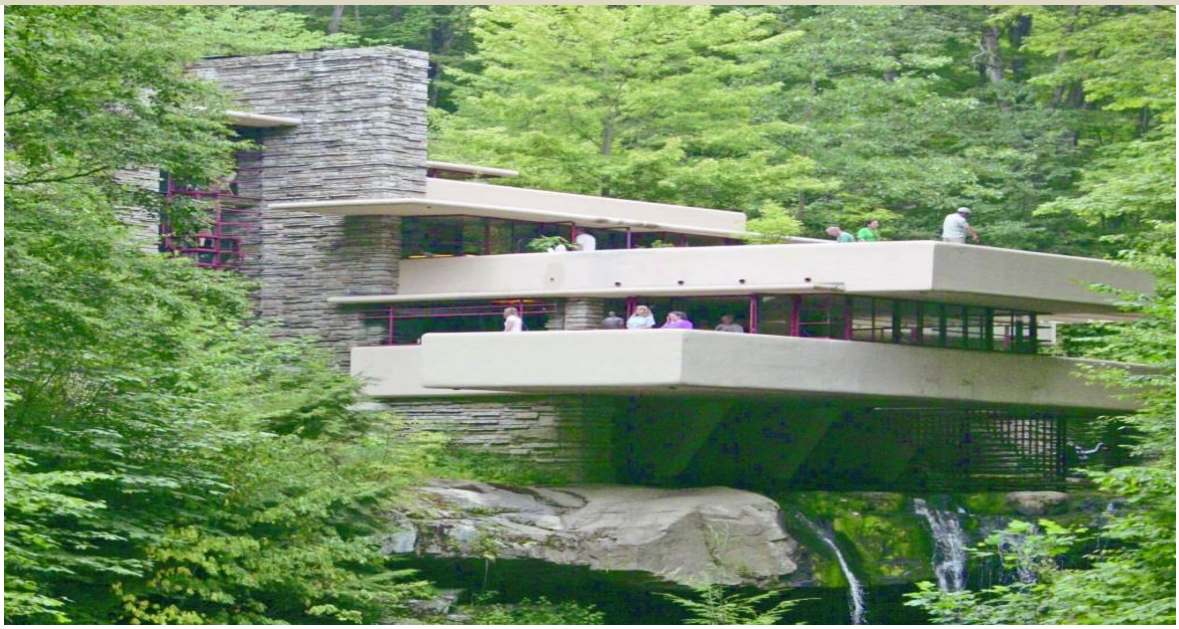
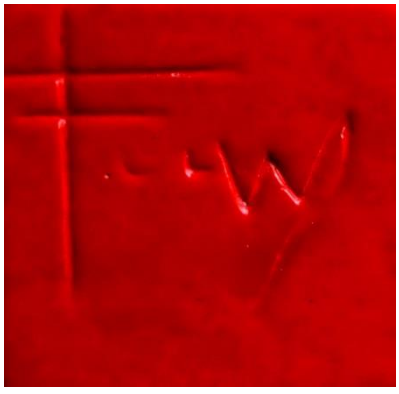
Frank Lloyd Wright's Fallingwater & Kentuck Knob





Smithsonian Associates Tours
September 14, 2025
Study Leader
Bill Keene

Photographs by Bill Keene

Frank Lloyd Wright
June 8,1867- April 9,1959

When he died in 1959 shortly before his 92nd birthday, the United States was an a highly urbanized, industrial nation, an economic and political world power. In 1867 at the time of his birth, the country was fundamentally an agrarian nation with settlements concentrated East of the Mississippi River and with only scattered settlements surrounded by vast tracts of little known and largely unexplored land stretching from the Mississippi to the Pacific. In 1867 the United States was recovering from a devastating civil war yet before Wright's life reached its halfway point, not only had the nation begun to emerge onto the world scene as a major power but the frontier had disappeared, and such inventions of the telephone, electric light, and the internal combustion engine profoundly changed business, industry and daily life. During the second half of his life, the pace of technological and social change accelerated impacted by two World Wars and the Great Depression. When he died in 1959, the United States had not only emerged as a highly urbanized industrial nation and a leading world power, but a myriad of technological innovations and social developments had profoundly impacted daily life and fundamentally changed architecture, construction and the decorative arts as well.

Early life:
During his early childhood, Wright's family moved frequently, to Iowa, Massachusetts, and several other locations before returning to Wisconsin in 1877. For several years, he spent summers on the family farm, where he developed a deep appreciation of the land and nature. At sixteen, following his parents' divorce, Wright dropped Lincoln as his middle name and adopted his mother's family name of Lloyd in its place. From an early age, he was a voracious reader, the works of Emerson, Thoreau and Whitman helped shape his belief system in which freedom, individualism and democracy were key elements. This philosophical outlook was not only inseparable from his belief that architecture was critical to the development of true culture and democracy itself, it underlay his life-long quest to develop an American architecture free from the historicism of past styles, one that reflected his time and place, based on contemporary needs and values and employing the latest in new materials and technological advances.

Early Career to 1893:
In 1887, Wright left an engineering program at the University of Wisconsin after less than three terms moving to Chicago to pursue a career in architecture. Wright's gifts as a draftsman were quickly recognized enabling him to move rapidly from firm to firm, each time for better pay. In 1888, he joined the progressive firm of Adler and Sullivan, quickly advancing to become the lead draftsman. He worked on projects that included factories, commercial buildings, synagogues, the Auditorium Building, and even the Transportation Building at the Chicago World's Fair of 1893. In addition, Wright with Sullivan's blessing worked on a number of residential projects which the firm did not seek but did not wish to turn down. Wright was paid by the firm for the projects which helped him hone his skills and earn added income for his rapidly growing family.

> *"The complete architect…is master of the elements: earth, air, fire, and water. Space, motion, and gravitation are his palette: the sun his brush. His concern is the heart of humanity. He, of all men, must see into the life of things; know their honor."*
>
> *Frank Lloyd Wright*

Wright on his own
Phase I: – Master of the Horizontal:
In 1893, after being leaving Sullivan ostensibly for working on commissions without the approval of the firm, Wright opened his own practice. During a career spanning seven decades, he developed an architectural form unmistakably his own, yet influenced by the cultural, architectural and technical developments of his time. Wright's buildings demonstrate a remarkable variety of forms, but are nonetheless based on the underlying principles of what he termed organic architecture: rooted in the natural landscape, providing users with a sense of peace and serenity which he viewed as essential for daily living. In so doing, he sought to create harmonious compositions embracing site, structure, and nature tailored to the specific desires and needs of the client. ostensibly

Wright's major accomplishment during this first phase of his career (roughly 1893 to World War I) was his contribution to the Prairie Style. While principally focused on residential construction, both residential and commercial buildings shared a number of common characteristics: they were long, low structures with a clear and strong emphasis on the horizontal, reflecting the flatness of the Midwestern landscape. The low-pitched roofs with broad overhanging eaves and horizontal bands of windows furthered the integration of the building with the landscape. Wright favored a central hearth and fireplace, restrained use of ornamentation, sturdy construction, a palette of earth tone colors, abundant use of wood, brick and stone, and perhaps above all quality craftsmanship. While not devoid of ornamentation, external decoration was used sparingly, at times including strips of trim so placed as to emphasize the horizontal or draw the eye around a corner.

Phase II – Eclipse:

During the second phase of his career beginning about the time of World War I and lasting until the mid-1930's, Wright executed relatively few commissions -- the most notable being Tokyo's Imperial Hotel and his series of textile block houses in California. Nonetheless, it was a time of experimentation with new and different building techniques often featuring designs based on geometric forms other than the square or rectangle. Wright also enhanced his standing among a generation of young architects in Europe and America through lectures, papers and especially in 1932 the publication of his autobiography and the establishment of the Taliesin Fellowship as a school of architecture. The combination of lectures, papers, the autobiography and the school contributed both directly and indirectly to a revival of his career as a new generation of architects and clients began reading his life story and philosophy of architecture.

Design Elements

General

- A building should appear to grow easily from site and should be shaped to harmonize with its surroundings.
- Colors – use soft warm optimistic tones of earth – avoid white
- Bring out the nature of materials (the wood, plaster, brick or stone) in designs.
- A building cannot be fine art when these factors are ignored but one with character has a good chance of becoming more valuable with time
- Breaking the Box – opening the corners of rooms either with windows, doors or overlapping rooms.
- Path of Discovery provided privacy, added interest to the entry, avoided the commonplace and differentiated a Wright project:
- Compression and Release low ceilings then a sudden often dramatic opening out of space vertically or horizontally:

Houses:

- A home should convey a sense of simplicity and repose
- It should contain as few rooms as possible to meet the needs of the occupants
- Openings (windows and doors) must be integral to the design and function
- Excessive detail ruins design and is hopelessly vulgar
- Standalone appliances or fixtures as such are undesirable – they should be designed into the structure –
- Pictures deface walls unless they are incorporated into general scheme
- Most furniture should be built-in and part of original scheme
- The Prairie has its own beauty with its quiet level vistas. The houses of the area should have gently sloping roofs, suppressed heavyset chimneys, sheltering overhangs, low terraces that set apart private gardens.
- There should be as many kinds of houses as people (as expressions of individualism)

Public Buildings

- Wright was often on the cutting edge employing the latest in technology and developing designs that provided workers with a light-filled, healthful, and inspiring environment.

Phase III – Reemergence:

By the late 1930's Wright reemerged as a major force in modern architecture. Two masterworks, Fallingwater and the S.C. Johnson headquarters building did much to launch this third and most productive phrase of his career. In January of 1938, Fallingwater appeared the cover of Time magazine and along with coverage of the Johnson building, as well as other works, and references to his philosophy of organic architecture and nature were also featured in Fortune, Life and a special issue of Architectural Forum. Extensive coverage of his work in other

magazines, professional journals, the Hearst newspapers and dozens of other publications soon followed. Over the course of the next two decades, Wright received some 40 percent of his commissions and completed more than 100 Usonian houses, the Guggenheim Museum, the Price Tower, the Marin County Government complex, several religious buildings including the Beth Sholom Synagogue, and twelve buildings for the campus of Florida Southern College. Among the dozens of unexecuted projects were houses, hotels and commercial buildings, a new capitol for Arizona, a complex of structures for Bagdad and a mile-high skyscraper for Chicago.

Elements of Style in Wright's Work

Wright rejected both historicism in design and the prevailing approach to the study of architecture as taught at the École des Beaux Arts in Paris. That curriculum emphasized classical orders from Greece and Rome, symmetry, and a design process that emphasized the façade and then developed the layout of rooms to fit into that design. The Beaux Arts approach to teaching so dominated the profession in both Europe and the United States at the end of the Nineteenth and early Twentieth Century that Beaux Arts became the style adopted for innumerable public buildings, banks, and major projects. But Wright's approach turned the process inside out, he first studied the site and required a topographic map to determine the best location and orientation of the project. He then collected detailed information from the client on requirements and lifestyle and from these elements his plan emerged. The placement of each room was carefully considered in relation to the whole, to the natural setting, the needs of the client and their lifestyle. Only when the floor plan was complete was the façade developed. The result was a structure based on and derived from function rather than a plan imposed from the outward form. To Wright form and function were one and inseparable.

> *"The Machine is a marvelous simplifier; the emancipator of the creative mind, and in time the regenerator of the creative conscience".*
>
> *The Art and Craft of the Machine, 1901*

Wright maintained that aside from Japanese architecture, that he was not influenced by other styles or architects. Nonetheless, Wright was aware of architectural theory in general and of contemporary developments in Europe in particular. He followed the writings of Viollet-le-Duc, John Ruskin, William Morris, Andrew Jackson Downing, the Vienna Secessionists, the Futurists, the Bauhaus, and others over the course of his career.

Arts and Crafts

Wright's affinity for quality workmanship and his use of wood, local materials, and highly skilled crafters, tie his Prairie Style buildings closely to the arts and craft movement. He was not only familiar with the work of Charles Rennie Macintosh in Scotland he also became friends with C.R. Ashbee (founder of the Guild of Handicraft, a leading Arts & Craft group in England). Ashbee not only visited Wright shortly after the turn of the 20th century but later wrote essays in publications featuring Wright's work. Advocates of the style, especially in England called for the rejection of industrialization, and a return to hand-crafted design with patterns based on natural forms. They embraced materials and practices of the medieval craftsmen in handcrafting in wood, stone, clay and metal.

Wright was a member of the Chicago Arts and Craft Society, and in his own work employed the best artisans to execute his designs of everything down to the smallest details his houses featured the best woods, local stone and other natural materials, executed to his high standards. Nonetheless, he differed from the Arts and Craft movement by embracing technology, he routinely incorporated the latest in heating and cooling, lighting, and structural materials in both his domestic and public buildings. Further, he admonished artists to embrace the machine for what it could do well, arguing that it could free them to develop designs reflecting current technological advances, contemporary society and incorporating new materials such as steel and concrete.

Art Nouveau

Aligned with elements of arts and craft in his early work were suggestions of the Art Nouveau style particularly in work before 1900. Wright is credited with influencing Art Nouveau developments in Europe and among the Art Nouveau elements in his own work are such items as the lunettes in his home in Oak Park (1895), and decorative touches on the Winslow house of 1894 including a screen in living room and a freeze and arches on the exterior.

Art Deco
Wright's use of strong geometric shapes, employing squares, triangles, hexagons, and circles links elements in much of his work to the Art Deco style. His hollyhock house (1917-1920) the textile block houses of the 1920's all in the Los Angeles area set the tone for California Art Deco based on Mesoamerican themes. Later, Wright returned to a less bold textile block approach in a number of his Usonian houses after World War II that nonetheless retained tinges of the Art Deco. Many of Wright's designs contain elements of Art Deco styling but the S.C. Johnson headquarters with its streamlined curves and unique use of glass rods stands out one of the most important and most iconic among all of Wright's work.

> *"In Organic Architecture then, it is quite impossible to consider the building as one thing, its furnishings another, and setting and environment still another. The Spirit in which these buildings are conceived sees all these together as one thing. The very chairs and tables, cabinets and even musical instruments, where practicable, are of the building itself, never fixtures upon it."*

International Style
Although he publicly shunned the International Style, both his masterpiece Fallingwater and his project for the 'House on the Mesa' of 1932, demonstrate a deep understanding of the style he consistently deprecated. Fallingwater in particular, demonstrates his ability to take inspiration from an existing style or example and make it his own through a transformation that moves far beyond that which provided the initial inspiration.

An American Architecture
Wright's work often reflects a blending of elements that could range from Arts and Crafts, Art Nouveau, Art Deco, and even the International style, along with influences from the Orient and Mesoamerica. However, in his projects, such elements were transformed, tailored to a specific site, the desires of the client, the availability of materials, and the budget. Further, underlying whatever stylistic approach he used for a particular project, his goal and his philosophy remained consistent: to develop a design that reflected the unique conditions and traditions he saw as central to life in the contemporary United States. These views were adroitly expressed in three dimensions in his buildings from humble single-family homes to the grandest public or commercial buildings.

Organic Architecture
From his earliest pronouncements, Wright was concerned with "Organic Architecture" consequently his writings are filled with references, pithy sayings and aphorisms about organic architecture that make a definitive definition difficult to shape. He was concerned not only with architecture but with education, human dignity, individual freedom, democracy, human endeavor and enriching the relationship between the individual and the environment. Wright's use of the term *organic* served as a synthesis of his thinking and it was broad enough to encompass and at times essentially be synonymous with such terms as nature, natural, rational and logic. He thought of architecture as the 'Master Art' which he saw as essential along with art, music, and poetry to a full life.

Because Organic Architecture is so intimately associated with Wright, it has often been confused with his unique style. However, by Organic Architecture he meant architecture growing from the use of organic principles not from imitating his style or the style of anyone. He challenged his apprentices to think for themselves, develop their own style, and adapt it to the specifics of the task at hand. "Given similar conditions, similar tools, similar people, similar language, I believe architects will, with proper regard for the organic nature of the thing produced, arrive at greatly varied results; buildings sufficiently harmonious with each other and more so with great individuality." Finally, underlying his work was the objective "to make the landscape more beautiful than before that building was built."

Technological advances and drawbacks
Wright was a pioneer in employing such materials as glass, steel, and concrete in new ways that often stretched them beyond previous limits. Consequently, at times roofs leaked, cantilevers sagged, heating and cooling systems proved inadequate. But it can be argued that without such efforts by Wright and other forward-thinking architects

willing to experiment and explore new ideas that modern architecture in the 20th century might have been quite different and developed later than what actually happened.

The Kaufman House "Fallingwater" and The Hagen House "Kentuck Knob"

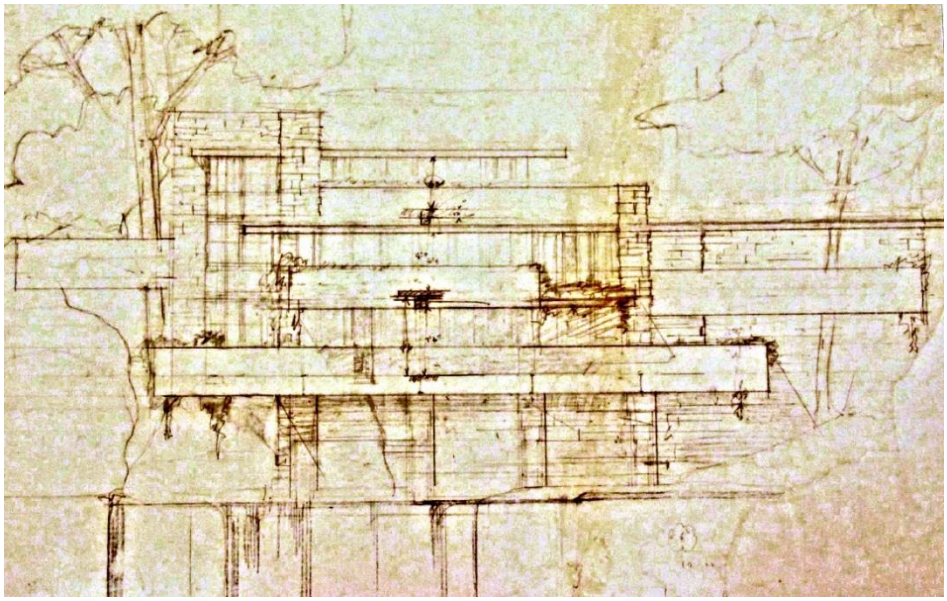


Figure 1 Fallingwater elevation drawn by Wright on the day of Kaufmann's visit.

Fallingwater

The house epitomizes modernity, daring innovation, spectacular design and engineering and a unique American form of architecture. Wright, at the time thought by many to be past his prime, old fashioned and out of touch with truly modern architecture, took on the International Style and produced a totally original composition. He designed the house as a weekend retreat for Edgar and Liliane Kaufmann of Pittsburgh. After months without seeing any plans, Kaufmann called Wright saying he would arrive later that day to see the plans for the house. Wright said they would be ready, then according to witnesses, starting from scratch, he sat at the drafting table and created a series of drawings for the house and its setting. The house had been completely envisioned before Wright put pencil to paper and it poured forth onto the paper like Athena springing forth fully formed from the brow of Zeus. (See Figure 1.)

Some argue that the Kaufmanns were surprised by the placement of the house over the falls since they believed that it would be placed downstream looking back at the falls. However, others cite evidence that Edgar Kaufmann at least was aware of Wright's decision well before he saw the initial drawings. Fallingwater is a unique combination of stunning engineering that seems to defy gravity yet remains a celebration of nature where the house, despite its prominence blends seamlessly into its setting becoming one with the landscape.

The site is over a waterfall, the form emerges as a series of concrete trays cantilevered outward over the waterfall. The trays are anchored into the rock; with uncut rock penetrating up into the house, forming a cave-like feature in the living room. The plan executed using natural materials is an open centrifugal concept that can be likened to a tree with a stone and concrete core representing the trunk and the cantilevered trays the branches. If the form is unexpected, the harmonious blending of structure with site makes Fallingwater perhaps the most tangible example of Wright's desire "to make the landscape more beautiful than before that building was built."

Kentuck Knob

Less well-known than its world-famous neighbor Fallingwater, Kentuck Knob nonetheless presents some of Wright's best work incorporating many of his signature design principles. Built for I.N. and Bernadine Hagen, the house wraps around the brow of the hill. The bedroom wing, with its low-slung copper roof blends with the sky and nearly merges into the hilltop just beyond the master bedroom. In an unusual arrangement for Wright, the entrance is placed near the center between the bedroom and living room wings anchoring the plan. Behind the entrance is a low stone tower that encloses the kitchen and the central fireplace and hearth. This core serves as a pivot point for the house and provides separation between the private spaces in the bedroom wing from the public wing containing the living room. A wide terrace on the south and west of the living room extends forward like a ship's prow appearing poised to

explore the limitless frontier that drew pioneers across the continent in the nineteenth century. To the left of the bedroom wing also rotated 120 degrees is the carport and storage room.

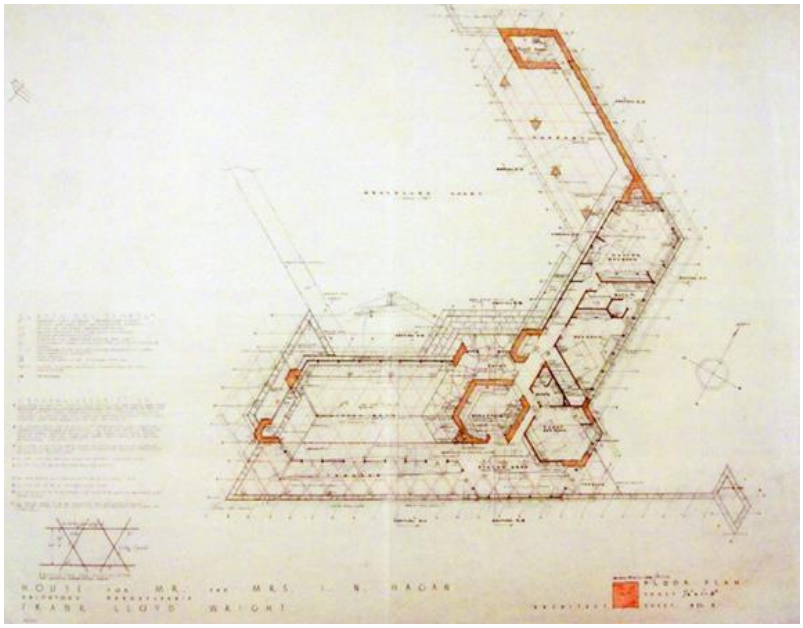


Figure 2 Kentuck Knob Working Drawing

Wright carefully integrated the plan with the site allowing sunlight to flow across the living room in winter but blocking the sun from directly penetrating into the room in the heat of the summer. The walls are made from roughly split sandstone that weathers over time to a gray finish harmonizing with the Tidewater cypress in the clerestory windows and trim. The plan is based on a 4-foot 6-inch unit coupled with a 13-inch vertical unit. Wright used many different unit grids during his career and argued that the unit system was essential both simplifying the plan and facilitating construction. His early buildings tended to be based on the square or rectangle while later works employed triangles, hexagons, circles or at times combinations. At Kentuck Knob the module is more complex, while appearing to be hexagonal it actually consists of four small triangles, a central hexagon, and two equilateral parallelograms. (T*his is shown near the lower left corner of* Figure 2.)

Wright and Machine-Made Products

During Wright's early career, he was profoundly dissatisfied with available machine made products of the time. He felt they were nothing but poor copies of things from the past and were without meaning in a contemporary setting. Consequently, for his early buildings he typically designed not only the house but fixtures, art glass windows, fabrics, and the like, blending everything into a coherent ensemble tailored and relevant to the way his clients lived. Later, particularly in the post-World War II period, Wright not only used off-the-shelf products he actively embraced them not only employing them in his basic homes but in high-end commissions as well. Further, he designed a broad spectrum of manufactured products himself ranging from furniture to fabrics and even a palette of colors for house paint (see Figures 5 & 6)

Wright's support for the machine as a tool to further art and design mesh with his overriding objective to develop an American style of architecture rooted in and fostering democracy.

Figure 4 Heritage Henredon Furniture designed by Wright

Cantilevers .

Definition: *Any rigid construction extending horizontally well beyond its vertical support, used as a structural element of a bridge, building element, foundation, etc.*

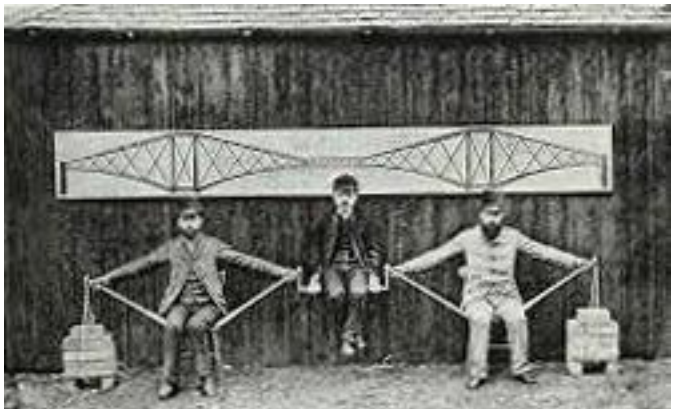


Figure 5: Firth of Forth Bridge – Scotland -- Demonstration of the Cantilever System c. 1883

What Went Wrong: Analysis of the Problem with the Cantilevers at Fallingwater

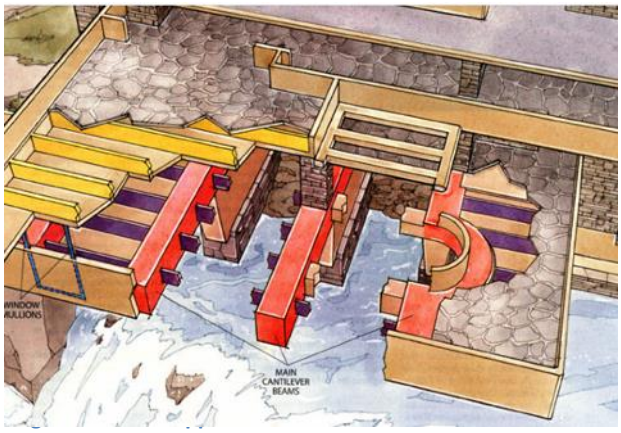
By Robert Silman

After much testing and non-destructive evaluation (NDE) work, our firm found that the major cantilever beams at the first floor were grossly under-reinforced — the reinforcing steel had exceeded its yield strength and the compressive stress in the concrete (approximately 4400 psi) was approaching the ultimate failure strength (approximately 5000 psi). How could this have happened? There were two structural engineers collaborating on the design, Mendel Glickman and Wes Peters, both highly competent. The theoretical problem was not difficult, even for 1936 — a simple concrete cantilever beam. Here are some of our theories:

Figure 6: Cantilevers supported by Steel I beams prior to repairs carried out in 2001-2002

1 The house was designed very quickly. Mr. Wright had visited the site just once and then had done nothing more. One morning he received a phone call from the owner, Edgar Kaufmann, who was visiting in Milwaukee, a three-hour drive from Taliesin, the architectural studio operated by Frank Lloyd Wright and staffed by his “apprentices”. When he asked to come and see plans of the house, Mr. Wright invited him for lunch. He then gathered the apprentices around him and, in the space of one morning, proceeded to draw all of the floor plans. While they were at lunch, the apprentices finished the elevations. Virtually nothing changed from that original set and construction began soon after.

2 We suspect that the engineers were being pushed by the contractor to produce the structural drawings so that they could build the next piece. It is very possible that the engineers did not realize that the load from the second floor was being transmitted to the tip of the first floor cantilevers by means of the four reinforced mullions.



living room

3 Even if these facts were so, there is still evidence that both the second and first floor beams were inadequately reinforced. It appears as though there were mistakes made. On the day that the formwork was decentered, the cantilevers deflected 1 3/8 inches and a significant crack opened in the second floor spandrel/parapet beam over the masonry supporting pier below. They called Mendel Glickman who went to check his calculations and when he returned to the phone he is reported to have exclaimed, “Oh my God, I forgot the negative reinforcing!” The originally designed reinforcing in the first floor cantilevers was also far too skimpy, not enough to even hold the weight of the first floor by itself.

4 The reinforced concrete contractor, also an engineer, determined by means of his own independent calculations that there was insufficient reinforcing in the first floor cantilever beams. The contractors wrote of their findings to Mr. Kaufmann, who passed the letter along to Mr. Wright. The latter, famously egocentric and unwilling to admit that he could ever be wrong, responded with a classic letter to his client, forcing him to choose between the veracity of the contractor or the architect. Mr. Wright’s words went something like this: “I have put so much more into this house than you or any other client has a right to expect that if I haven’t your confidence — to hell with the whole thing.” Mr. Kaufmann backed down and deferred to Mr. Wright’s power of persuasion. After a contentious exchange with Mr. Wright, the contractor “sneaked in” double the amount of reinforcing called for on the original design drawings. This was still inadequate for the dead loads of the concrete — they had apparently not accounted for the load of the second floor on the tip of the first floor cantilever either, even though it was clearly shown on the original drawings.

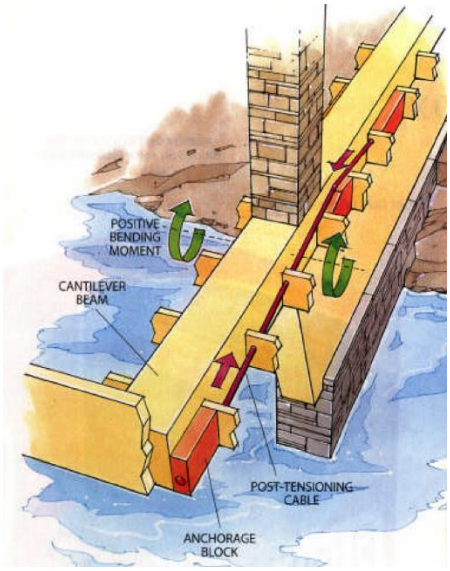


Figure 8: System of post-tensioning cables to address the deformation of the

In summary, we never were able to conclude what went wrong. But wrong it did go and it remained in that dangerous state for 65 years until this elegant repair was completed. ▪

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Other Examples of Cantilevers Employed by Wright

Gale House -- Oak Park, Illinois 1909

Hagen House (Kentuck Knob) -- Ohiopyle, Pennsylvania 1954

Robie House – Chicago, Illinois 1909

Fallingwater -- Canopy to Guest House Addition 1939