

# When less was more: the construction of Mies van der Rohe's Crown Hall.

*Cuando menos fue más: la construcción del Crown Hall de Mies van der Rohe.*

Zaida Garcia-Requejo (\*)

## ABSTRACT

*The S. R. Crown Hall is the first constructed example of a large-span universal space in the career of the architect Ludwig Mies van der Rohe. Intended to house the school of architecture of which he was director, the project also had to summarise the first of the principles on which his teaching at the Illinois Institute of Technology was based: structure as an architectural factor, its possibilities, and limitations. This article explores the development process of Mies' project, putting it in context with his experience as a professor at the IIT, seeking to establish possible connections between his architecture and his teaching. To do so, the final structural solution is compared with one of the projects supervised by him as part of the graduate program: Jacques Brownson's house. Two structures on a different scale, but identical in typology, both of which were developed with the collaboration of structural engineer Frank Kornacker.*

**Keywords:** Mies van der Rohe; Frank Kornacker; Crown Hall; graduate program IIT; architectural education; Geneva House.

## RESUMEN

El S. R. Crown Hall constituye el primer ejemplo construido de *espacio universal* de gran luz en la trayectoria del arquitecto Ludwig Mies van der Rohe. Destinado a albergar la escuela de arquitectura de la que era director, el proyecto debía además resumir el primero de los principios sobre los que se asentaba su docencia en el Illinois Institute of Technology: la estructura como *factor arquitectónico*, sus posibilidades y limitaciones. Este artículo profundiza en el proceso de desarrollo del proyecto de Mies, poniéndolo en contexto con su experiencia como docente en el IIT, buscando establecer posibles conexiones entre su arquitectura y sus enseñanzas. Para ello, se compara la solución estructural definitiva con uno de los proyectos supervisados por él dentro del programa de posgrado: la vivienda de Jacques Brownson. Dos estructuras de diferente escala, pero idéntica tipología, para el desarrollo de las cuales se contó con la colaboración del ingeniero estructural Frank Kornacker.

**Palabras clave:** Mies van der Rohe; Frank Kornacker; Crown Hall; programa posgrado IIT; educación arquitectónica; Casa Geneva.

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In the book *Mies van der Rohe At Work*, Peter Carter explores the professional career of his former teacher, establishing three main typologies: high-rise skeleton buildings (these, in turn, may be office buildings, or apartment blocks); low-rise skeleton buildings; and open-plan buildings. The last category includes the Farnsworth House, the Crown Hall, the National Theatre for Mannheim, the National Gallery of Berlin and the proposal for a Convention Hall. Mies van der Rohe began to work on the development of *open spaces* as early as 1945, tested for the first time in the unbuilt proposal for the Cantor Drive-in restaurant in Indiana, and firstly built with the construction of Farnsworth House in Plano, Illinois. Until the completion of the Neue Nationalgalerie in Berlin in 1968, he developed many projects that explored the possibilities of a space free of internal structural supports; a flexible space, a *universal space*.

"His first large-scale, clear-span, universal-space building (...) a place where all teacher and all students, regardless of their levels of experience, could come together and work, literally within sight and reach of each other."<sup>1</sup> (1) The Crown Hall was the first of the long span *universal space* built, and the one with the largest span built using the unidirectional structure. Moreover, as Kevin Harrington points out, the school project also brought together Mies' teaching aspirations, embodying in *three dimensions* what was included in the curriculum. (2)

Numerous architecture critics and historians have spoken about the definition of the project as well as the relationship between the structural component and the architectural space, but few have explored the process of developing the proposal or the different phases of construction, nor is there any published study on the possible connections between this architecture by Mies and his teaching at the IIT. The main objective of this research is to analyze the process that led to the definitive structural version of the school's project. For this purpose, the Crown Hall project is compared with a final master's thesis written under his supervision as part of the IIT's graduate program, in order to verify whether there is a relationship between his architecture and his work as a professor.

Accurate research calls for the selection of study objects whose variables allow for the valid application of the comparative method. For this reason, a selection of final master's theses is made that resolve universal spaces, distinguishing whether they are unidirectional or bidirectional structures. Of the forty-eight final master's theses documented and conserved in the University Archives and Special Collections of the IIT, and which have been available for consultation during the course of the research, sixteen propose a unitary space to resolve the architectural problem. Within the unidi-

1945-49	(1949) <b>Reginald Malcomson</b> "The theatre: historical development and present possibilities"	1950-55	(1950) <b>Leonard Klarich</b> "A Concert Hall"	1955-60	(1956) <b>Peter Roesch</b> "A Non-Denominational Church"
			(1951) <b>Gene Summers</b> "A Field House"		(1958) <b>Peter Carter</b> "An Art Museum"
			(1953) <b>David Haid</b> "An Arts Center"		(1959) <b>Masami Takayama</b> "An Art Museum"
			<b>Louis Rocah</b> "A Chapel (Non-denominational)"		<b>Cathal O'Neill</b> "A Cathedral for Dublin"
			<b>Philmore Hart</b> "A Synagogue and Community Center"		<b>Arthur Takeuchi</b> "A Cultural Center"
			(1954) <b>Yujiro Miwa, Henry Kanazawa y Pao Chi Chang</b> "A Conventional Hall. A co-operative Project"		<b>Julius Ruecker</b> "A Community Center"
			<b>Harvey Stubsjeon</b> "A Community Hall for a City of Forty-Thousand Population"		<b>Henry Hawry</b> "A Theater"
			<b>JACQUES BROWNSON</b> "A STEEL AND GLASS HOUSE"		
			(1951-53) <b>Casa McCormick</b> Elmhurst, Illinois		(1962-68) <b>Neue Nationalgalerie</b> Berlin
			(1950-56) <b>S. R. CROWN HALL</b> Chicago, Illinois		(1961-74) <b>Brown Pavilion, Houston Museum of Fine Arts</b> Houston, Texas
			(1954-58) <b>Cullinan Wing, Houston Museum of Fine Arts</b> Houston, Texas		
	(1945-51) <b>Casa Farnsworth</b> Plano, Illinois				(1955-63) <b>Casa Greenwald</b> Weston, Connecticut

Figure 1. Table listing the final master's theses supervised in the IIT's graduate architecture program (1939-59) that resolve a *universal space*, and the *universal spaces* built by Mies. Elaborated by the author.

<sup>1</sup> Drexler, A., Schulze, F. (1985) *Mies van der Rohe Archive 1910-1937*. New York: Museum of Modern Art, 206.

rectional structures, a distinction is made between those that use trusses and those that make use of girders as the main horizontal elements (Figure 1). The project selected for analysis is the only one developed within the classrooms that uses the same structural typology used by Mies at Crown Hall. It is the single-family dwelling presented by the students Jacques Brownson, designed with four frames from which the roof plane is suspended. In addition, both Mies in the construction of the Crown Hall and Brownson in the development of his final master's thesis had the collaboration of the structural engineer Frank Kornacker for the final definition of the structure.<sup>2</sup> And so, after a review of the modifications made by Mies to the graduate curriculum and the conditions that prompted the school's commission, the design and construction process of Mies' Crown Hall is first outlined, including the contributions of the structural engineer, and then compared with the single-family house designed by his student in order to establish a possible connection between teaching and architecture in Mies' work.

## 1. ARRIVAL AT THE ARMOUR INSTITUTE OF TECHNOLOGY.

Mies moved to the United States in 1938, and on his arrival took over as director of the Department of Architecture at the Armour Institute of Technology. At the beginning of the 20th century, the aspirations of the Armour made it into one of the world's leading schools of technology. So Mies arrived at a department of architecture that was part of a technological school: the Chicago School of Architecture, a department of the Armour Institute of Technology.<sup>3</sup>

Mies had some old acquaintances on the American continent from the Berlin Bauhaus period, such as the young architects John Barney Rodgers and William Priestley, who received him in New York in 1937 when the German travelled on account of the commission he was undertaking at the time, the Resor House, which was never built. As Schulze and Windhorst state in their revised biography, it was also Priestley who accompanied him to a meeting in the city of Chicago with representatives of the Armour Institute of Technology. (3)

These had been years of change at the Armour. Jerrold Loebel was the head of the Architecture Department before Mies arrived. Negotiations to bring Mies onto the teaching staff had already begun under the chairmanship of Willard E. Hotchkiss, who had resigned from office, and had been replaced by Henry Townley Heald. Mies accepted the post of principal on the condition that he could rework the curriculum, which reflected his ideals, but at the same time had to respond to the particular needs of the school.

Even before Mies' arrival, the Armour Institute of Technology offered a graduate program leading to Master of Science degrees in the fields of chemical, civil, electrical and mechanical engineering, and architecture. After taking office as Director of the Department of Architecture, Mies, in addition to configuring the undergraduate curriculum, also took over the graduate program in architecture, introducing a number of modifications.

In order to obtain the master's degree in architecture, it was necessary to take *Advanced Architecture* courses. These courses were given by Mies, and they did not last a fixed period of time, but rather those students who had demonstrated their ability to do independent, quality architectural work were allowed to start developing their thesis project. This process usually took one year after the completion of the architecture degree. Similarly, the institution also offered advanced studies for the master's degree in urban planning, whose subjects were mainly taught by Ludwig Hilberseimer.

As described in the official AIT Bulletin of 1939, the objectives of the Advanced Architecture courses were the understanding of structure as an architectural factor, its possibilities and limitations; space as an architectural problem; proportion as a means of architectural expression; the expression of the value of materials; the relationship between painting and sculpture and architecture; and, finally, the application of these principles through free creative work. Therefore, from the very beginning, structure was considered to be the first *architectural factor* to be taken into account in the teaching of architecture in the graduate program.

After studying the subject of Advanced Architecture, students had to deal with solving a complete architectural problem: their final master's thesis project, which was more complex than any of those they had dealt with during their undergraduate studies. Just as the first steps that the student took in the degree involved becoming familiar with construction, seeking to understand the technique as a tool, and to understand the functions that modern society demanded, this was also the process of approaching the architectural problem of the thesis. The types of buildings chosen tended to represent functions created in the industrial era, with the aim of satisfying their needs and aspirations. As a result, the proposals ranged from office buildings or museums to large halls for concerts, exhibitions or conventions, although it was also possible to prepare typological studies or housing projects. (4)

## 2. A NEW BUILDING FOR THE SCHOOL OF ARCHITECTURE.

in 1938 the Armour's South Campus was bounded by 31st Street to the north, 34th Street to the south, State Street to the east and the Rock Island Railroad to the west. In the late 1930's, the Armour's administrators began to purchase adjacent land, growing from a 9-acre (3.6 ha) site to a 30-acre (12 ha) site. For this reason, a proposal was made to Mies to draw up a plan for the new campus during his first year as director of the Department of Architecture. Mies' final plan, approved in 1941, was based on a 24-foot (7.32 m), 12-foot (3.66 m) high ground plan module used for both the planning of each of the buildings and their location. An example of the close relationship between Mies' professional practice and his teaching is the link that can be established between his own commissions and the proposals for final master's theses that he presented to his students. For example, at the beginning of the 1950s a group of students worked on a proposal for a university campus, not only on an urban planning level but also on the definition of each of the buildings it was to

<sup>2</sup> It has been possible to document the participation of engineer Frank Kornacker in six of the forty-eight documented final master's theses, and all of them correspond to the typology of *universal space*.

<sup>3</sup> In 1940, the Armour Institute of Technology and the Lewis Institute joined together to form the Illinois Institute of Technology.

contain. James Ferris was in charge of developing the urban planning part, while Yau Chun Wong, Jose Polar, Wei Tung Lo and Richard Durand and David Tamminga, individually worked on projects for buildings that formed part of the complex. Apart from these, there are two theses preserved in the IIT Archives that focus on the theme of the school of architecture, prepared by students Charles Worley in 1941 and Frederick Seidel in 1953. (5)

Until 1945, the Armour's Department of Architecture was housed in the attic of the Art Institute of Chicago, which shared this teaching function with its main museum function. Just as had happened to Mies when, after taking over the Bauhaus in Dessau, he was forced to move his headquarters to Berlin, occupying a former telegraph factory that was painted white for that purpose, the Art Institute did not have the appropriate conditions to operate as a school of architecture (Figure 2). In all likelihood, these characteristics, with all their pros and cons, were a starting point for Mies when he had to deal with the design of his own school project.



Figure 2. Images of the different classes at the Armour Institute of Technology, including the Art Institute of Chicago's architecture classes in the attic. (University Archives and Special Collections, Paul V. Galvin Library, Illinois Institute of Technology).

In 1947 the school moved to the new south campus of what was now the Illinois Institute of Technology, in the newly completed Navy Building (later Alumni Memorial Hall), de-

signed by Mies as part of the new campus plan, but intended for a totally different use. This construction followed the guidelines of the rest of the buildings on the campus: a structure of metal columns based on the grid of 24 by 24 feet, and the use of brick and glass as materials for the enclosure. Once again, the spaces in which he taught had not been planned for this purpose. After twelve years as head of the Department, he was finally able to design a building that would embody both his architectural and educational principles. (6)

In 1950, the urban development work on the new campus and the construction of each of its buildings was still in progress. It was at that time that Mies began work on designing the building that was to house the school of architecture, although the earliest designs are still close to the composition of the rest of the buildings on the campus. It was a construction with a structure made of metal supports, a brick base, and with large glass panels in the upper part, which was still based on the general module of 24 feet (7.32 m) (Figure 3).

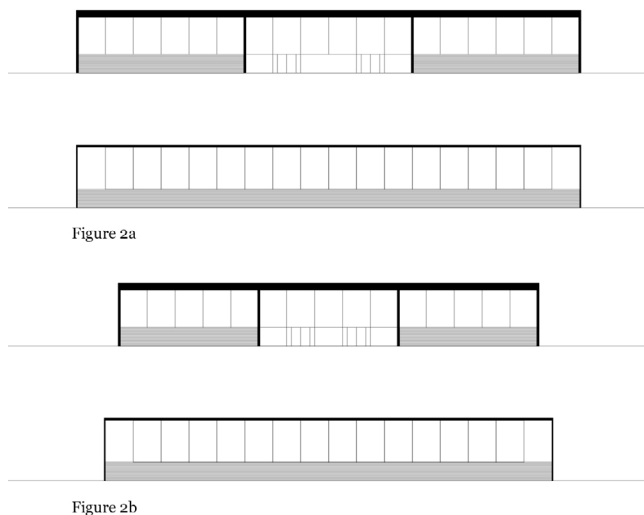


Figure 3. Elevations of the Mineral and Metal Buildings (1942-43) and the first proposal for the IIT School of Architecture (1950-52) by Ludwig Mies van der Rohe. Drawing by the author.

The turning point in the project's development occurred in the second half of 1952, when the institution focused its efforts on erecting a building to house the School of Architecture and the Institute of Design, directed by former Bauhaus professor László Moholy-Nagy.<sup>4</sup> Although the exact moment when Mies opted for the new spatial configuration is not known, there are two drawings dated October 1, 1952, which, although they do not configure a floor plan, as they are only spatial studies (one drawing refers to the school of architecture and the other to the institute of design), are still based on the 24-foot grid. The following drawing is dated November 10, 1952. It shows a roof plan with a configuration that is very similar to the one that was finally built, including the terrace on the south elevation, the roof beams and the façade columns. (7)

<sup>4</sup> Moholy-Nagy had moved to Chicago in 1937, invited by the Chicago Association of Art and Industry, with the aim of founding a design school called New Bauhaus. Financial problems forced the school to close, after a short time, in 1938. However, it reopened its doors in 1939 and was named the Chicago School of Design. In 1944 it was renamed the Institute of Design and in 1949 it became part of the Illinois Institute of Technology.



### 3. CONSTRUCTION OF THE S.R. CROWN HALL

For the configuration of the new proposal, the use of the 24-foot (7.32 m) module used in the rest of the campus was discarded and a 10-foot (3.05 m) module was taken as the new base measurement. The building has a rectangular floor plan, of 120 (36.58 m) by 220 feet (67.06 m), with the longitudinal axis running in an east-west direction, and on one level plus a semi-basement, with the main floor being raised 5 feet 11 inches (1.80 m) with respect to street level, thereby allowing natural light to enter the lower floor. The main entrance is through the south facade through two symmetrical doors. They are accessed through two flights of stairs with an intermediate platform in Travertine, reminiscent of the solution used years earlier in the design of the Farnsworth House, although in this case both flights of stairs are positioned in the same direction. There are also two symmetrical secondary entrances on the north facade, accessed by two flights of concrete stairs parallel to the facade, and two direct entrances to the basement. The distribution of the floors is as follows: the ground floor, accessed by two symmetrical staircases, contains workshops, offices, machine room and toilets, while the main floor is configured as a unitary space (Figure 4).

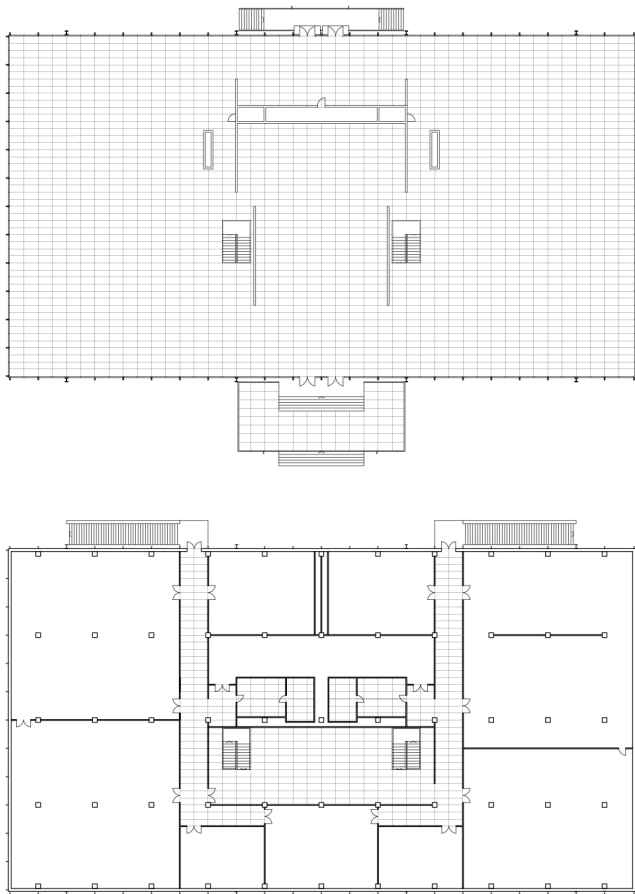


Figure 4. Lower and upper floor plans of the project for the School of Architecture, Planning and Design, Illinois Institute of Technology, by Ludwig Mies van der Rohe, October 15, 1954. Redrawn by the author.

The longitudinal elevations are defined by the position of four metal frames, spaced 60 feet apart, from which the roof is suspended, with a 20 foot overhang at both ends. It is this configuration that allows the interior of the main floor to be

free of structural supports, being configured as a large space that accommodates all of the school's students. The vertical mullions, separated by 10 feet (3.05 m) from each other in both the longitudinal and transversal elevations, mark the design of the façade. All the mullions end 3 inches (7.62 cm) above street level and 8.5 inches (21.59 cm) below the roof-top, emphasizing the difference between them and the main vertical structural elements. The enclosure is made of glass, which is translucent on the basement level and up to a height of 7 feet 9 inches (2.36 m) from the top of the main floor, and transparent up to the top of the roof, except for the central span of the north and south elevations where the entrances are located, which is made of transparent glass. In this way, the configuration of the enclosure permits a relationship with the exterior in the upper zone, not only allowing natural light to enter but also allowing the treetops that surround the building to be seen, a relationship that is filtered to the level of the work zone due to the use of translucent glass. Since the frames are fixed, ventilation grilles are fitted in the lower part of the enclosure to allow air to circulate (Figure 5).

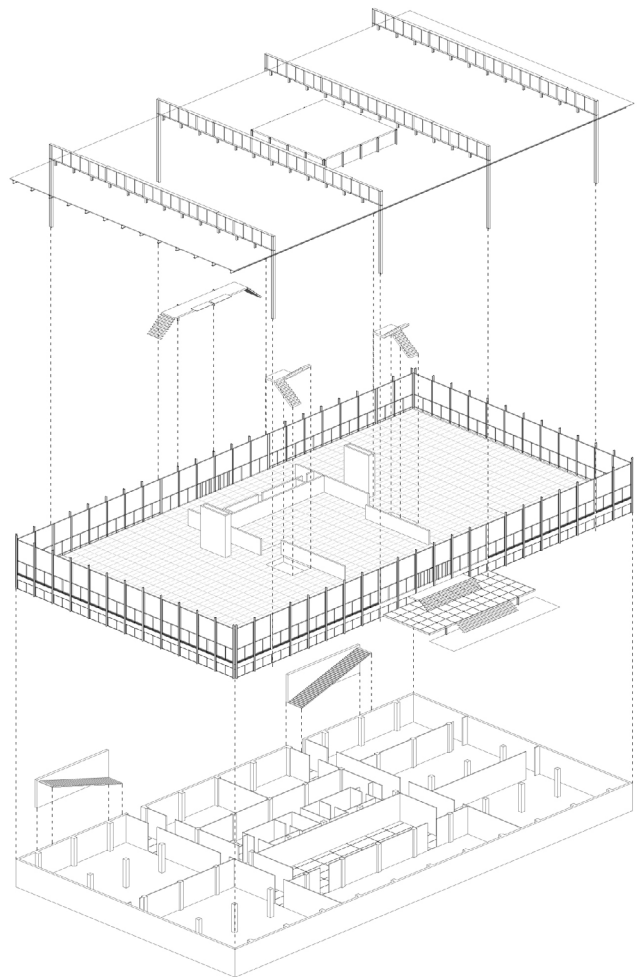


Figure 5. Perspective of the project for the School of Architecture, Planning and Design, Illinois Institute of Technology, by Ludwig Mies van der Rohe, October 15, 1954. Drawing by the author.

The union between the vertical supports and the girders that make up the four main frames is one of the defining characteristics of the external image of the school building. In the MoMA archives, several draft alternatives are preserved for resolving this encounter, even attempting at first to use truss-

es instead of girders. With a girder span of 120 feet (36.58 m), a rigid connection between column and girder would have resulted in a much larger column section, having to absorb the negative bending moment generated in the beams. It can be assumed that Mies wanted such a slender column for reasons of proportion, so the solution was to take into account the construction process when dimensioning the structure.

The first step of the construction process consisted of arranging the metal columns that supported the roof girders, which were assembled in the workshop and dimensioned as simple-supported to receive the gravitational loads due to their own weight as well as the weight of the roof construction elements. These beams were lifted in one piece to their final position, with an initial camber corresponding to the expected deformation after receiving the gravitational load as supported. Once in place, the girders were welded to the columns forming a rigid joint. This method made it possible to dimension the column to support the bending moment only due to the variable loads of use and snow, as well as stresses due to horizontal wind actions. Another defining feature of the building's design is the way in which the roof is suspended from the four main frames. The beams, standardized 16WF58 profiles spaced 10 feet apart, are suspended from the main girders by 10-inch long hangers with the same cross section. These hangers are welded to the lower flange of the girder and the upper flange of the joists, creating a diaphragm that stabilizes the entire assembly. It can be assumed that the use of connectors as a mechanism for hanging from the roof plane was a contribution by structural engineer Frank Kornacker, who had already used a similar solution in the structural configuration of a single-family house designed and built by Mies' graduate student at the IIT, Jacques Brownson (8).

Jacques C. Brownson submitted his Master's thesis entitled 'A Steel and Glass House' in June 1954 (9). In the preface of the work, the student explains that it is his own house, built between 1949 and 1952 in Fox River (Illinois), some 38 miles west of the city of Chicago, and where he had been living for two years at the time of the completion of his thesis. Following this explanation, he acknowledges the supervision of Professors Mies van der Rohe and Hilberseimer, as well as the help of Professors Daniel Brenner and Reginald Malcolmson, and engineers Frank Kornacker and Ernest Vlad.

The house is located on a 1.25 acre (5,059 m<sup>2</sup>) wooded plot of land and is reached by a path on the south side, which leads from Batavia Avenue to the private property. It is a rectangular house measuring 32 by 88 feet (9.75 by 26.82 m), with the longitudinal axis running east-west. It is possible to access the interior through three of the facades: there are two doors placed asymmetrically on the longitudinal elevations, and two symmetrical double entrance doors on the east facade. The enclosure is entirely made of glass except for two brick panels which are raised between the two frames to the west (Figure 6). As Brownson explains in the first chapter of the written report, none of the enclosure walls are structural. Both the profiles that make up the frames and the subdivisions of the glass enclosure and the perimeter profiles of the roof plane are painted black, while the lower surface of the upper horizontal plane is white. The glass facades allow direct contact with the surrounding countryside, and interior privacy is achieved by means of

grey curtains from floor to ceiling.



Figure 6. East, west and south elevations of Jacques Brownson's home in Geneva, Illinois. Redrawn by the author.

In his written report, Brownson states that since the building has no structural supports inside, it can be compartmentalised at will. Therefore, functionally the house is divided into three sections: an exterior porch at the east end; the day area (living room, dining room, kitchen, service room and entrance); and the night area (3 bedrooms, 2 bathrooms and the boiler room) (Figure 7). In the day area, a large space of 32 by 48 feet (9.75 by 14.63 m), a core offset from the geometric center of the space in the longitudinal direction contains the kitchen and utility room. This asymmetrical layout defines the rest of the areas of use in this zone: the living room is connected to the porch, occupying most of the surface area; the entrance space is to the south; the kitchen is to the west; and the dining room to the north. The night area is accessed through two doors situated symmetrically on both sides of the boiler room. On both sides of these doors are the two bathrooms, also symmetrical, and to the west the three bedrooms. Brownson explains that the night area is compartmentalised with plastered partition walls, while the day area is subdivided by the masonry wall of the fireplace and the wooden panel partitions that make up the enclosed core. In this way, the partitions can be modified if necessary, as the only fixed elements inside are the installation ducts. To reinforce the concept of unitary space, a continuous hanging ceiling painted white is fitted under the roof plane. The student even states that instead of plaster partitions, it would be possible to compartmentalize the space only with wooden partitions, which would facilitate possible future changes, something unimaginable in a 'conventional building'.

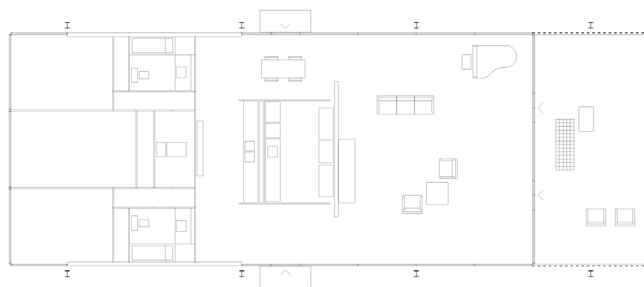


Figure 7. Floor plan of Jacques Brownson's House in Geneva, Illinois. Redrawn by the author.

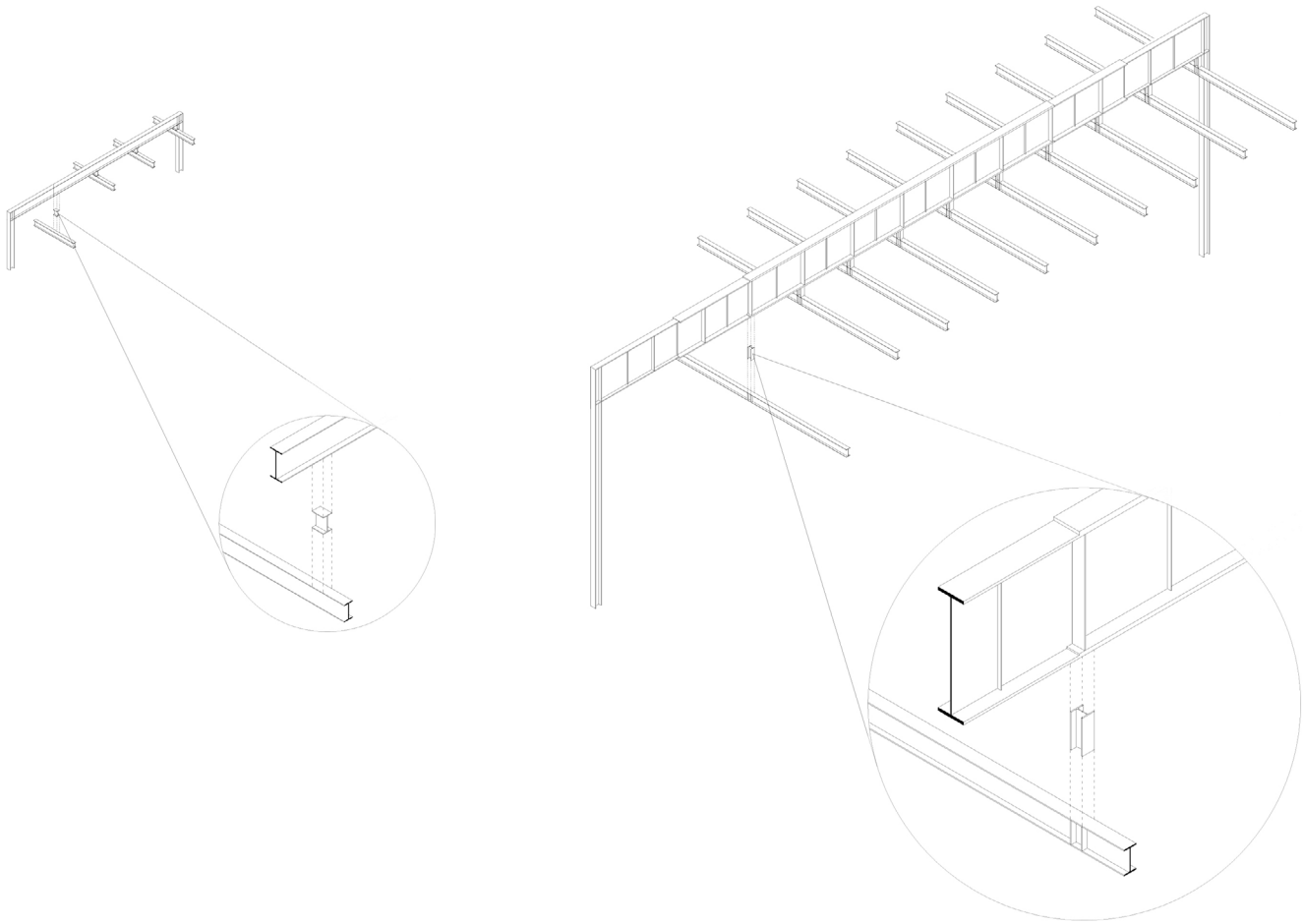


Figure 8. Comparison of structural systems of the House in Geneva by Jacques Brownson and the S. R. Crown Hall by Ludwig Mies van der Rohe. Drawing by the author.

In a similar way to the Crown Hall, in a first approximation to the house it is possible to decipher the main structural system, formed by four parallel rigid frames spaced 24 feet apart, which cross a span of 34 feet, from which the roof plane is suspended, which has two cantilevers in the final 8 feet. In the chapter dedicated to the structural system, Brownson explains that the use of rigid joints solves the problem of bracing against horizontal wind action without the need to introduce diagonal elements, which were immediately discarded due to the nature of the space. Therefore, the solution used in this case is not the same as in Mies' school, where the construction process was decisive in the dimensioning of elements. Therefore, the beams, 18 1/4 inch (46.36 cm) wide type I 18WF60 profiles, are welded to the columns, type I 10WF33 profiles, to form the four main rigid frames. Brownson describes in detail the connection between the main girders and the roof plane, explaining how the idea of having the thinnest possible roof is achieved by suspending the secondary roof beams from the main frames, using hanging elements. The longitudinal beams are continuous along their entire length, reaching 88 feet (26.82 m), i.e. three times the 24-foot (7.32 m) distance between frames plus the two 8-foot (2.44 m) end cantilevers. Both the longitudinal beams and the hanging elements, spaced 8 feet apart, and the perimeter roof trusses are assembled with the same type I 10WF21 profile. The hanging elements are 6-inch (15.24-cm) long pro-

file pieces reinforced with border plates welded between the flanges, arranged in parallel to the lower longitudinal beams, and bounded by an L-profile forming an unprotected gravel area 8-inches (20.32-cm) on each side. Therefore, despite the obvious similarities, the arrangement of the connectors and the functioning of the two structures are different (Figure 8): Firstly, in the case of the Brownson house, the hangers are arranged in parallel to the joists, while in the Crown Hall they are positioned vertically along the longitudinal axis; secondly, in the case of the house, there are four rigid frames, while in the case of the Crown Hall, the girders are initially simple-supported, and are then welded to the columns once they receive gravitational loads.

Although it is not known exactly when Frank Kornacker joined the design team for the school building, there is evidence of his involvement in resolving other key issues: the tendency of the upper web of the main girders to buckling. Kornacker describes the solution to this problem in a letter dated 1957, stating that this same solution had also been proposed for the unbuilt National Theatre in Mannheim.<sup>5</sup> In his letter, Kornacker explains how it is possible to brace the upper beam of a truss or the upper flange of a beam by making use of the stability of the lower horizontal element, a resource widely used in bridge engineering. Thus, by defining the elements that contribute to

<sup>5</sup> Letter from Frank Kornacker to David Haid, 4 March 1957, conserved in the Mies van der Rohe Archive, Museum of Modern Art, New York (Project 5001, Crown Hall, folder 92), unpublished.

the stabilization of the deck plane and the connection of the horizontal plane with the under flange of the main girders through the hangers, the engineer describes the strategy used to transfer this stability to the upper flange. Just above each of the connectors, the web and flanges of the main girders are welded to the  $\frac{3}{4}$  inch thick stiffeners. In addition, since the web of the main girders is only  $\frac{1}{2}$  inch thick, it is reinforced by smaller stiffeners, welded at an intermediate distance of 5 feet from the main ones, the same ratio with the base module used in the configuration for the school.

Having analysed the design and construction process of the Crown Hall, highlighting the contribution of Frank Kornacker in the design of the structural component, and having established a comparison with the structural system of the house of Mies' graduate student, Jacques Brownson, also designed in collaboration with the engineer, it is possible to identify the following similarities, always from the point of view that is relevant to this research. Firstly, despite addressing two such different functional themes as a school of architecture and a single-family dwelling, both proposals were conceived from the perspective of the structure. Both the Crown Hall and the dwelling in Geneva are based on the definition of a structural module that determines the separation between the frames and the roof overhangs; the structure is the basis of the construction and imposes its order. Secondly, both Brownson and Mies propose a unitary space that can be divided at will, as well as ensuring its suitability for possible future changes: family conditions may vary, as may the number of students in a school as well as its curricula and teaching methods, but the structure remains. Thus, in an attempt to free the space from fixed elements, the structure is moved to the outside. Thirdly, in both projects, we can see an experimentation with the possibilities offered by the metal structure: the technique is used as an architectural element and, furthermore, it is not coated or modified, but is presented 'as it is'. This is the experimentation that both Mies and Brownson carried out in collaboration with the structural engineer Frank Kornacker.

## REFERENCES

- (1) Drexler, A., Schulze, F. (1985) *Mies van der Rohe Archive 1910-1937*. New York: Museum of Modern Art.
- (2) Achilles, R., Harrington, K. y Myhrum, C. (1986) *Mies van der Rohe: Architect as Educator 1938-1978*. Chicago: Illinois Institute of Technology.
- (3) Schulze, F., Windhorst, E. (2016) *Mies van der Rohe: una biografía crítica. Nueva edición revisada*. Barcelona: Reverte.
- (4) Chang, P. Y Swenson, A. (1980) *Architectural Education at IIT, 1938-1978*. Chicago: Illinois Institute of Technology.
- (5) Garcia-Requejo, Z., Lizondo, Sevilla, L., y Santatecla Fayos, J. (2019, 18th-19th October). The Evolution of the Structure from the perspective of the Teaching Work of Mies van der Rohe: 1938-1953 en *Mies van der Rohe. The Architecture of the City. International Conference*. Milano, Politecnico di Milano.
- (6) Blaser, W. (2001) *Mies van der Rohe: Crown Hall – College of Architecture, Illinois Institute of Technology, Chicago*. Basilea, Boston, Berlín: Birkhäuser.
- (7) Harboe, G. (2002) *S. R. Crown Hall: Historic Structure Report / submitted by McClier for the Illinois Institute of Technology, College of Architecture*. Chicago: Illinois Institute of Technology.
- (8) Santatecla Fayos, J., Lizondo Sevilla, L., Garcia-Requejo, Z. (2018) Relaciones entre Arquitectura y Estructura. Arquitectura estructural en Mies van der Rohe. *ZARCH* 11: 78-93. doi: [http://doi.org/10.26754/ojs\\_zarch/zarch.2018113208](http://doi.org/10.26754/ojs_zarch/zarch.2018113208)
- (9) Brownson, J. (1954) A Steel and Glass House (Tesis de maestría no publicada) Chicago: Illinois Institute of Technology.
- (10) Elnimeiri, M., Goldsmith, M. y Sharpe, D. (1996) "Design and Planning of Tall Buildings at IIT", Beedle, L. Y Rice, D. (Ed.), *Tall Building Structures: A World View* (pp. 13-20). Estados Unidos de América: Council on Tall Buildings and Urban Habitat.
- (11) Mies van der Rohe, L. (1950) Architecture and Tecnology. *Arts and Architecture*, 67 (10): 30.

<sup>6</sup> Elnimeiri, M., Goldsmith, M. and Sharpe, D. (1996) "Design and Planning of Tall Buildings at IIT", Beedle, L. Y Rice, D. (Ed.), *Tall Building Structures: A World View* (pp. 13-20). United States of America: Council on Tall Buildings and Urban Habitat.

## 4. CONCLUSIONS

*"It was Mies van der Rohe (...) who brought with him the idea of structural architecture to the school. The concept of structural architecture creates a new problem for the structural engineer in that the structure must not only be economical and efficient but must have an aesthetic quality as well."*<sup>6</sup> (10)

This research has explored in depth the development of Mies' definitive proposal for the Crown Hall, bringing to light contributions by Mies' regular collaborator and engineer, Frank Kornacker, and relating it to the single-family house designed and built by his graduate student Jacques Brownson, who also collaborated with the engineer on structural questions. Despite solving different functional themes, both Mies' school and the Brownson house make use of a unique space, free of structural supports, moving the structure to the exterior. In both cases, it is this structural proposal that allows for complete interior spatial flexibility while giving expression to the building. Thus, the space is conceived through the structure, although far from defining the spatial configuration, this is set aside and moved to the exterior, freeing the ground plan from any structural element

The relationship established between the structural proposal of Mies' school and the Brownson house highlights the parallels between Mies' professional work and his facet as a professor: what he designs and builds is what he teaches at the school. Mies' proposal for the Crown Hall can be understood as a confluence between his philosophy, his work and his teaching, as well as a summary of all his previous academic experiences and the embodiment of a teaching concept. Similarly, the Brownson house is the result of lessons learned from Mies in the classrooms of the IIT. In both cases, the structure is revealed as the first *architectural factor*: it is what makes the construction of the space possible, and what confers its significance, *its form itself* (11).