PHILOSOPHY OF STRUCTURES

The Encounter between Jaroslav J. Polívka and Eduardo Torroja

Exhibition texts

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I From Prague to Zürich, Vienna and back to Prague 1886—1918

Jaroslav Josef Polívka was born in Vinohrady near Prague in 1886. His father, a wine merchant, died when he was five. He helped support his family by teaching languages. He graduated in civil engineering from Prague's German Technical University in 1909. One of his first projects was a concrete bridge in Postoloprty. There he met his future wife, Maria Irma Pollak.

He worked for several companies in Switzerland and Italy and led the Zürich office of a Sander & Co. firm. His reinforced concrete projects included bridges, factories, a cycling track in Zürich and a casino in Viareggio. During the First World War, he moved to Vienna to work with engineer Fritz Emperger and avoid military service.

He earned his doctorate in Prague in 1917. Later that year, he was drafted into the Austro-Hungarian army. He served on the Italian front and kept a war diary. After being wounded in 1918, he returned to Prague and reunited with his family. He briefly returned to war, but the war ended in October 1918 and he returned to a new country, free Czechoslovakia.

II Prague residential development 1918—1931

After the war, Polívka returned to Prague with substantial savings from his work in Zürich. He bought many plots in Bubeneč, residential district in Prague that was about to be further developed. There he financed, designed and built family houses and villas for sale. He also built apartment buildings for rent. His own villa on Mongolská Street had a mansard roof and a balcony overlooking the garden. With Alexander Rott, he designed the Schönbaum brothers' double villa (1928—1929), with a columned entrance and roof terraces. The Žák villa (1927—1928) on Vietnamská Street contained two spacious apartments. For four terraced houses on Terronská Street, he planned connected gardens, tennis courts and a playground.

His homes often had traditional forms but offered modern comfort, sunlight, and gardens. With the builder Vlček, he also designed and built a cycling and motorcycle track in Letná. Construction began in 1921.

Polívka wrote widely about engineering and edited the journal *Stavitelské listy* (Builders Journal) from 1920 to 1927. He was also an art collector and a supporter of artists and writers. His friends included visual artists Alfons Mucha, Jan Konůpek and Josef Váchal. In the late 1920s, he began publishing illustrated editions of poetry and prose, including translations and works by young authors.

III Changing the face of Prague 1927—1931

In the late 1920s, Polívka helped transform central Prague with modern commercial palaces. They combined shops, offices, cafés and apartments. Reinforced concrete frames allowed flexible interiors and large windows. Working with Josef Havlíček brought him closer to the architectural avant-garde. Their Habich Palace (1927—1928) had stepped upper floors and lightweight Isostone partitions. Chicago Palace (1927) on Národní Avenue had long bands of windows and fast American lifts.

For Dunaj Palace (1928—1930), the client chose Adolf Foehr's design over Havlíček's sketch. Rounded corners and patterned brickwork shaped its exterior. Polívka designed the steel roof over its hall. Cork and Calofrig partitions allowed offices to change size.

He also worked with Oldřich Tyl on Klazar Palace, built in a courtyard off Panská Street. Its concrete frame and brick walls housed shops and offices. It formed part of a plan for new pedestrian routes through the city's courtyards.

In 1927, Polívka acquired Týnec, a Baroque château near Klatovy, from Jindřich Kolowrat, who had commissioned the Chicago Palace. In 1928, he remodeled it into a luxury hotel, where he welcomed friends from political and artistic circles, including Alice Masaryková, daughter of the president, and Alfons Mucha.

IV Developing the countryside 1926—1935

Polívka expanded his work beyond Prague. In Brno, he built the Jalta, Siemens—Concordia palace and the palace of the Commercial and Industrial Employees' Cooperative (DOPZ). They combined business with housing or leisure. For the 1928 Exhibition of Contemporary Culture, he financed several buildings, including a model apartment house designed with Josef Havlíček. He hoped to attract more work, but gained no further building commissions in Brno.

In Luhačovice, he built the luxury Miramonti Hotel with Vladimír Hejný. It offered 70 rooms and roof terraces for sunbathing. In Slovakia, he helped expand the Palace Sanatorium in Nový Smokovec (1934—1935) and designed Villa Limba in 1935 for his future son-in-law.

The Depression ruined his business and forced him to close his office after 1931. He sold his Prague villa and Týnec château. He became a sales representative for Thermolux. He researched glass and published studies promoting its use in modern construction.

V Olympic games, World Fairs and Corn Exchange building 1935—1940

For the 1936 Berlin Olympics, Polívka designed a glass-and-concrete dome for the House of German Sports. He then worked with Jaromír Krejcar on the steel-and-glass Czechoslovak pavilion at the 1937 Paris World's Fair. Its translucent dome was only six centimetres thick. In Rotterdam, he designed the vast glass-and-concrete roof of J. F. Staal's Corn Exchange (1937—1940). He also tested a transparent model of the Podolsko Bridge, using polarised light to reveal structural stresses.

He supervised construction of Kamil Roškot's Czechoslovak pavilion for the 1939 New York World's Fair. It opened unfinished despite Nazi efforts to stop it. Polívka stayed in New York and that summer, he worked on a construction of a factory for the Baťa shoe company in Maryland. He also designed a mobile sales pavilion for the company.

Correspondence with Professor Howard Eberhart led him to the University of California, Berkeley, in autumn 1939. There he continued his research on structural stresses and began teaching. His research post was initially unpaid. His sons Miloš and Jan had emigrated in 1938 and 1939, his daughter stayed in Slovakia during the war. His Jewish wife, Maria Irma, escaped occupied Prague in 1940. She crossed Siberia and travelled through Japan before sailing to San Francisco to rejoin her husband and sons.

VI Designing the California Modernism 1940—1960

During the Second World War, Polívka worked for Kaiser Industries at the Richmond shipyards. With engineers Leonard McClintock and Bill Ball, he designed portable timber-and-steel frames for launching ships. His work helped adapt construction methods to the demands of rapid wartime production.

His collaborators included Paolo Chelazzi, an Italian engineer who specialised in suspended structures. Together they developed suspended arches for large roofs and portable aircraft hangars. Their system was patented in 1958, but never entered mass production. Polívka also helped Chelazzi seek work in America after his imprisonment in Japanese-occupied Shanghai.

Another close collaborator was Victor "Bobby" di Suvero, an Italian former diplomat who had worked in China before moving to San Francisco. He was the father of the sculptor Mark di Suvero.Together, they developed cable systems to limit wind-induced movement in suspension bridges. They also explored ways to stabilise the Leaning Tower of Pisa. Polívka's residential work brought structural experiments into everyday life. At Midglen House in Redwood City (1949), he collaborated with William Patrick and other former students of Frank Lloyd Wright. He designed concrete supports and blocks cast directly on site. The glazed living space projected from a slope, while a tree grew through the centre of the house. He also worked on a house by Frederick Langhorst, another former student of Wright.

His own designs increasingly embraced the open interiors and close connection to nature of California modernism. For Nina and Jack Peat in Carmel (1954—1955), he designed a low, timber-clad house with large windows opening the living space towards the garden. In Berkeley, he designed a house for his son Miloš and apartment buildings inspired by Richard Neutra. His own home became a place for experimentation, with wooden terraces, a studio and a thin concrete-shell carport.

He also contributed to two Methodist churches: the Chinese church in Oakland and Easter Hill in Richmond. For the Oakland church, designed by David A. Wright, he developed slender prefabricated concrete arches that reduced construction costs. The Richmond church used prefabricated timber frames beneath a steep roof.

His practice extended to factories and warehouses, where he experimented with lightweight, curved roof systems. Working beyond California, he undertook warehouse projects in Mexico City, Caracas and Maracaibo, and a factory in Panama City.

VII Engineering the organic with Frank Lloyd Wright 1946—1952

On 15 February 1946, Polívka wrote to Wright after reading his claim in Architectural Forum that engineers were fools. He expressed his admiration and suggested spider webs as models for structural design. Wright recognised their shared interest in nature and invited him to Taliesin West in Arizona. Polívka and his wife arrived on 25 April, beginning their collaboration.

For the Guggenheim Museum in New York, Polívka used calculations and model tests to develop a concrete spiral ramp without inner columns. His proposals shaped both its structure and form.

He also worked on the foundations of the Johnson Research Tower in Racine and proposed Thermolux glass panels for the Rogers Lacy Hotel in Dallas. He contributed to the V. C. Morris shop in San Francisco and proposed lightweight panels for Morris's planned cliffside house. In 1947, Polívka invited Wright to develop his idea for a new crossing of San Francisco Bay. He worked on the engineering of their Butterfly-Wing Bridge and promoted it to officials and the press.

VIII Engineering the organic with Frank Lloyd Wright 1954—1959

In February 1952, Polívka met Aaron Green, Wright's new San Francisco representative. Green demanded the Morris house plans back and reported Polívka's complaint about unpaid fees. On 15 March, Wright accused Polívka of altering the Butterfly Bridge model and handling the Morris project without permission. Polívka defended his work and documented the debt. On 20 March, Wright replied: "You are my consulting engineer. I am not your consulting architect." Communication largely stopped. Polívka offered Wright a warehouse project through his son Jan. They met again in New York in November 1954. He also defended Taliesin's status as a school. Their relationship improved, but never regained its earlier warmth.

In 1956, Polívka studied ways to limit sway in Wright's mile-high skyscraper. For the Belmont Park racetrack pavilion in 1957, he developed a vast roof using suspended arches and stabilising cables. They also proposed a concrete bridge over the Panama Canal. These projects remained unbuilt. Wright died in April 1959; Polívka followed in February 1960.

IX The Encounter with Eduardo Torroja in the United States, 1950

In 1936, at a lecture organized by the Instituto Técnico de la Construcción y Edificación (ITCE), Eduardo Torroja presented three reinforced concrete thin-shell structures that placed Spanish architecture at the European avant-garde: the Algeciras Market Hall, the Recoletos Pelota Court, and La Zarzuela Racecourse. Photographs by Sibylle von Kaskel immortalized these works in the book *Obras principales de hormigón armado proyectadas y dirigidas por Eduardo Torroja de 1926 a 1936*.

In 1947, this book came into the hands of Raymond E. Davis, director of the Engineering Materials Laboratory at the University of California, Berkeley, where Polívka worked as a researcher. Fascinated by these structures, Polívka shared the book with Frank Lloyd Wright and wrote to Torroja to acquire his own copy. This marked the beginning of a professional and personal relationship between the two engineers that would span more than a decade.

In 1950, on the occasion of a trip by Torroja and members of the ITCE to the United States, the Spanish engineer expressed to Polívka his desire to meet Wright. Having admired Torroja's work through the 1936 book, the renowned architect agreed to host the Spanish delegation at Taliesin West, his winter home and studio in Arizona.

It was there that Torroja and Polívka met in person for the first time. Two films shot by the Czech-American engineer document the visit. Together with Jaime Nadal and Francisco Lucini of the ITCE, they accompanied Wright to Phoenix, where Polívka captured the two men strolling through the city on camera. Following their stay in Arizona, Torroja joined Polívka on visits to the Berkeley and Stanford campuses, where they met with Professor Howard Eberhardt, *Architectural Record* editor Elisabeth Kendall Thompson, and Pier Luigi Nervi.

Encouraged by Polívka and Wright, Torroja returned to Spain determined to put his philosophy of structural design into writing. The result was his acclaimed 1957 book, *Razón y ser de los tipos estructurales*, published in North America a year later as *Philosophy of Structures*, translated by Polívka and his son Miloš.

X Philosophy of Structures

In 1950, Polívka suggested the term “philosophy” to Torroja for the title of his book. The term responded to a shared conviction between both engineers: structure was not merely a problem of calculation, but a form of thought capable of integrating physical laws, structural analysis, creative design, and humanist sensitivity.

The idea of a “philosophy of structures” transcended its two protagonists. It reflected the spirit of an era in which architecture and engineering were conceived as interdependent disciplines. An intellectual horizon that Torroja and Polívka shared and actively helped shape.

Between 1951 and 1958, Polívka acted as a true ambassador for *Philosophy of Structures* prior to its publication. He prepared an illustrated digest of the work and sent it to professors and academic leaders at numerous North American universities, requesting feedback and promoting its use as a textbook. The responses received revealed the keen interest sparked by the combination of technical rigor, theoretical reflection, and attention to aesthetic values championed by Torroja.

That same network extended to other spheres of cultural and professional dissemination. Between 1954 and 1956, the traveling exhibition *Structure and Space in Contemporary Architecture*, organized by the Museum of Modern Art, featured several of Torroja’s works thanks to Polívka’s mediation, touring museums, universities, and educational centers across the United States and Canada. In 1955, a letter published by Polívka in Architectural Forum introduced the core ideas of the forthcoming book to the North American public and fueled a debate involving architects, engineers, and critics from various countries.

If the 1936 book aroused Polívka’s admiration for Torroja’s work and led to their meeting, *Philosophy of Structures* served as the vehicle through which an intense editorial and translation collaboration was forged, while simultaneously forging an international community united by a shared conception of structural design. The memory of these relationships and debates has been preserved in the Jaroslav Josef Polívka Fonds.

XI The Jaroslav Josef Polívka Fonds: Memory of an Exchange

In 2023, the Centro de Estudios y Experimentación de Obras Públicas (CEDEX) received the donation of a collection of documents accumulated by Polívka. Inside a moving box were the papers the engineer had gathered around his professional and personal relationship with Torroja.

● 414 letters ● 41 manuscript revisions ● 20 reviews ● 46 clippings
● 34 notes ● 5 publications ● 8 photographs ● 2 films

The archival processing of this body of documents gave rise to the Jaroslav Josef Polívka Fonds. This material is organized into four archival series that reflect four ways of approaching the Polívka-Torroja relationship. The first series, *Correspondence*, showcases their most direct and ongoing communication, while the second, *Philosophy of Structures*, gathers their primary working material and the central axis of their collaboration. This is complemented by the third series, *Collections*, which compiles documents accumulated by Polívka that frequently relate to the Spanish political and technological context, or to Torroja and his work. Finally, the *Audiovisual Material* series includes the two home movies shot by Polívka, bearing witness to Torroja's trip to the United States.

The letters preserved in the Fonds are particularly noteworthy for their volume and significance. Polívka's correspondence primarily brings together his exchange with Torroja, though other interlocutors help to outline the bond between the two engineers with greater clarity and richness.

These back-and-forth exchanges predominantly took place between Spain and the United States, but also include various locations in Germany, Argentina, Mexico, and the United Kingdom. The topics addressed in these letters include the engineers' projects, the revision, translation, and editing process of *Philosophy of Structures*, as well as brief glimpses into the daily lives of senders and recipients.

From Polívka's initial encounter with Torroja's work to the publication and dissemination of *Philosophy of Structures*, the Jaroslav Josef Polívka Fonds preserves the memory of an exchange of ideas and a collaboration spanning from 1947 to 1959, which remains open to new interpretations today.

Displayed images:

1.1 Jaroslav Polívka, 1957
(Ron and Victoria Polívka family collection)

2.1 Street in Prague-Vinohrady,
where Jaroslav Polívka was born, 1880s
(City of Prague Museum)

2.2 Bridge in Postoloprty,
main engineer
Karel Herzán (photo Jiří Zikmund)

2.3 Jaroslav Polívka, his wife Maria Irma,
older daughter Elisabeth and younger son
Jan in front of their rented house in Zürich,
Switzerland in 1916 (Ron and Victoria Polívka
family collection)

2.4 Casino in Firenze where Jaroslav
designed a new dome (period postcard)

2.5 The Songavazzo Bridge in Italy
(Ron and Victoria Polívka family collection)

2.6 Oerlikon velodrome in Zurich
(Ron and Victoria Polívka family collection)

3.1 Polívka's own villa, 1924
(Ron and Victoria Polívka family collection)

3.2 Karel and Emil Schönbaum villa,
demolished (period print)

3.3 Zikmund Wintr villa,demolished
(period print)

3.4 The Žák's family villa (photo Jiří Zikmund)

3.5 Apartment building in Prague
(photo Jiří Zikmund)

3.6 Collective housing in Prague,
unbuilt (period print)

3.7 Apartment building in Prague
(photo Jiří Zikmund)

4.1 Chicago palace in Prague
(with Josef Havlíček) (period print)

4.2 Habich palace in Prague
(with Josef Havlíček) (period print)

4.3 Dunaj palace in Prague
(unbuilt design with Havlíček) (period print)

4.4 Dunaj palace (with Adolf Foehr)
(photo Ladislav Jackson)

4.5 Klazar palace (with Oldřich Tyl)
(period print)

4.6 Týnec baroque castle owned by Polívka
between 1927—1935 (period postcard)

5.1 Apartment buildings in Brno
(photo Jiří Zikmund)

5.2 Palace Jalta with a business passage and a
movie theater in Brno (photo Jiří Zikmund)

5.3 Business passage with the Moderna movie
theater in the Jalta palace (period print)

5.4 Palace of the Commercial and Industrial
Employees' Cooperative in Brno (period print)

5.5 Restaurant at the Exhibition of
Contemporary Culture in Brno (period print)

5.6 Model apartment house at the Exhibition
of Contemporary Culture in Brno
(photo Jiří Zikmund)

5.7 Promotional brochure written by Polívka
for the company Thermolux (period print)

6.1 Dome in the House of Sports
at the Belin Olympic complex (period print)

6.2 Czechoslovak pavilion at the 1937 World's
Fair in Paris (with Jaromír Krejcar and Ladislav
Sutnar) (Vera and Jan Beneš Polívka family
collection)

6.3 Dome in the Czechoslovak pavilion
at the 1937 World's Fair in Paris (period print)

6.4 Jaroslav Polívka after he arrived to
New York City in September 1938
(Ron and Victoria Polívka family collection)

6.5 Czechoslovak pavilion at the 1939
World's Fair in New York (Vera and Jan Beneš
Polívka family collection)

6.6 Corn exchange building in Rotterdam
(with Jan Frederik Staal) (period print)

6.7 Detail of Thermolux glass blocks at the
Corn exchange building in Rotterdam
(period print)

6.8 Podolsko bridge (with Antonín Brebera and
Jan Blažek) (photo Jiří Zikmund)

7.1 Polívka's invention for portable timber-
and-steel frames for launching ships in
Richmond docks (period print)

7.2 Chinese methodist church in Oakland,
California, with prefabricated gothic arches
(with David Archibald Wright)
(photo Ladislav Jackson)

7.3 Methodist church in Easter Hill in
Richmond (Polívka with the pastor Wilbur
R. Johnson) (Ron and Victoria Polívka family
collection)

Displayed images:

7.4 William Patrick's House Midglen in Redwood City, California, where Polívka designed the prefabricated blocks (period print)

7.5 Polívka's design for Nina and Jack Peat's House in Carmel, demolished
(Ron and Victoria Polívka family collection)

7.6 Polívka's own house in North Berkeley, California (period print)

7.7 Polívka's experimental house with a prefabricated basement, reproduced in Eduardo Torroja's book Philosophy of Structures (period print)

7.8 House for a Frank Lloyd Wright inspired Miloš and Joyce Polívka
(photo Ladislav Jackson)

8.1 Frank Lloyd Wright (period print)

8.2 Frank Lloyd Wright's seat and campus Taliesin-West, Scottsdale, Arizona
(photo Ladislav Jackson)

8.3 Guggenheim museum in New York (with Frank Lloyd Wright and William Weasley Petrers) (period print)

8.4 Polívka's design for the ramp for the Guggenheim museum project
(Kay Polívka Starkweather family collection)

8.5 S. C. Johnson & Co. Wax Headquarters with the new tower annex
(with Frank Lloyd Wright) (period print)

8.6 VC Morris Cliff House in San Francisco, unbuilt project (with Frank Lloyd Wright and Aaron Green) (The Frank Lloyd Wright Foundation Archives; The Museum of Modern Art | Avery Architectural & Fine Arts Library, Columbia University, New York)

9.1 Polívka's original design for the Bay bridge project before collaboration with Frank Lloyd Wright

9.2 First design of the Butterfly-Wing Bay Bridge with rotating segments (with Frank Lloyd Wright) (Kay Polívka Starkweather family collection)

9.3 Butterfly-Wing Bay Bridge
(with Frank Lloyd Wright) (period print)

9.4 Polívka's project for the Bay bridge after Wright left the project (with Henry Tweed)
(period print)

9.5 Belmont Race Track Pavilion in New York, unbuilt project (with Frank Lloyd Wright)
(Kay Polívka Starkweather family collection)

9.6 Rogers Lacy Hortel in Dallas, Texas, unbuilt project (with Frank Lloyd Wright)
(The Frank Lloyd Wright Foundation Archives; The Museum of Modern Art | Avery Architectural & Fine Arts Library, Columbia University, New York)

10.1. Eduardo Torroja Miret
(Fondo JJP, CEHOPU-CEDEX)

10.2 Algeciras Market Hall (with Manuel Sánchez Arcas, 1932-1935)
(Fondo JJP, CEHOPU-CEDEX)

10.3. Recoletos Pelota Court (with Secundino Zuazo, 1935-1936)
(Fondo JJP, CEHOPU-CEDEX)

10.4 La Zarzuela Racecourse
(with Carlos Arniches and Martín Domínguez, 1934-1936) (Fondo JJP, CEHOPU-CEDEX)

11.1 Clipping from the daily "Ask Andy" column, published in the San Francisco Chronicle in the 1950s. In it, a ten-year-old girl, Tonia Felix, asks Andy, "What is philosophy?" (Fondo JJP, CEHOPU-CEDEX)

11.2 Letter from Eduardo Torroja to Jaroslav J. Polívka, 28 July 1950, in which the Spanish engineer explains the main thesis and lists the chapters of the book Philosophy of Structures, at that time titled The Philosophy of Structural Design (Fondo JJP, CEHOPU-CEDEX)

11.3 Constellation of scholars related to the dissemination of Philosophy of Structures and of Torroja's thought and work across North American and international academic circles . They are direct interlocutors or figures mentioned in the Fondo JJP documents
(by CEHOPU-CEDEX)

12.1. Representation of the classification scheme of the Jaroslav Josef Polívka Fonds. The diagram highlights the presence of Polívka (in blue) and Torroja (in red) across each of the documents in the four series of the Fonds
(by CEHOPU-CEDEX)

12.2. Exchange of letters between Torroja, Polívka, and other professionals from 1947 to 1958 (by CEHOPU-CEDEX)