolic Paraboloids in Post-War America (1949-1972)

The hyperbolic paraboloid form enjoyed wide spread use in the United States between 1949 and 1972. As the built environment underwent massive stylistic and material changes from its pre-war condition, this geometric shape – a doubly curved surface generated by the rotation of straight lines along an axis - emerged as a defining built form of the post-war era. Central to the popularity of the hyperbolic paraboloid form was the logic it afforded as a constructible system.

Constructed in many different ways, from many different materials, the hyperbolic paraboloid was a common medium for innovative experimentation of construction technologies. Its straight-line generation facilitated construction from a variety of linear industrially produced materials – from thin shell concrete (formed with linear boards), to extruded aluminum, timber, and stressed high-strength cables. Aligning with the architectural trends and structural capabilities of the post-war era, hyperbolic paraboloids were designed as everything from churches to warehouses, residences to gas stations, libraries to arenas – simultaneously an object of high design and simple infrastructure.

This paper traces many of the different construction practices used to build hyperbolic paraboloid forms in the post-war Americas - beginning with the cable-hung roof of Matthew Nowicki's Dorton Arena in 1949, and culminating with the largest concrete dome in the world, the Kingdome, in 1972. While previous scholarship on the form has primarily focused on the work of Felix Candela, this paper draws from new archival sources, interviews and field-surveys to show the incredible variation of materials and construction methods used to build these shapes across the American landscape - revealing the many avenues of construction innovation that developed during this time period. Despite the fact that by the late 1970s, the form had fallen out of favor, these advances in construction practice continue to shape the built environment to the present day.

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Abstract for Presentation at CHSA 2012 Annual Meeting

The Ames Shovel Works: Innovation in the Planning, Design, and Construction of the Mid-19th Century Factory

Jay Wickersham, Harvard Graduate School of Design
Chris Milford, Milford & Ford Associates
May 21, 2012

The Ames Shovel Works in North Easton, Massachusetts, constructed between 1852 and 1880, is one of the best-documented and best-preserved industrial complexes of its era. This presentation will show how the use of innovative organizational, design, and construction strategies make this complex an important transitional link between the hydro-powered New England textile mills of the early 19th century and the Fordist factories of the early 20th century.

By the Civil War, 60% of the world's shovels were being produced at the Ames Shovel Works in this village in southeastern Massachusetts. Our presentation will show how the first two generations of Ameses were innovative and influential industrial pioneers. They shifted from dependence on water power to coal and steam, and they organized the Shovel Works complex according to three linear movement systems: rail transport of materials and finished products, energy transmission to the machines, and progression of shovel components from one specialized work station to the next. In response to a catastrophic 1851 fire, the buildings were constructed of a uniform modular system of load-bearing granite walls and fire-resistant timber frames, reflecting the requirements of factory mutual insurance companies.

The Shovel Works, designed and built by the Ameses with anonymous in-house engineers and local builders, also provides contrast and context for the architectural patronage practiced by the family's third generation, who commissioned four major buildings in North Easton designed by the great architect H.H. Richardson and built by Norcross Builders, the pioneering national contractor, with landscapes by F.L. Olmsted.

The presentation will conclude by describing recent efforts to save the Shovel Works from demolition. The complex, listed by the National Trust in 2009 as one of America's eleven most endangered historic sites, is now being preserved for reuse as mixed-income housing.

The paper will rely on previously unexamined sources: the collection of company records in the Tofias Industrial Archives at Stonehill College, and the physical fabric of the Shovel Works buildings, which have been measured and documented during the ongoing redevelopment process.

The presenters are also available to lead a tour for conference participants to visit the Shovel Works and the Richardson buildings in North Easton, located only 45 minutes from Boston.

Bios of presenters

Jay Wickersham, FAIA, an architect and lawyer, is a founding partner in the Cambridge, MA firm Noble & Wickersham LLP, specializing in environmental and construction law. He is on the faculty of the Harvard Graduate School of Design, where he teaches courses in the history, law, and ethics of architectural practice. Recent articles include "The Financial Misadventures of Charles Bulfinch" (*New England Quarterly*, 2010) and “Learning from Burnham: The Origins of Modern Architectural Practice” (*Harvard Design Review*, 2010). Jay is a graduate of Harvard Law School, the Harvard Graduate School of Design, and Yale College.

Christopher Milford, AIA, is an architect, and a principal of the architecture and interior design firm Milford & Ford Associates, in Wellesley, MA. He has taught architectural history and theory at the Boston Architectural College and been a guest lecturer at the Harvard Graduate School of Design. Chris is a member of the Natick Historic District Commission. He is a graduate of Cornell University.

Wickersham and Milford’s article, “Richardson’s Death, Ames’s Money, and the Birth of the Modern Architectural Firm,” will appear in *Perspecta* (Issue 47). They served as lead consultants to the non-profit Friends of the Historic Ames Shovel Works, which successfully advocated for preservation and reuse of the complex.

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Out-of-Area: Skidmore Owings Merrill's Façade Construction for the American Consulates in Germany, 1953-58, and its Impact on German Post-war Modern Building

The very first issue of the internal publication *SOM News*, dated August 15th, 1953 featured Skidmore Owings and Merrill's US Consulate in Bremen. A rendering of the building, then nearing completion, shared the page with a photograph of the recently occupied J. Heinz Company manufacturing building and news from SOM's offices in Istanbul and Tokyo. SOM's international reach and its growing oeuvre of large-scale glass-fronted buildings as represented in the newsletter was implicated in broader tendencies: the fact that the United States identified itself in the post-World War II era with Modern art and architecture to communicate its values period has been well documented, from Jane Loeffler's impeccably researched *The Architecture of Diplomacy*[1] to Serge Guilbaut's Pynchon-esque *How New York Stole the Idea of Modern Art*[2]*.* Less attention has been given to the ways in which US building abroad influenced architectural developments out-of-area through the material cultural practices embedded in project realization. Though relatively few, the buildings completed by SOM in Germany were harbingers of later changes in German construction: transforming construction norms accelerated shifts in architectural expression, as was the case in the work of Sep Ruf,[3] a German architect whose significant career intersected with SOM in the mid 1950s. This paper will look at three of Ruf's buildings, realized between 1951 and 1959, as a means to track the influence enjoyed by SOM's building practice in Germany. The relevance of building construction as a factor in transposing American High Modernist

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[1] Jane C. Loeffler, *The architecture of diplomacy : building America's embassies*, 1st ed. (New York: Princeton Architectural Press, 1998).

[2] Serge Guilbaut, *How New York stole the idea of modern art : abstract expressionism, freedom, and the cold war* (Chicago: University of Chicago Press, 1983).

[3] Ruf (1908-1982) studied at the Technical University of Munich with German Bestelmeyer and Adolf Abel, and studied building construction with Sigismund Goeschel, completing his studies in 1931. After working for one year in Munich for Norkauer & Lechner, he opened his own office, building mostly smaller private houses in a traditional style – prismatic volumes with steeply pitched tiled roofs. His first building in a Modern idiom was a house for his friends Dora and Karl Schwend.in 1933. Throughout the 30s, Ruf continued to build for high profile clients in the theater and the arts. As of 1937, he undertook a series of larger-scale projects for Junkers. From 1942-45, he was a soldier on the Russian front; his return to architectural practice after the war was almost immediate, and in June of 1945, his Munich architectural license was re-activated. See http://www.sep-ruf.com/39994.html (viewed on October 9, 2012).

tendencies to German practice is particularly significant in Ruf's case, since he did not subscribe to any American architecture periodicals and was not, until much later, in correspondence with German émigré architects in the United States.[4]

Within the Consular and America House building program sponsored by the US Department of State and the US High Command in Germany, SOM completed four consulates in Germany: Bremen (1952-3), Düsseldorf (1953), Frankfurt (1954-55) and Stuttgart (1954-55). The buildings share similar partis: slender, low-rise bar buildings lifted off the ground plane at entry level and – site permitting – set perpendicular to a lower, more solid bar. A fifth consulate project had been planed in Munich, but after conflict with the city's building administration, which judged SOM "arrogant"[5], the HICOG retracted the commission. Instead, Ruf, whose relations with both Munich bureaucracy and American administration were good, received the commission directly in October of 1954. In April of 1955, the HICOG's agent sent him a set of the SOM drawings for the Munich project and the construction set for the Frankfurt consulate; Ruf also visited the Bremen consulate.[6] The difficulties in Munich marked the end of SOM's post-war work in Germany. In the summer of 1954, SOM moved its German staff to a smaller space in Frankfurt and closed the office altogether after the completion of the Stuttgart consulate in spring, 1955[7].

SOM's reception in Germany corresponded to the corporate image which SOM itself constructed, in part through its international projects. Although small in comparison to such contemporary commissions as Lever House (1950-52) or Connecticut General Life (1954-57), the German projects were treated by SOM as prestigious:

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[4] There are no US journals in the extensive office archive maintained by Ruf's daughters. Later correspondence with Gropius, Mies and Neutra begins in the 1960s. Ruf collaborated with Egon Eiermann for the famous German pavilion at the Brussels' World's fair of 1958, which has been described relative to Mies' influence on German architecture; but the projects in question here largely predate that collaboration.

[5] Loeffler, *The architecture of diplomacy : building America's embassies*. P. 96: According to Loeffler's research, SOM did not contact anyone in the city building administration prior to submitting the final project.

[6] In a letter to Ruf dated 21.10.1954 from Ernst Werner, the agent retained by the US to negotiate with the Munich Commission on Rebuilding (Wiederaufbaureferat), assurances are given that "no other American architect will be commissioned but instead, that exclusively Prof. Ruf working together with the state official Director Gensemer…will execute the architectural direction." On April 4, 1955, Gensemer wrote to Ruf: "I am very glad you were able to find an opportunity to visit the completed American consulate in Bremen….I am sending you under separate cover a set of working drawings of the Frankfurt consulate in order that you may see the type of complete drawings and details which were made for our projects." The April 15, 1954 issue of SOM News notes that the Munich consulate had "reached the stage of working drawings."

[7] The closing of SOM's German office was not announced on the newsletter's primary pages. The only notice appears in the August 15, 1955 issue, under 'Here and There': "Edward G. Petrazio has been assigned to the Chicago office after two and one half years in Germany. With the completion in June of the remaining consulates in Stuttgart and Frankfurt, the SOM office in Frankfurt has been closed." It is interesting that many of the architects who had worked in the German office were made associates in the mid-late 1950s: Paul Pippin, Edward Petrazio, Sherwood Smith, Carl Bitter, David Hughes and Natalie de Blois.

run through the New York office, the projects' design team was led by Gordon Bunschaft, who was sent to Germany at least twice a year. Nathalie de Blois, Bunschaft's acolyte, spent a full year in residence there in 1952-3 following her Fulbright grant year in Paris. Images of the Bad Goedesberg office, opened in 1951 to oversee the detailing and construction of the Bremen Consular Housing and Consulate, show rows of desks occupied by white coat-clad German draftsmen, overseen by American architects in smart suits. Not only was the Bad Goedesberg office one of the largest in Germany at the time, but its organizational structure played out the SOM corporate philosophy described in a 1950 article by German ex-patriot art historian Fritz Neugass in the German language, American-edited newspaper *Sonntagsblatt Staats-Zeitung und Herold*: "So it is that today in America, large buildings are not designed by individuals but instead by an entire staff of specialists."[8]

This culture and its advantages were soon adopted by Otto Apel, SOM's contact architect for all the German projects and later partner in the firm ABB, which boasted such corporate clients at Deutsche Lufthansa. Apel assumed both the office structure and its collaborative authorial practices, changing the name of his office to 'Otto Apel Architektengemeinschaft'. The ethos of non-proprietary authorship between SOM and Apel apparently extended to publication: a 1956 publication of all four consulates in the German journal *Bauen und Wohnen* lists Apel Architekten-gemeinschaft first as the architect, with SOM noted only as collaborator.[9] In their architectural expression and materialization, the German projects belong to the idiom developed by SOM internationally at that time: the facades are in controlled relief, using offset planes of structure, infill wall or spandrel, window frame, glazing and, in some cases, an additional exterior frame which emphatically re-delineates the underlying grid. The materials used – aluminum windows, grey spandrel glass and shell limestone in Frankfurt and Stuttgart, white painted steel windows, Roman travertine and exterior aluminum frames in Bremen – and the glazing details express the strong, wealthy American economic and political power they are meant to represent. Surprisingly, none of the building components were sourced in the US. Given the material shortages and manufacturing devastation in post war Germany, it is relevant to ask how the detailing of SOM's German projects, drawn and specified by Apel's employees in the Bad Goedesberg office under SOM's supervision, compared to the general state of the German building industry in 1951-55. And how did it compare to the detailing of contemporary public projects completed for German civic clients?

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[8] Fritz Neugass, "Die neue Architecture: Amerika besinnt sich auf einem eigenen, zeitgemässen Stil," *Sonntagsblatt Staats-Zeitung und Herald*, November 5 1950; ibid.

[9] Further evidence of the German interest in SOM's corporate structure is the 1959 monograph on Connecticut General Life *Bürobau mit Blick auf die Zukunft* by Claus W. Hess, the first book published by the Schnelle brothers who would later found the Quickborner Team, the consultants who coined the term 'Bürolandschaft." In 1967, the Quickborner Team was hired by Eastman Kodak to design the interior layouts for their headquarters in Rochester – a re-importation of ideas that had their kernel in this particular German reception of SOM's corporate spaces.

The impeccably preserved construction documents for Sep Ruf's 1950-54[10] Akademie der Künste in Nürnberg provide an apt benchmark. Prior to this project, Ruf had collaborated intermittently with Apel on housing and master planning projects for the HICOG, but his focus was on his own independent practice in Bavaria, where he enjoyed enormous success as a Modernist in an otherwise stylistically conservative region. The Academy was built in a park on the city's edge, and comprises a series of courtyard plan pavilions threaded along an axis that intersects the main building at a right angle. Both spatial organization and architectural expression evoke continuity between interior and exterior spaces. A thin, deeply cantilevered roof eave shades the steel and glass façade, insuring its transparency; the repetition of the same materials on either side of the full-height glazing underscores the spatial continuity.

Great care is evident in the buildings' construction. Ruf, for example, meticulously corrected gardeners' invoices and painters' time sheets, evidence of his presence at the job site. The glass façade is detailed with equal intensity: every element of the frame is a simple rolled steel L-section, cleverly pieced together to create the thinnest possible sight lines. The fact that the windows were laid up specifically for this project is born out by correspondence between Ruf and the window manufacturer, Jucho, which complained to him about money lost when fulfilling an order for more windows after the first shipment. The staging for the windows was, apparently, *ad hoc* since the later order required the manufacturer to re-tool without the earlier economies of scale. The Academy's glazing elements are not "building products": they are large-run bespoke elements. The detailing at the exterior wall of the cafeteria also captures the German construction site in the early 1950s, working with both standardized and bespoke methods: The perfect symmetry of the floorboards around the structural column could only be achieved in a construction environment which allowed for millimeter tolerances even in floorboards. The building's elegance comes by virtue of – or perhaps in spite of – its simple finish materials and bricolage details.

Contemporaneous façade details from the Bremen consulate, drafted in Bad Goedesberg in July of 1952 and approved by Jack Gensemer, Ruf's contact during the Munich consulate project, describe a different approach, predicated on a contrasting set of assumptions about materials and construction technologies. SOM's details deploy highly specific storefront glazing systems. Set 40 mm proud of the exterior frame, comprising white-painted I-section columns filled in place with aerated concrete, are bays of six windows above six identically dimensioned travertine spandrel panels. The storefront glazing system is detailed as stick construction, pieced together on site to absorb only minimal tolerances in the concrete frame. In the horizontal, slotted tabs welded to the steel façade fascia are bolted through to hold to an L-angled on the interior and an unequal leg C-channel on the exterior to which a threaded nut has been welded. A highly specific steel angle shape for the

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[10] The building is usually dated 1951-54, but Ruf's office continued to work on the project punch list through the summer of 1956.

fixed frame was bolted into place on the C channel and the operable frame, another function-specific shape with a smaller u-shaped thin-gage steel glass stop, then installed. In the vertical, a welded L-section was used to anchor the frames to the concrete structure, and, on its interior side, to receive the leading edge of an insulated panel, which abuts the acoustic dropped ceiling. A thin-gauge, breaked aluminum exterior trim, affixed with a setscrew, clipped over the bolts, which connect the fixed frame to the interior back-up structure. In comparison to the detailing at Nürnberg, the Bremen documents indicate the availability of much more sophisticated, function-specific façade elements; they specify large quantities of sheet aluminum, among one of the more rare commodities on the post-war construction market. Unlike Nürnberg, the façade drawn for the Bremen consulate is conceived as a system. Each piece serves a legible function: back-up structure, anchorage, fixed frame, operable frame, weather protection and drip. The elements all could, however, easily be reassembled slightly differently to produce a similar, but different façade. There is an implicit economy of scales in the Bremen façade that was missing from the Nürnberg glazing.

The advantages of a systematic, products-based approach may have been clear to those German architects for whom the emergent *Wirtschaftswunder* meant increasing volumes of commissions and increasing scales of work. These advantages were definitely not lost on producers, who had actively sought economies of scale in high-precision construction-scale metal work before and even during the war. The path to success in the building product industry seems to have pointed towards product rather than trade-based specialization: many of the construction and building product firms that contributed to the Akademie der Künste flourished, using that strategy. Jucho, for example, which had delivered only unglazed steel window frames to the Academy, was offering a full series of steel and aluminum windows by early 1954.[11] Although this business tendency existed independent of SOM's presence in the German building market, SOM's buildings offered a direct precedent for architects and fabricators working on storefront façades: the more didactic expression of each element within the system – in the Bremen consulate, for example, the offset and reveals between embedded structural steel, mounting tab, structural back-up, fixed frame and exterior trim – was a marked departure from the filigree style of the early 50s. Sep Ruf's American Consulate in Munich, begun in the year of the Academy's official completion[12], attests to this stylistic turn.

Although Ruf received SOM's detail drawings in April, 1955, he did not have FBO (Foreign Building Office) approval to proceed until the end of August, when Gensemer encouraged him to start on working drawings. The city of Munich

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[11] The glazier, Brehm, still exists as a window manufacturer; and Schuster Schmitt, which had provided steel doorframes, became a manufacturer and installer of prefabricated buildings.

[12] Ruf sent his initial project with at least three variations to Jack Gensemer in March of 1954. The building proposed by SOM had initially been sited on Briennerstrasse, the formal boulevard laid out by Leo von Klenze; Ruf developed schemes for that site and a less visible location on the edge of Munich's public park, the English Garden, where the building was ultimately built.

approved Ruf's project in early October, 1955, and construction began in late 1956. The project correspondence indicates the strong hand that the FBO and HICOG had in the building's design, which might imply pressure to streamline detailing and to rely on existing building techniques and products that had proved effective in the other consulates. Certainly the building's appearance is radically different from that of the Academy: in contrast to the tapered horizontal eave and the transparent, filigree glazing behind attenuated white columns, the consulate is stolidly prismatic, its windows part of a aluminum-gridded plane set in very low relief against the stone-clad structural skeleton.

While the desire to standardize the American consulates in Germany may partially explain the idiomatic differences between the two Ruf projects, changes in Ruf's approach to materialization and expression was more far-reaching, as evidenced by Ruf's College of Administrative Sciences in Speyer, for which construction records also are preserved. After winning the project competition in late 1954, Ruf's office began work on final drawings in 1956 and the building was occupied in 1960. Ruf chose to organize the academic complex around exterior spaces and to focus on interior-exterior continuity, as he had in Nürnberg. Here, however, the component program pieces are subsumed in a compact volume, configured around the central courtyard. Unlike the Academy's informal, conjoined courtyards, the courtyard in the Speyer college, framed by the formal lecture hall at one end and the library on the other, is formally landscaped; one end is occupied by a fountain spanned by irregular, rough hewn stones, a counterpoint to the geometricized plantings and repetitive facades. This staged juxtaposition of "geometric" façade and "organic" landscaping recalls the collaboration between SOM and Isamu Noguchi at the Lever House (1951-52).

The façade palette at the college is broad: aluminum fixed glazing, operable steel windows and some glazed wood-framed door and windows, all of which are thickly dimensioned. Aluminum fixed glazing flanks the courtyard, running between lecture hall and library. It comprises heavy, 80 mm aluminum box sections into which double-glazing has been mounted using 15mm aluminum glass stops. The steel façade, designed for the tall glazed wall of the lecture hall on the courtyard's west edge, uses no fewer than eight specifically-configured steel channel shapes, finessed so that the upper hopper windows and the doors below have been configured to appear identical, except for their motion. Detailed almost perfectly in plane, the steel frame is a hefty 150 mm at the horizontal between door and hopper and 80 mm at the jamb and sill. By contrast, the steel windows for the Nürnberg Academy were 38 mm in height, and were offset 15 mm from the 40 mm fixed frame to appear even more slender. At Speyer, the attention to detailing and the skill dedicated to the facades is no less intensive than at Nürnberg; but the elements of construction have been industrially optimized, and their appearance shows an affinity for High Modernist tendencies.

In contrast to the largely glazed main college building, the dormitory building façade is a variant of the spandrel façade idiom Ruf had adopted for the consulate. The dimension of the student double rooms, rather than the grid of an office layout, determines the façade rhythm; but Ruf's composition clearly references the low relief of solid wall, glazing frame and spandrel. What appears to be a spandrel element is, however, an enameled steel railing behind which a steel-framed French door opens to access a tiny balcony. Rather than maximizing the interior/exterior transparency, as Ruf had done at the Academy or in his contemporaneous apartment building in Munich-Türkenstrasse, he chose here a façade composition driven by ideas about systemic façade configuration.

There are, of course, always multiple factors at play in any architect's stylistic development. In Ruf's case, however, the transformation of his idiom from the Nürnberg Akademie der Künste to the Speyer Hochschule für Verwaltungswirtschaft within a few short years raises interesting questions.[13] I would assert that the impulses deriving from construction practice, in part encountered through his assumption of SOM's Munich consulate commission, were at least as influential in Ruf's case as the intellectual and aesthetic architectural discourses of the time. Throughout his career, Ruf's construction drawings evidence the intensity of his dialogue with the architectural implications of construction decisions. He always worked closely with the fabricators of his building's façade elements,[14] making him perhaps even more sensitive to changes in available products and practices. His direct contact with the American consular program and its construction norms do much to help understand his shift in the mid 1950s towards an architectural expression we now recognize as post-war International 'High Modernism'.

Loeffler, Jane C. *The Architecture of Diplomacy : Building America's Embassies*. 1st ed. New York: Princeton Architectural Press, 1998.

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[13] Ruf's abiding affinity for Hans Schwippert and the architectural ideas he had developed beginning with his public presentation at the Darmstädter Gespräch of 1951 and continuing in his work as the head of the Deutscher Werkbund and committee chair for the German pavilion at the 1958 Brussels World's Fair indicate Ruf's loyalty to a set of specific German Modern architectural precepts. In context, his stylistic turn cannot be explained superficially.

[14] As evidenced in project files and in conversation with his daughter, Notburga Ruf, who worked in his office in the 1970s. NR in conversation with the author, July 22, 2012.