Eminent Structural Engineer: Pier Luigi Nervi (1891–1979)—Art and Science of Building

Cristiana Chiorino, PhD History of Architecture, School of Architecture, Politecnico di Torino, Turin, Italy.

Contact: cristiana.chiorino@gmail.com

Brief CV

1891	Born on 21 June in Sondrio, Italy
1913	Graduated in Civil Engineering, University of Bologna
1913–1923	Engineer in the technical division of a concrete construction company, Società per le Costruzioni Cementizie, in Bologna and Florence
1920–1932	Own construction firm, Nervi and Nebbiosi in Rome
1932–1978	Head and Director, Nervi and Bartoli Engineering and Construction Company
1946–1962	Professor of Technology and Construction Techniques, School of Architecture, University of Rome
1950	Honorary Doctorate, University of Buenos Aires
1956	Honorary Member, American Institute of Architects
1957	Honorary Member, American Academy of Arts and Letters, New York
1957	Foreign Member, Royal Swedish Academy of Art at Stockholm
1958	Brown Medal, Franklin Institute, Philadelphia
1959	Corresponding Member, Academia Nacional de Ciencias Exactas, Fisicas y Naturales, Buenos Aires
1960	Royal Gold Medal, Royal Institute of British Architects
1960	Honorary Doctorate, University of Edinburgh and Technische Hochschule, München
1960	Honorary Member, American Academy of Arts and Sciences, Boston and Member, Academy of San Luca, Rome
1960–1978	Studio Nervi, engineering consulting office with his sons Antonio (Architect), Mario (Engineer) and Vittorio (Architect)
1961	Honorary Doctorate, University of Warsaw and Charles Eliot Norton Professor at Harvard University
1969	Honorary Member, American Concrete Institute
1973	Honorary Member, AICAP Italian Reinforced and Prestressed Concrete Association
1979	Passed away on 9 January in Rome, Italy

Fig. 1: Nervi in front of one of his boats in ferrocement

Introduction

Pier Luigi Nervi (*Fig. 1*) is one of the greatest and most inventive structural engineers of the 20th century. With his masterpieces, scattered the world over, Nervi contributed to create a glorious period for structural architecture. Nikolaus Pevsner described him as "the most brilliant artist in reinforced concrete of our time".

On the 30th anniversary of his death, Pier Luigi Nervi will be celebrated with an international exhibition entitled *Pier Luigi Nervi: Art and Science of Building*, planned for 2010–2013. Promoted by the Pier Luigi Nervi Research and Knowledge Management Project, Bruxelles with CIVA-Centre international pour la ville, l'architecture et le paysage, Bruxelles, MAXXI, Italian National Museum of the Arts of 21st Century in Rome and CSAC, Centro Studi Archivi e Comunicazione in Parma and sponsored by the American Concrete Institute and Italian Reinforced and Prestressed Concrete Association (AICAP), the exhibition will first be presented in Europe (Brussels, Rome and Turin) and then in North America (New York, Montreal and Washington), and will be accompanied by a research/educational programme developed in parallel.

Such an extended analysis and critical appraisal of Nervi's work is expected to offer a significant contribution and new hints to the present debate on the role of formal inventiveness in the design of structures and, in a broader perspective, to the dialogue between architecture and engineering.

Formative Years

Pier Luigi Nervi graduated in Civil Engineering at Bologna University in 1913, in a fertile period for scientific, technical and architectural ideas. Thanks to the contribution of a few pioneers, builders, and designers, like Wayss, Hennebique and Maillart, in the early years of the 20th century the new technique of reinforced concrete was fast developing and it was associated, from the very beginning, with a more or less conscious search for stylistic results.

It is against this background that Pier Luigi Nervi's professional career began. Like the pioneers who had preceded him, after an initial period of training in the technical office of a construction company, Nervi set up

his own construction business in 1920. Nervi was to maintain this dual role of designer and builder throughout his life. He has been described as having an engineer's audaciousness, an architect's imagination and a businessman's practical realism. His use of the most advanced technical solutions always went hand in hand not only with the pursuit of formal elegance but also with an equally strong attention to the technical and economic aspects of the building process.

Early Works

The stadium in Florence (1930) was the first great work that attracted the attention of critics and the public, both in Italy and abroad. Besides the intrinsic beauty of the project, characterized by the elegance and strong visual impact of the curved tapered corbels of the cantilevered roof, the competition was won on account of the low cost of the construction.

The series of great hangars for the Italian air force at Orvieto and Orbetello (*Fig. 2*) followed between 1935 and 1940.

Here, Nervi designed a daring geodetic roof with intersecting arches to enclose an internal space which is dramatically simple in structure. The first group of hangars was constructed using traditional scaffolding and wooden forms for the concrete structure. In those which followed, he used precast elements for the ribs, which were then connected on-site. The use of precast components would afterwards become a constant in Nervi's work. He always sought to exploit to the maximum the outstanding compositional and structural freedom which this technical process offers.

Model Testing

The hangars were also the first structure for which, in addition to static calculations, Nervi had recourse to tests on reduced scale models, which were performed at the Politecnico di Milano by Prof. Guido Oberti, using celluloid elastic models on a 1 : 30 scale. Nervi would maintain this procedure for most of his later works. The scientific collaboration with Oberti continued for more than 30 years within the new research laboratory of ISMES in Bergamo, and was a high-point for Italian experimentalism. Besides elastic models, microconcrete models were also used in later projects to perform tests beyond service conditions for an estimate of the ultimate strength of the prototype.

Ferrocement: A New Technique for Structural Architecture

In his first important post-war work—the astonishing central hall of the Turin Exhibition Complex built in 1949 (*Fig. 4*)—to make the precast elements for the magnificent transparent 94 m barrel-vault, Nervi used the new technology of ferrocement. This technique, originally adopted by Nervi for the walls and roofs of a warehouse and for the hulls of small ships (*Figs. 3, 1*), consists of a thin layer of concrete reinforced by a thick mesh of small diameter wires, exhibiting remarkable ductility and resistance to cracking. Ferrocement can be used to mould elements of any geometric shape (undulating in the case of the Turin vault and in the great ribbed dome of the 1960 large Sports Palace in Rome) to be connected by cast-*in situ* concrete. For the 55 m × 157 m dome of the Hall C of the same Turin complex, designed and built by Nervi in 1950, the ferrocement elements become thin diamond-shaped tiles (20 mm thick) functioning as formwork for the concrete cast on their upper surface and within the contact channels at their sides, after their assemblage. The result is a particularly elegant mesh of reinforced intersecting ribs. A pattern characterizing the structural fabric of the vaults and domes of some of Nervi's most famous later works: the Kursaal at Ostia (1950), the Ballroom at the Chianciano spa (1952), the small Sports Palace in Rome (1957, with Antonio Vitellozzi), (*Fig. 5*) the Leverone Field House and Thompson Arena at Dartmouth College (New Hampshire, USA, 1962 and 1975, with Campbell and Aldrich), the Norfolk Scope Arena (Virginia, USA, 1968, with Williams and Tazewell and W. Blum) and St Mary's Cathedral in San Francisco (1971, with Pietro Belluschi), see *Fig. 8*. In this last work, the ferrocement tiles and the mesh of concrete ribs adapt to the elegant hyperbolic paraboloid surfaces of the dome.

In the Gatti Wool Mill (1951), the tiles are used to build a flat floor: the design of the ribs that mark the ceiling is derived from the lines of the principal

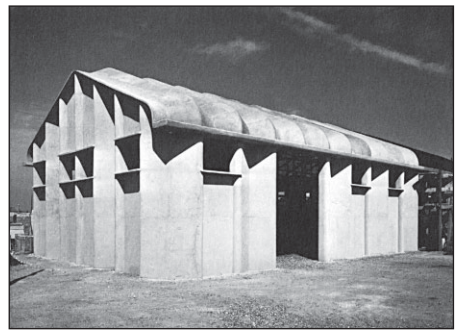

Fig. 3: The experimental warehouse in ferrocement, La Magliana, Rome, 1945

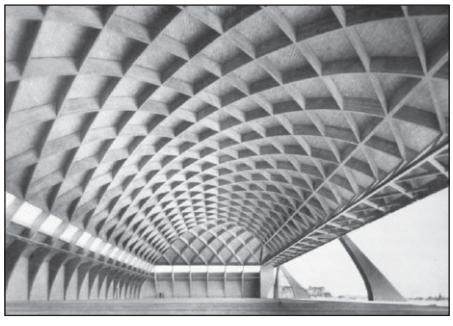

Fig. 2: Orvieto aircraft hangar, 1935

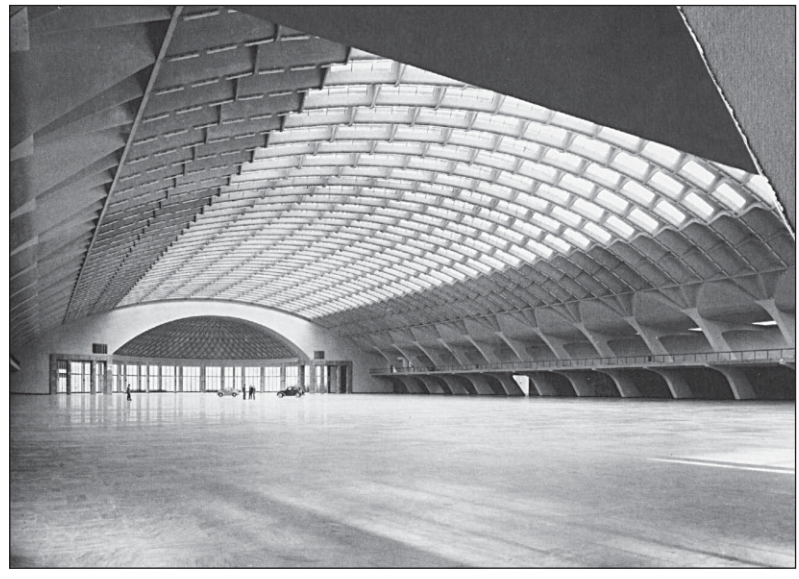

Fig. 4: Central hall of Turin exhibition complex, Turin, 1949

Fig. 5: Small Sports Palace, 1956–1957, with Antonio Vitellozzi

bending moments, again resulting in a particularly refined formal outcome that is found in a number of other subsequent projects.

Maturity Works and International Recognition

Nervi's first important work outside Italy was the United Nations Educational Scientific and Cultural Organization (UNESCO) headquarters in Paris (1953–1958, in cooperation with Marcel Breuer and Bernard Zehrfuss), its most characteristic feature being the fascinating folded structure in exposed concrete of the walls and roof. A series of other prestigious commissions followed. Besides those already mentioned above, the list includes: George Washington Bridge Bus Terminal in New York (1962), Montreal's Victoria Square Tower (1962–1965, with Luigi Moretti), see *Fig. 7*, Australia Square and MLC Center Towers in Sydney (1964–1972, with H. Seidler) and the Italian Embassy in Brasilia (1979). In Italy, the most celebrated works of his later period include: the Pirelli Tower in Milan (1955–1959, with Arturo Danusso and Gio Ponti), the complex of works for the 1960 Rome Olympics (besides the two Sports Palaces, the Flaminio Stadium and the Corso Francia Viaduct), the Palazzo del Lavoro in Turin (1960), see *Fig. 6*, with its geometrically fascinating columns whose striped slanting surfaces are covered by a steel umbrella-like structure (designed by Gino Covre), the Ponte

Fig. 6: Palazzo del Lavoro, Turin, 1961, with Gino Covre

Fig. 7: Victoria Square Tower, Montreal, 1961–1966, with Luigi Moretti

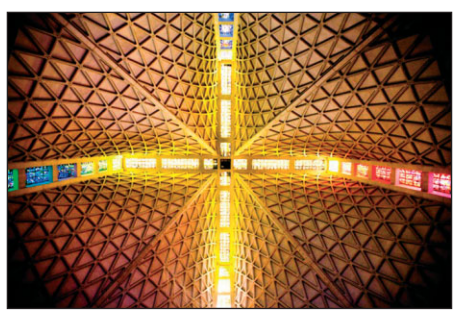

Fig. 8: St. Mary's Cathedral, San Francisco, 1966–1971, with Pietro Belluschi

Risorgimento in Verona (1963–1968) with the sculpturally highly effective shape of the concrete girder and the Papal Audience Hall in the Vatican (1966–1971), which recalls the themes of the Turin Exhibition Hall of 20 years earlier while enhancing them to create an imposing composition.

Philosophy of Structures

When, with his profound knowledge of construction techniques, Nervi discusses the answer to the fundamental question *Science or art of building?* that titles his most famous book published in 1945, far from underestimating the importance of the mechanics of structural systems, he undoubtedly emphasizes the priority of the intuitive moment in the conception of structural architecture: *The conception of a structural system is a creative action only partly based on scientific data; static sensitivity entering in this process, although deriving from equilibrium and strength considerations, remains, in the same way as aesthetic sensitivity, an essentially personal aptitude*. In this vision—that he shares with another master of structural architecture of the 20th century like Eduardo Torroja—Nervi fears that the forced need to use analytical models for the reliability assessment of structures might limit a designer's inventiveness. He believes that structural imagination frequently transcends the possibilities—at the times confined by the lack of modern computerized structural analyses—of analytically rigorous verification. This struggle for a design freedom was also the principal justification for his keen interest for experimental research on mechanical scale models.

These concepts were at the base of Nervi's extensive and interesting writings focusing especially on the language of architecture and the relationship between structure and form, and on the ethical value of building in a correct way. These were also the typical themes of the university teaching he regularly carried out at Rome's School of Architecture and of some of his important speeches and lectures at prestigious universities from Buenos Aires (1951) to Harvard (Norton lectures, 1961–1962). They characterized as well his exchanges of ideas and professional collaboration with those who shared his culture and mind-set, such as Mario Salvadori, structural engineer and professor at Columbia University.

The true art of Nervi, and of these other eminent protagonists, is the ability of composing the fracture between art and techniques in spaces that border poetry, without renouncing, in the conversion of the inspiration into a design and of the design into a construction, to the *modus operandi* of the engineers, but rather emphasizing it with original and innovative contributions.