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The Geometry of Wright

Mark and Linda Keane describe a seminar that seeks to answer these questions with evidence of a renaissance of work in the twenty-first century that emanates or owes allegiance to mathematical explorations configured in Wright's body of work. This seminar, *The Geometry of Wright*, offers students in the state of Wisconsin the opportunity to learn about Wright's life, those who influenced him, and those whom he influenced. The combination of history, theory, mathematics, and design activities in this seminar offer students an opportunity to become aware of Wright's use of geometry, understand its roots and precedents, and apply them to a project of their own. This whole language approach to learning embeds appreciation of mathematical principles and encourages students to apply geometric relationships in their own search for proportion and form.

From the very beginning my T-square and triangle were an easy media of expression for my geometrical sense of things.

Frank Lloyd Wright [1946: 95]

Premise

There has been an enormous expression of public interest in Wright in the last two decades. Publications, exhibits, tours, artifacts, drawings, documentaries, catalogs of Wright paraphernalia and even an opera have created new recognitions and appreciation for Wright's work well beyond the architectural profession. However, there remains a gap between the public presence of Wright and the academic integration of instruction of Wright's use of mathematics and geometry in architectural institutions. What has been the influence of Wright in the profession of the late twentieth century and what is the influence of Wright in the current generation of architects? This paper describes a seminar that seeks to answer these questions with evidence of a renaissance of work in the twenty-first century that emanates or owes allegiance to mathematical explorations configured in Wright's body of work. This seminar, *The Geometry of Wright*, offers students in the state of Wisconsin the opportunity to learn about Wright's life, those who influenced him, and those whom he influenced. The combination of history, theory, mathematics, and design activities in this seminar offer students an opportunity to become aware of Wright's use of geometry, understand its roots and precedents, and apply them to a project of their own. This whole language approach to learning embeds appreciation of mathematic principles and encourages students to apply geometric relationships in their own search for proportion and form.

Introduction

Vincent Scully suggests that many twentieth-century historians have marginalized Wright. "The excellent students who flocked to Gropius and his associates at Harvard and elsewhere in the forties were indoctrinated with a deep suspicion of Wright's motives and a kind of sociological contempt for his buildings." Soon the younger architects were themselves acting as critics in most of the better architecture schools throughout the country and today are in leadership positions in many of those same schools. For this reason, "no serious attempt to teach and develop the principles of Wright's design concepts have been consistently sustained in America, outside of Wright's own inbred Taliesins." Henry Russell Hitchcock and Philip Johnson eventually refer to Wright as the Michelangelo of the twentieth century, as the "exception that illustrates the rule" [Hitchcock and Johnson 1948; Johnson 1979: 75].

Sixteen buildings have been designated by the American Institute of Architects to be retained as examples of his architectural contribution to American culture:

- *Home and Studio*, Oak Park, IL, 1889-95
- *Winslow House*, River Forest, IL, 1893
- *Willits House*, Highland Park, IL, 1901
- *Unity Temple*, Oak Park, IL, 1906
- *Robie House*, Chicago, IL, 1909
- *Hollyhock House*, Los Angeles, CA, 1917
- *Taliesin*, Spring Green, WI 1911-25
- *Johnson Wax Administration Building*, Racine, WI, 1935
- *Fallingwater*, Bear Run, PA, 1936
- *Taliesin West*, Scottsdale, AZ, 1937
- *Johnson Wax Tower*, Racine, WI, 1945
- *Unitarian Universalist Meeting House*, Madison, WI, 1948
- *Price Tower*, Bartlesville, OK, 1948
- *Beth Shalom Synagogue*, Elkins Park, PA, 1954
- *Guggenheim Museum*, New York, NY, 1956

This seminar, “The Geometry of Wright”, aims at exploring and building evidence and continuation of the geometric heritage of Wright’s prolific practice to his influence on practitioners today. The quality of Architecture is left to interpretation, but geometry is different. Since mathematics is present in all of physics, and letters are the foundation of words, geometry must be found in architecture. As we respond to architecture with emotion, the mathematics of geometry appeals to our intellect. It is about relationships and the search for absolute truth just as the architect searches with relationships for absolute beauty.

This seminar is organized in four parts:

1. Introduction to Frank Lloyd Wright’s life (focusing on significant influences on his uses of geometry in design);
2. Introduction and analysis of Wright’s use of geometry;
3. Review and Research of Current practices which translate, interpret and innovate from the mathematics and geometry used by Wright;
4. Conceptualization and construction of an artifact.

1 Introduction to Frank Lloyd Wright’s Life

The seminar summarizes key influences from practice, education, and travel that informed Wright’s use of mathematical relationships and influenced explorations of geometric relationships in possibilities for habitation, spatial manifestations, and form achieved in the landscape. Many historians have articulated a series of influences upon Wright. Vincent Scully [1960], Kevin Nute [1997], Anthony Alofsin [1993], Robert McCarter [1997], Grant Manson [1958], and many others have established the educational process that Wright found outside of academia. Wright enrolled briefly in the School of Engineering at the University of Wisconsin in Madison, but was educated as an architect from childhood education, mentors, and his contemporaries. The education of Wright is introduced to draw parallels and highlight differences with the young collegiate designers.

Frank Lloyd Wright was born Frank Lincoln Wright on June 8, 1867 in Richland Center, Wisconsin. He lived until 1959 and built close to 500 buildings, with hundreds of other projects unbuilt. He worked for two architects, first Joseph Lyman Silsbee and, later, Louis Sullivan at the firm Adler and Sullivan in Chicago. He lived most of his life in Wisconsin, also living in Illinois and his winter retreat at Scottsdale, Arizona. His life was built on reconciling the machine to the patterns of nature, the rights of the individual to the need for community, and the cause for American architectural values.

William Cary Wright, his father, was an English non-Conformist who emigrated to the US. He was an itinerant Baptist preacher, pianist, and composer who instilled in the young Wright a reverence for music, and a passion for Bach and Beethoven. William worked his way through a diverse range of occupations—lawyer, administrator, minister, music teacher, pianist and organist. Anna Lloyd Jones, his mother, married William in 1866. She was the daughter of Welsh immigrants, fifteen years younger than William. As a schoolteacher, she instilled in young Wright a reverence for poetry and literature. Frank was the first of three children. Anna gave Wright copies of *Stones of Venice* and *The Seven Lamps of Architecture* by John Ruskin, mentor to art and architectural appreciation of the Victorian Age. At the 1876 Philadelphia Centennial, when Frank was nine years old, Anna first found the Froebel series of educational blocks.

Frederich Froebel, a major childhood influence to Wright, was a crystallographer before becoming an educator. The connection in his *Education of Man* in 1826 says that whether inorganic or organic, crystalline or non-crystalline, developmental processes all remain the same—a balance between inner and outer, or an outward developed from within. He strove to strengthen the inner forces or natural inclinations and enrich the outer forces of the environment. The block system that he designed was to nurture learning about form and relationships in children from two years old to adolescence. In the kindergarten education system, four main natural laws apply.

1. The Law of Unity, which unites all entities;
2. The Law of Opposites, each entity having a polarity;
3. The Law of Development, entity develops through transformations;
4. The Law of Connections forms a continuum of time from the smallest particle to the cosmos.

The first half of the exercises is called **Gifts**, the second half is called **Occupations**. Altogether, the gifts form a complete whole with parts that explain each other. Each part is a complete whole connected to further development. They cover intuitive and sensory instruction through spatial instruction. The patterns were not intended to be merely aesthetically appealing, but to engage the intellect to understand a sense of harmony. The arrangements are categorized into three types of forms: **abstractions of familiar objects**, **principles of simple mathematics**, and **forms of beauty** from the infinite variety of symmetrical and asymmetrical balanced forms. The Gifts move from the concrete to the abstract—from the solid to the planar—in an attempt to reveal the rhythmic structure in Nature. This comprehensive vision in which aesthetics are inseparable from the universal principles of form informed Wright's work throughout the decades.

Wright moved from the rural Unitarian transcendentalism of south-central Wisconsin to the speed of the Industrial Revolution in post-Fire Chicago, a city where a new building was built every eighteen hours after the Great Fire of 1871. By century's end, the stylistic debate of the nineteenth century had been eclipsed by the Art Nouveau. In the Midwest, the greatest contributor to the Art Nouveau was Louis Sullivan, with his rich integration of ornamentation. As

the most direct and significant influence on Wright, it is important to review the key Sullivan influences.

In Chicago, the Adler and Sullivan partnership was in the mainstream of architectural development from 1883 until Adler left in 1895. Wright was made responsible in 1890 for the firm's domestic work. Sullivan had published a transcendentalist interpretation of the form follows function idiom. H. H. Richardson's Romanesque designs were a catalyst for early Sullivan work. Then, Moorish architecture of Muslim form and principles of design was evident in three commissions between 1890 and 1892—the Getty and Wainwright tombs, and the Transportation Building at the 1893 Fair. The Getty Tomb is the first complete application of his design system of ornamentation. Sullivan progressed to a naturalism of organic and geometric combinations. However, the decorations never reached beyond the surface. Wright culminated his work with ornamental integration turning intellectual theory into art.

Another early influence, Josef Maria Olbrich was a principle member of Otto Wagner's Vienna Secessionist movement, in which a rejection of historical forms was declared as well as a reassertion for principles such as harmony, order, and symmetry. Wright, William Maher and Robert Spencer visited the 1904 St. Louis World's Fair where they would have seen Olbrich's German Pavilion and several interior design installations by other Secessionist architects and designers.

The Museum of Modern Art's 1937 exhibit on the International Style presented Wright as a predecessor to Modernism but a contemporary would be more accurate. Many of Wright's ideas were contemporary to the Bauhaus of 1925. Each was concerned with the possibilities of geometries. Froebel has been acknowledged as an influence on both Wright and the Bauhaus. Both stressed primary shapes and agreed upon the symbolism of each. The Bauhaus integrated total design much the way the Frank Lloyd Wright School of Architecture at Taliesin integrates the Arts in their curriculum. The Dutch Modernist J. J. P. Oud acknowledged Wright in the Dutch publication of *De Stijl* citing "new plastic architecture, using the primary means of the movement of planes to open up entirely new aesthetic possibilities for architecture." "Nature has a practical school beneath her more obvious forms in which a sense of proportion may be cultivated..." [Oud 1918].

Wright also looked eastward for inspiration. The Aesthetic Movement of the 1880s had a cult of the Japanesque and Wright was introduced to authentic Japanese art in prints and the exhibits at the 1893 Fair in Chicago. The Fair's Ho-o-den Japanese pavilion contained a cruciform plan, and a repeated square as basis for proportioning around a central shrine. The "elimination of the insignificant," a process of simplification in Japanese prints, was a great resource to Wright in giving direction to new concepts of space, furnishings, and the detailing of materials by reducing complex natural forms into their simple geometrical essence. Wright wrote *The Japanese Print* [1912] as a publication on Ukiyo-e, in which he explains the mystery of the Japanese print. Wright would work through the process of abstraction to neutralize the subject. Stressing aesthetic idealism, spirituality, democracy, and organic natural influences from Japan, Wright understood the complex idea of collapsing transcendental ideas into architectural form.

Arthur Dow was a teacher of the first Modernist generation and author of a general system of art education radically different from the norm. In Dow's text, *Introduction to Composition* [1998], the relations of line mass and color, could not be given by dictation or acquired by reading, but understood through completion of exercises in creating harmony through composition dependent on proportion. The five devices are: Opposition, Transition, Subordination, Repetition, and Symmetry. These aspects were incorporated into a general theory

referred to as pure design. The principles brought together harmony, balance, and rhythm in art. Abstraction of form through elemental geometry created simple arithmetic ratios. All aspects of Wright's work artifacts are treated as a whole based on a system of design.

2 Introduction and Analysis of Wright's Use of Geometry

This part of the seminar is an introduction of the relationship of mathematics, in particular geometry, to the architecture of Frank Lloyd Wright. Students begin their work with analysis of the geometry of Wright of various sites. We know that from the visual world to the invisible sub-atomic world, all forms are made of connected geometric patterns and relationships. Geometric diagrams are ways to reveal timeless and universal ideas hidden from our senses. A common mathematical solution can become a resource for great intellectual and spiritual insight.

The square, rectangle, octagon, triangle, hexagon, parallelogram, circle, spiral, and arc are keys to the consistent and systematic quality underlying all of Wright's work. They allow an ordering of space that encompasses both composition and construction. Using nature as his mentor and geometry as his tool he developed what he called organic architecture. He used number, geometry, proportion, pattern, hierarchy and orientation in all of his work. Wright used geometry as a formative idea with the concepts of plane and solid geometry determining the built form. Besides basic platonic geometries, Wright used combinations, multiples, derivatives, and manipulations. This structural vocabulary that was developed throughout his life consists of a three-dimensional field of lines through which the solid elements of the building are located enabling the voids to be integral to the whole and equally meaningful. Architecture was, after all, the space.

To achieve the qualities of repose and unity, the natural ornament was conventionalized through geometry to bring out the underlying form—a nature pattern study. Wright used a range of geometric grammars in which the controlling geometric unit ordered the plan and drove the detail development. Units can be equilateral triangles, or four foot squares or a series of circles. "Planned progressions, thematic evolutions, the never-ending variety in differentiation of pattern and to integral ornament always belonging naturally enough to the simplest statement of the prime idea upon which the superstructure is based" [Wright 1946: 423].

3 Seminar sites (vary from year to year):

- *Willits House*, Highland Park, IL. An asymmetrical matte of tartan grid lines from rectangular rather than square blocks, would express the grid at all points down to features such as balconies and built-ins, urns and clustered piers. The simple uniform grid moved to a symmetrical grid, which in turn moved to an asymmetrical grid. The line-ideas generate the decorative designs of windows [McCormac 1968: 143].
- *Cheney House*, Oak Park, IL. Cheney House uses a tartan grid for the entire site, part of a grid for the city and the whole state. The processional path to the center of the house moves the viewer through a series of framed vistas passing planters and steps observing the house all around the grid. This oriental expression of space prepares the viewer for the private domain and many the confrontations of texture the materials and transparency of the public and private zones.
- *Jester House (Pfeiffer House)*, Phoenix, AZ. The tessellation of a singular unit, either square, hexagon or triangle is used in many of his works. In the *Sundt House* of 1938 he used a hexagonal grid with an overall triangular grid that contains it. In the *Life Magazine Home* of the same year, he used a square grid and in the *Jester*, a circular system. Mapping out Wright's homes in terms of functions, many homes are schemed to be identical but look markedly

different due to a change in unit geometry. In these three homes, one arrives under a carport, passes through a yard area, enters the kitchen or office, or passes through to the entry area and onto the family room around which radiate the living, dining and bedrooms.

- *Greek Orthodox Church*, Wauwatosa, WI. This church sets a concrete bowl upon a Greek cross structure. The structural system is based on the same ordering as the textile block. The plan reduces itself to one dominant entry. The main altar does not lie on the same axis as the entrance loggia.
- *Jacobs I*, Madison, WI. The Usonian houses are natural transformations and developments from the prairie houses. The diagonal movement experience of the prairie houses became the primary spatial order of the Usonian houses. Outside and inside merge with overlapping and layered spatial definitions. Balance between abstract geometry and nature is examined in Sargeant [1975 and 1976].
- *Hollyhock House*, Los Angeles, CA. Poured-in-place concrete greatly advanced ornament towards structure in helping to modify or emphasize the lines or planes of a composition. Surface patterns in bands of stucco or terracotta panels were exchanged for energetic three-dimensional devices at the *Hollyhock House* (Indian princess surveying her lands) and *A D German Warehouse*. The Hollyhock fireplace with reflecting pool, relief mural, and skylight above incorporate overlapping disks and the square, and ideas unique to Ms. Barnsdall.
- *Guggenheim Museum*, New York, NY . The dome of this most important commission is a web of 6 parabolic arches focused on a central hexagon framing a central circle. The viewer in the cylinder identifies with the geometry. The earth and heaven with a column of light establish the vertical axis. A 1/4-mile gallery at 3% grade gives a sense of the cosmos of this reversed ziggurat.
- *Johnson Wax Administration Headquarters*, Racine, WI. The slender monolithic dendriform shafts stand on metal tips bedded at the floor level. In botanical terms, it describes the various parts—stem, petal, and calyx. The innovations allowed the column to be an aesthetic element and not just a support device. Wright's endeavor to synthesize technology in a building produced a structured architecture. The elements of a building can be brought together in a logical manner, freed from ambiguous meaning, into a form whose character is governed by a sense of order.

The scholarship grows in this area, building upon important work from Richard McCormac [1979], Nute [1997], Sargeant [1975 and 1976], Eaton [1998], Laseau and Tice [1991], and Koning and Eizenberg [1981].

4 Review and research of current practices, which translate, interpret and innovate from the mathematics and geometry used by Wright

Part three of this seminar analyses the work of contemporaries and the first generation of work after Wright. These architects represent work achieved in Denmark, Germany, Holland, Belgium, Italy, Spain, England, France, the United States, Mexico, Canada, Chile, Argentina, and Brazil.

Anthony Alofsin [1999] and Heidemarie Kief [1982] both cover many influences globally but stop short of twenty-first century contemporary practice.

Twentieth Century:

*Jorn Utzon
Enric Miralles
Bruce Goff
Rudolph Schindler
John Lautner
Theo van Doesburg
JJP Oud
Greene and Greene
Josef Maria Olbrich
Otto Wagner
Richard Neutra
Paolo Soleri
Willem M Dudok
Hendrik Berlage
Robert Mallet-Stevens
Carlo Scarpa
Walter Burley Griffin
Peter Behrens
Luis Barragan*

*Jan Wijdeveld
William Moser
Gerrit Reitveld
Mies van der Rohe
Jan Wils
Robert Van t'Hoff
Andre Lurcat
D E Harrington
M. Ginsburg
Irving Gill
Luis Barragan
Don Erickson
G Samona
S Michaeli
John Randall MacDonald
EE Roberts
George Maher
Robert Spencer
Purcell & Elmslie
Tallmadge & Watson*

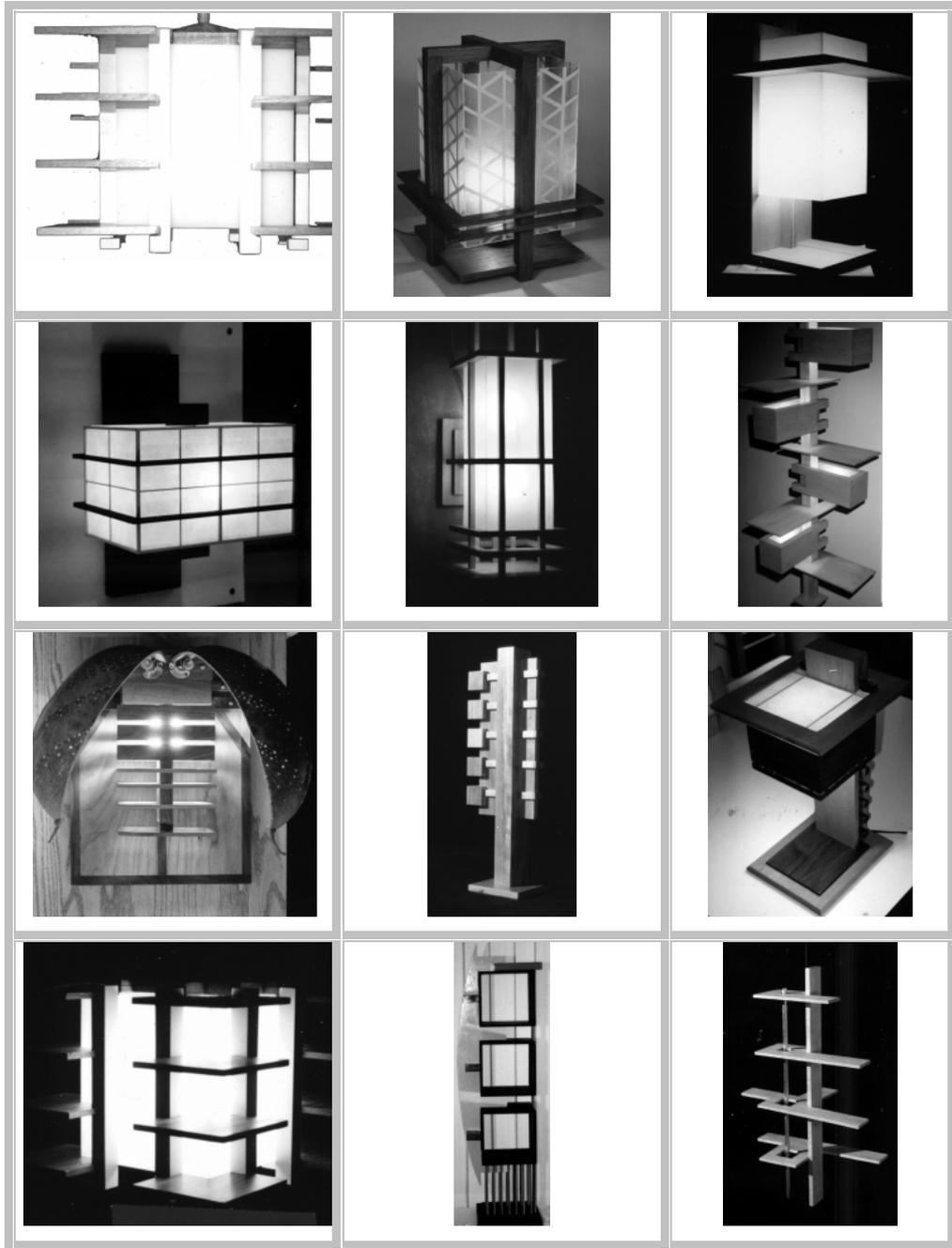
*Barry Byrne
Dwight Perkins
Richard Hunt
William Drummond
Charles White
Van Bergen
Marion Mahoney Griffin
Herman Von Holst
Aldo Rossi
Ernest Anderegge
Gio Ponti
Schoder
Lowe u. Giest
Kuhnert u. Pfeifer
Eric Mendelsohn
Buurma
Duiker & Bijvoet
Walter Gropius*

Twenty-First Century:

*Santiago Calatrava
Bart Prince
Gunnar Birkerts
Will Bruder
Douglas Cardinal
E Fay Jones
Eric Lloyd Wright
Stanley Tigerman
Antoine Predock
John Portman
Carlo Ranalli
Clause Archts.
L Taratino
Alfred Parker
Frank Gehry
K. Johnson
T. Guggenheimer
Wiehle & Carr*

*William McDonough
Ricardo Legorreta
Philip Johnson
Agustin Hernandez
Tadao Ando
Arthur Erickson
Thomas Beeby
Andres Duany
John Eifler
Patrick Pinnell
Robert McCarter
Carlo Ranalli
Clause Archts.
L Taratino
Alfred Parker
Frank Gehry
K. Johnson
T. Guggenheimer
Koning and Eizenberg*

*Lauro Boselli
Tadori Mori Herve Bailey
Ken Dahlin
Chris Rudolph
Susan Susanka
MED archts
Will Bruder
Mark Zinni
Randolph Henning
Art Dyson
Wiehle & Carr
T. Olson
M. Sykora
E. W. Ingraham
D. Wheatley
R. Henning
Sydney Robinson A. Sartori*



Examples of student work

5 Conceptualization and construction of an artifact

Students have a chance to apply ideas about geometry in nature through the ideation, development and construction of an artifact. Desk lamps, sconces, mobiles, desk organizers, candleholders, glassworks, fountains, storage units, etc. are all attempted and achieved through a series of traditional design studio exercises. Students are evaluated on concept, use of geometry, geometries expressed, scales, appropriate use of materials and craftsmanship. Examples of student work are shown below.

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About the Authors

Mark Keane and Linda Keane were trained in the 1970s in an architectural education of modernism transitioning into post-modernism. Linda received her first architectural degree along with an environmental design degree from Ball State University, College of Architecture and Planning. Mark received his first architectural degree from the University of Illinois at Urbana-Champaign. Linda's introduction to Wright began in high school art class with study of the Modern masters, Mies van der Rohe, LeCorbusier, and Wright. In college, architectural history lectures of the Robie House in Chicago, the Home and Studio in Oak Park, and the Guggenheim Museum in New York preceded field trips to these sites. For Historic American Building Surveys, she completed documentation of a Wright Usonian home, the Haynes Residence, in Fort Wayne, Indiana. Her graduate experience in Chicago was an introduction to the classical language, Chicago's tall buildings, and critical studies in the process of aesthetics, design, and architecture. Mark's experience with Wright came from lectures by Professor Walter Creese at the University of Illinois at Urbana-Champaign, and tours of Wright's work in Oak Park.

Mark and Linda's first studio of collaborative practice was established in Oak Park near Wright's Home and Studio, at a time when they were both teaching in the Department of Interior Architecture at the School of the Art Institute, whose original founder, Marya Lilien, was the first female apprentice to Wright at Taliesin. Linda also team-taught a third year studio at UIC that focused on disseminating differences in reinterpreting the modern language of Mies van der Rohe, Le Corbusier, and Frank Lloyd Wright.

In the 1990s Mark and Linda began the Frank Lloyd Wright Initiative at the University of Wisconsin at Milwaukee. In 1993, the University of Wisconsin-Milwaukee established an enhanced program that expands the students' understanding of the importance of Wright as an architect and as cultural icon. "The Frank Lloyd Wright Initiative" has generated graduate level studios, seminar courses on the impact of Wright on American Heritage, and expanded Historic American Building Surveys of important Wright structures. A series of research projects, including "Wrightscape: The Geometry of Wright," has been partially supported by the Wright Initiative. A number of distinguished guests have given public lectures on the legacy of Frank Lloyd Wright, promoting greater accessibility and understanding of the work of this master architect.