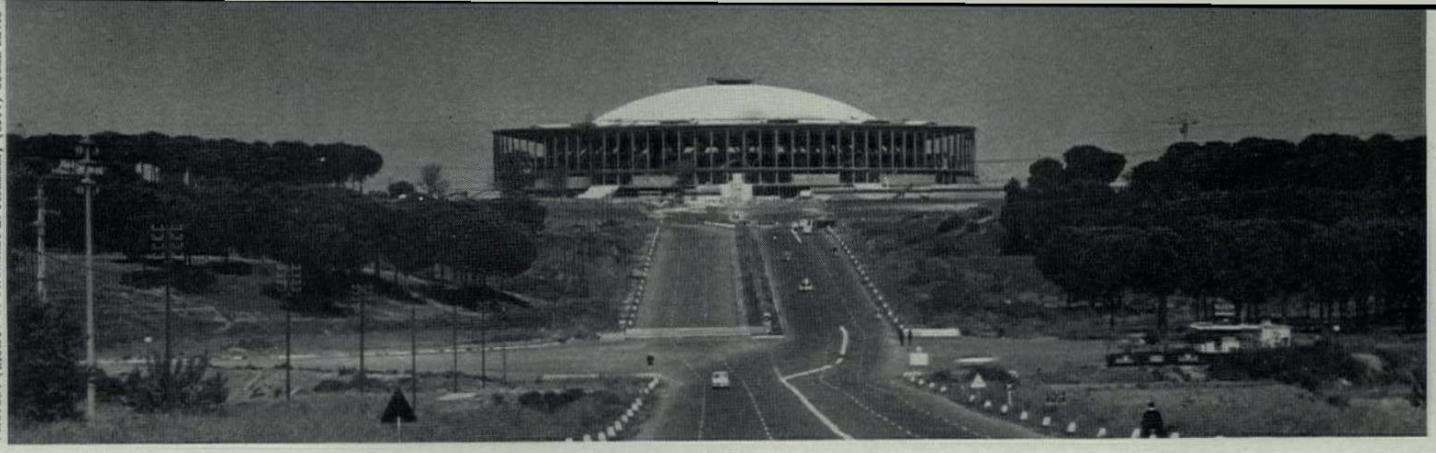

PHOTOS: (RIGHT) G. CHERARDI-A. FIORELLI; (OPP.) OSCAR SAVIO

Technology

The grace of Rome's giant Sports Palace evolves from a devotion to simple geometry and sophisticated prefabrication.

BY CLOVIS B. HEIMSATH*

Nervi's methodology

The name Pier Luigi Nervi stands internationally today for "Grand Old Man" of engineering. His esthetic sense is admired as is his economy in construction. No "old master" can escape attack, however. Nervi is criticized for his classical, symmetrical building shapes, and for his use of concrete in small pieces and "pretty" patterns to create huge interiors. On these pages an American student of Nervi, interviewing the master, shows how compellingly these results of Nervi's derive from a central concept—a concept of master building. —ED.

The giant Sports Palace, the third and latest of Nervi's works in Rome for the summer Olympics, represents a culmination of his methodology and design philosophy. Nervi's early sketches and the photos of the building, shown on these pages, illustrate his method of design and construction and the architecture it creates. The building's simple geometric form is at the heart of his design in concrete, for it gives scope to Nervi's principles of prefabrication. Before these principles can be used in more complicated forms —hyperbolic paraboloids, warped surfaces, and sculptural three-dimensional curved forms—yet with the economies now enjoyed in the concrete vault or dome, another Nervi may have to come along and teach the world how to build such structures with similar prefabrication and economy.

Nervi is a "master builder"—an architect, engineer, and contractor, all in one. Thus, he is as much involved in the forming of a structural rib on the site as he is with drawings in his office. To reach a good and economical solution to a problem, he must keep all aspects of a building in mind, with primary emphasis on the system of construction. This helps to explain his use of simple geometry: a hemispherical dome, like that of the Sports Palace, can be built in precast units, each equal to the next through 360 degrees.

Modular units have long been Nervi's stock in trade. As early as 1938, he built poured-in-place hangars with lamella-type framing, and in 1942, he developed a similar hangar of precast parts; prefabrication soon became a mainstay of his design. He won the commission for the Turin Exhibition Hall in 1953 by inventing ways to prefabricate most of the structure.

A simple geometric form, such as a hemispherical dome, offers the optimum in prefabrication, being symmetrical about both axes and displaying a con-

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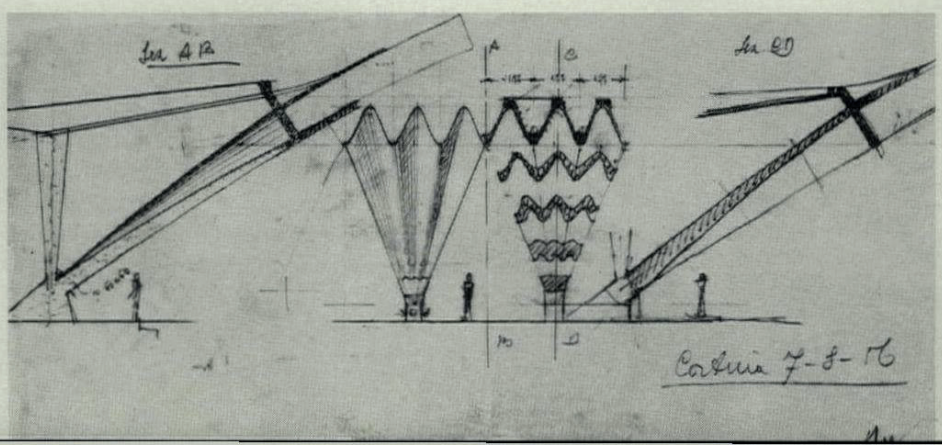
Nervi's sketches, *shown on the following pages, are representative of dozens he made for the large Sports Palace over a two-year period. At right is a sketch which helped him to determine the point of connection between the cupola and the "pilaster," or strut. Three fan-shaped rib units are shown converging at one support; then, in rapid succession, the detail is defined by sketch elevations and sections. Left: a photo of the pilasters.*



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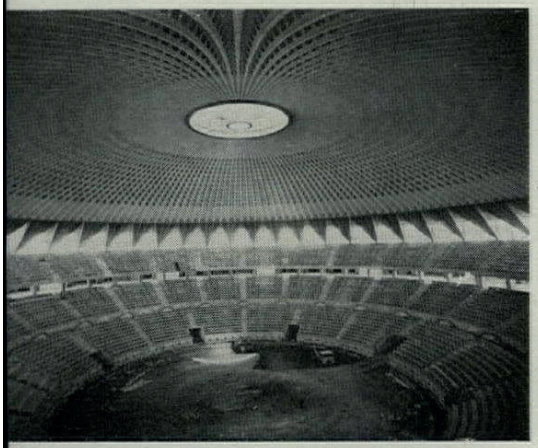
Two structures in one: *The photo above shows the palace's two roofs: the cupola (foreground) and the surrounding gallery roof which is a separate structure. Below: the spacious interior.*



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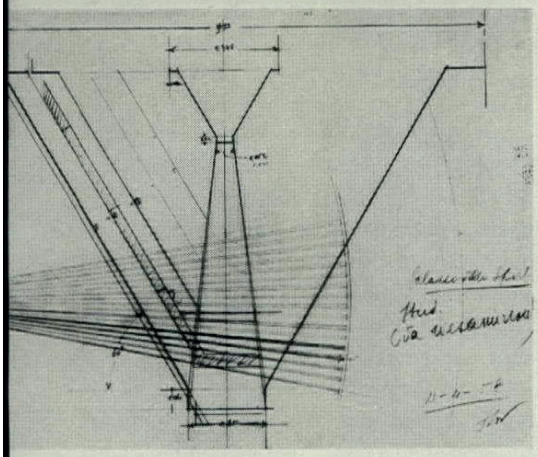
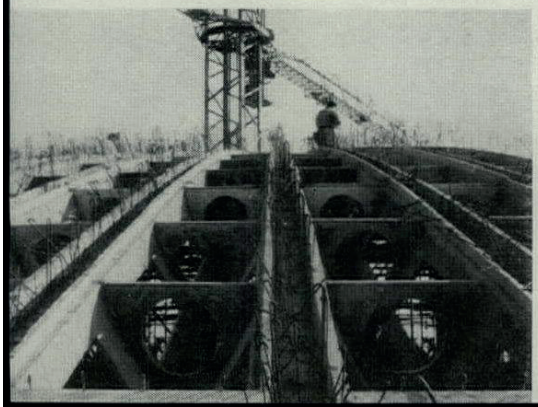


Cupola rib section *is sketched (above) in its final stage of development. Photo (below) shows several of the roof's 144 ribs after they had been lifted into place by the crane, shown in the background. Superimposed on the rib sketch is a section of Nervi's roof-framing plan. A dimensioned sketch such as this one needs only to be drawn up and checked for final calculations.*



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stant change in curvature: one unit can be used again and again; one set of calculations is as good in one quadrant as the next.

Nervi the teacher

At the height of his career, Pier Luigi Nervi sees his role as both builder and teacher. His course at the University of Rome, "Technology of Materials and Technique of Construction," is attended each year by some 150 Italian students and 20 Americans. As participants in his 1959 class (Nervi has taught at the University of Rome since 1948), we had an opportunity to study three of his major works now being completed in Rome: the small Olympic Sports Palace (5,000 seats), the large Sports Palace (15,000 seats), and the Flamina Stadium (50,000 seats). And through visits to his 13-man office, we were able to learn something of his methods of operation.

Nervi is cordial, informal, and anxious to have his techniques understood, as is exemplified in his remarks to his 1959 group of American students:

Question: What is your method of producing the first schemes of your designs? At what point are calculations made?

Mr. Nervi: At the outset, let me say that I intend to answer the questions from the point of view of statics and structure, a point of view to which I am principally dedicated.

The design begins with a general examination, I should say a presentation to myself, of the various statical and constructive possibilities in the particular case. For example, for covering a large space, I may consider beams in one direction or intersecting beams, a barrel vault or a cross vault, a structure primarily in tension or one in compression. This first mental examination is made almost always without the aid of drawings, and usually in an odd moment during the day or when awakening for a brief moment at night. Sometimes, I go to the point in this mental examination where I can evaluate—though very approximately—the complex of forces in play: loads, thrusts, etc.

Almost simultaneously, I try to envision for each possible solution a method of execution and a calculation of cost. I immediately discard solutions which are too difficult to execute or too expensive. Then begins a more precise design state of the remaining possibilities; these, without exception, are made through geometric drawings to scale: plan, section, elevation, and so on. In this phase, considerations of an esthetic nature come into play, as do functional requirements, such as illumination, passage for air conditioning, heating, thermal protection, acoustics.

The study progresses through tentative stages, and successive modifications are made to determine which solution will best correspond to all the complex needs and which solution is the best compromise among the various alternatives. Because of my "contractor complex," I place great importance on problems of construction and economy. These elements go hand in hand. Moreover, I have never found such elements in conflict with esthetics or architectonics. Having at last arrived at a solution and its particulars, I go on to refine the form and proportions of the over-all composition and of the details. Finally, I make a definitive study of construction methods. Here I make statical calculations, again bringing them to the last approximation necessary for exact dimensioning. A third definitive calculation is made while working drawings are under way in the office.

Question: Many of your works incorporate fine geometric patterns. To what extent are these forms good structure and to what extent are they merely good geometry?

Mr. Nervi: The layout of ribs of a cupola like the Sports Palace is first of all determined by economy in construction. In fact, a convenient weight of the prefabricated elements is determined relative to the capacity of the crane and the means of transportation. With the size of the members established, the geometric play of the ribs to be disposed along the parallels and meridians remains free, able to produce coffers or any other pattern so long as it is a system symmetrical to the meridians. Actually, the true statical substance of the cupola comes from the continuous shell; the ribs are important only as they meet the supports and as they impede the phenomena of elastic instability. It is very difficult, however, to separate the various factors that work together in the final solution.

Question: What effect does the use

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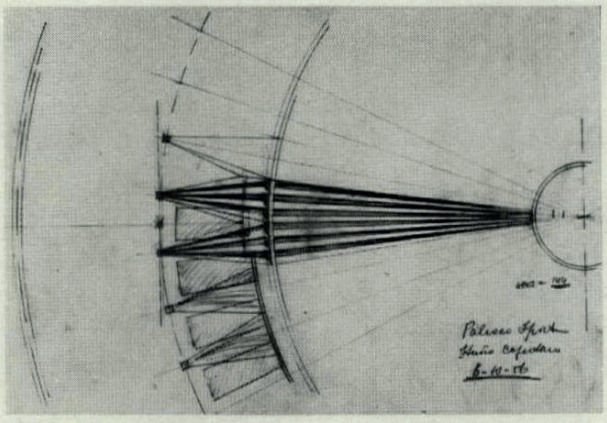
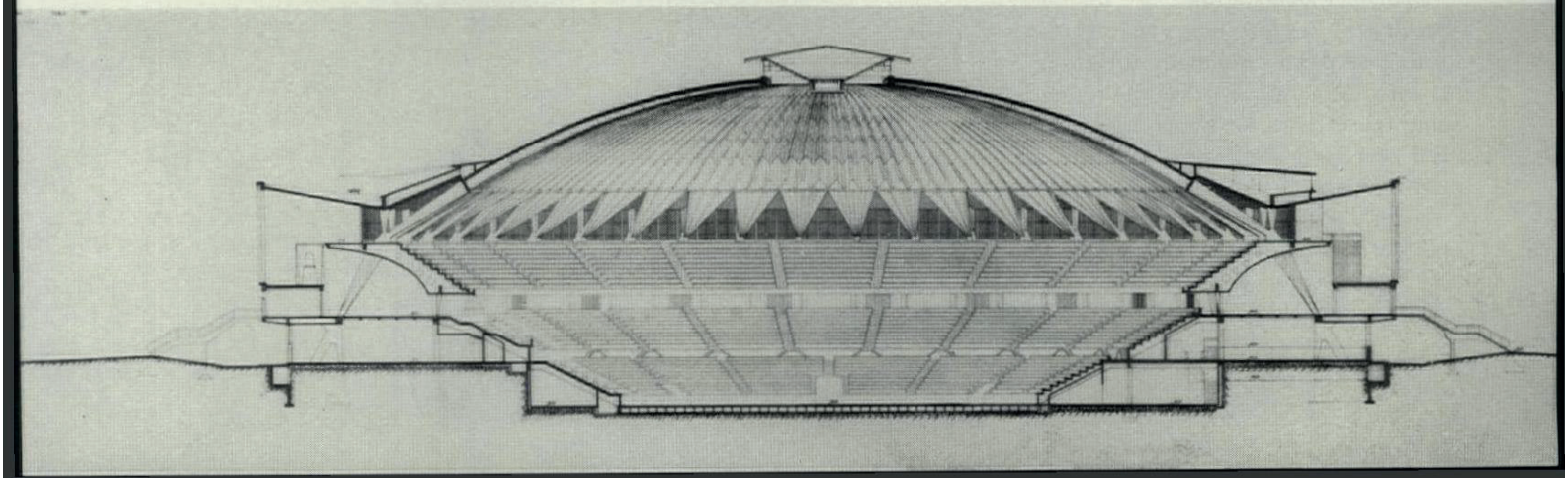


The sweep of an idea: *In the sketch (left) Nervi has drawn the roof-framing plan showing six of the 144 rib units. These extend from the central ring to the inclined pilasters. Having arrived at this form, which was both structurally sound and feasible to construct, Nervi was able to create a large architectural idea, through the ready multiplicity of a single detail. The section (below) and the photo (above) illustrate how Nervi was able to allow light to penetrate between the 48 points of support; he does this by gathering three ribs at each support, and these loads, in turn, are transferred to the building's 48 inclined pilasters.*



of prefabricated elements have in your final design?

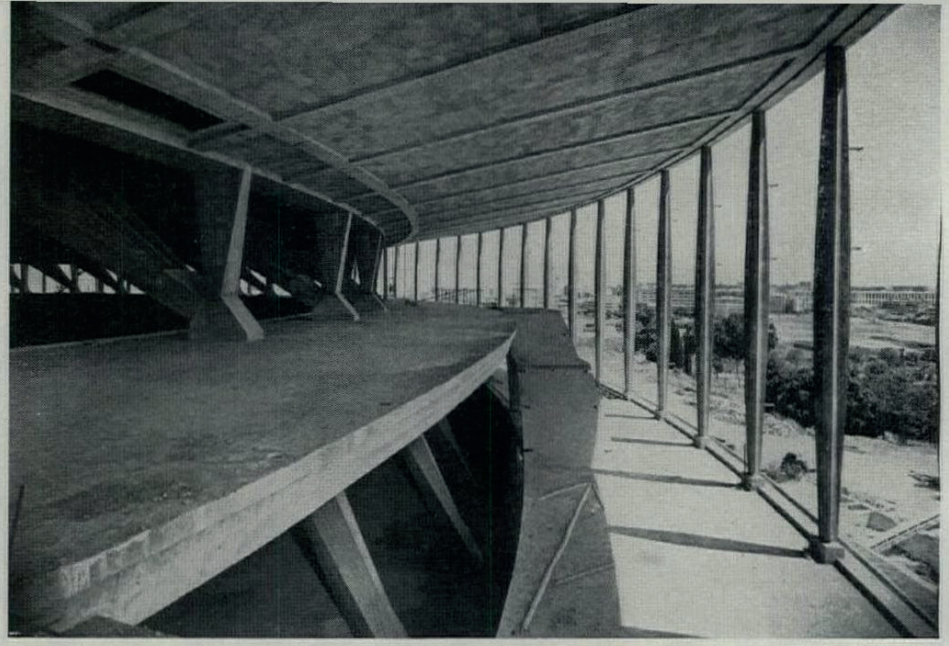
Mr. Nervi: Prefabrication permits a formal enrichment of structure, due—above all—to the repetition of a great number of equal elements and the perfection and exactness of the individual unit. Moreover, in the cupola of the Sports Palace, I have used a system of prefabricated radial ribs that, aside from creating a noticeable formal enrichment, takes care of the problems of lighting and the passage of air conditioning, and creates—I hope—good acoustics in the large locale.

Question: Does the role of the architect and engineer coincide?

Mr. Nervi: This is the most difficult question to clarify, because of a basic verbal misunderstanding. If we go back to the etymology of the words and assign to the architect the role of "master builder," he becomes solely responsible for the technical and esthetic fields. The fact is, however, that over a period of time, particularly in the last century, the architect has become limited to designing the external decoration of buildings. In contrast, during the same period of time, the techniques of building have developed at a very rapid pace, due to new materials and more scientific methods of construction.

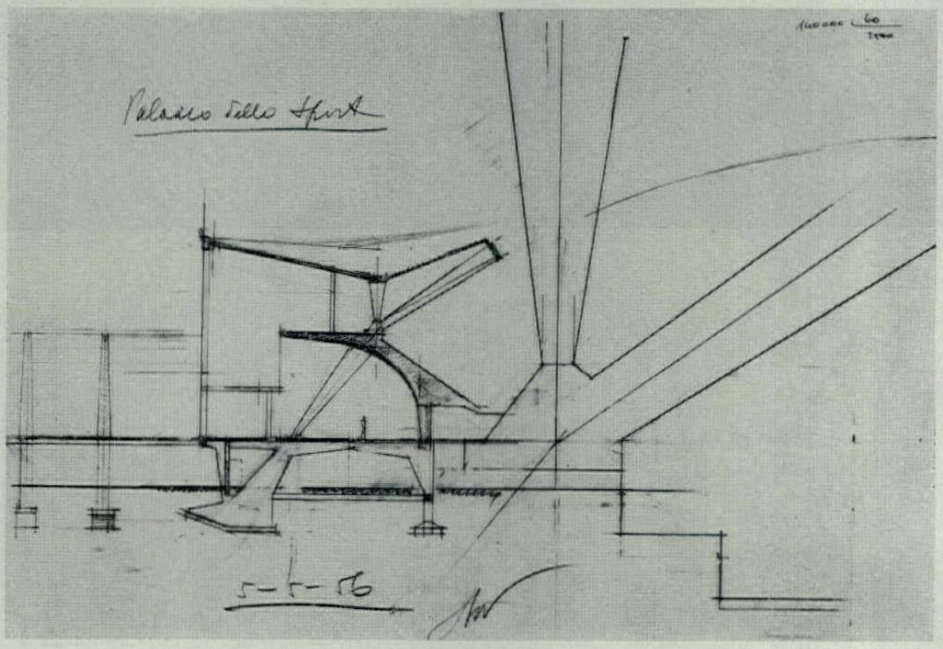
At the beginning of the century, there arrived a complete separation: on the one hand, the Beaux-Arts architect, with a formal and "drawing" preparation; on the other hand, the civil engineer, concerned almost exclusively with technical matters of construction. With the rebirth of mature architectural concepts in the first decades of this century, bringing to light the inseparable unity of the formal and technical aspects of a building, the incompleteness of the "architectural professor of architectonic drawings" and the engineer as pure technician became evident. As construction becomes ever more complex, this separation is daily more painful and damaging.

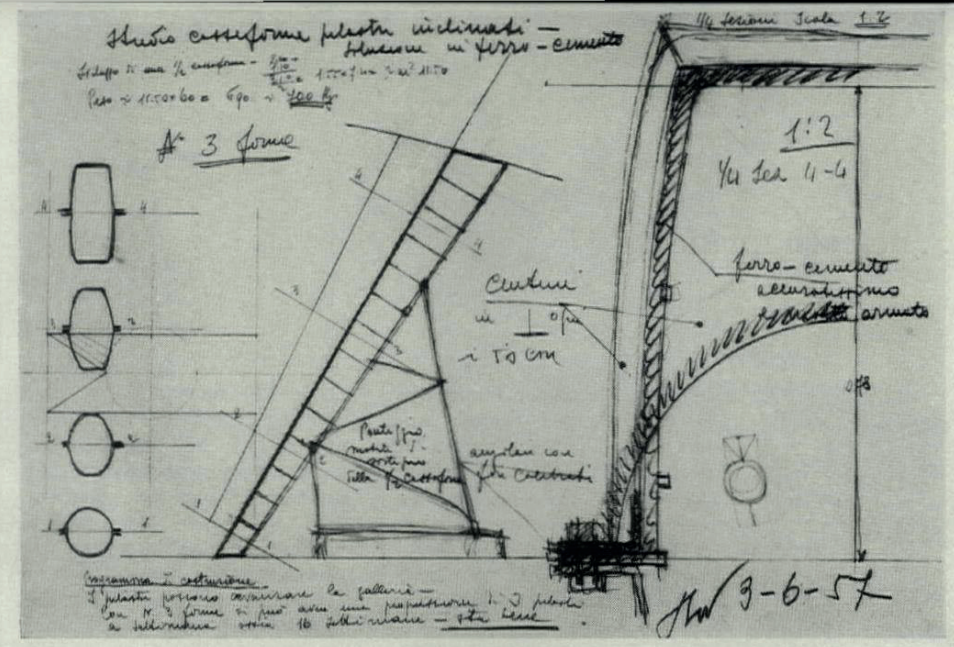
While waiting for an improved faculty of architecture, one teaching a unified technical-esthetic direction, I believe that the only possibility is a sincere collaboration between engineers and architects. Only such collaboration can reconstruct that unity which slowly was lost, beginning with the formalism of the Renaissance, after the splendor of the Ancient and Gothic periods.

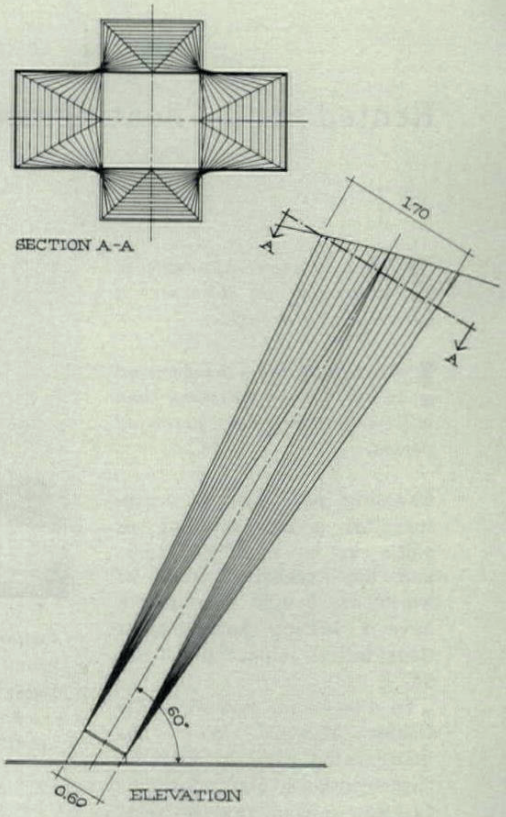


PHOTOS: OSCAR SAVIO

Early design: *As long ago as May 1956, Nervi clearly envisioned the arena's major elements (sketch, below): the seating shelf, buttressed by an inclined pilaster which follows the line of thrust from the cupola, and the circular covering for the gallery, also shown in the sketch as is an enlarged detail of the connection. Above: a photo of the gallery which encircles the arena.*







Evolution of an idea: *Nervi's original approach for forming the inclined pilaster is shown in this sketch (above). He was trying to evolve a four-stage, precast form to be used in the pouring of all pilasters. His scribbling to himself reads: "If we can quickly construct the pilaster, the gallery will go up fast. With three forms, we can build three pilasters a week: 16 x 3 = 48. Thus, 16 weeks in all. O.K." But he did not use this approach in the final design (the form turned out to be too expensive). Instead, he developed a more economical wood-framing system (right). Like many of Nervi's ideas, the discarded one will likely show up in another structure. Below: a finished pilaster with a staircase in background. Note how the wood forming adds texture in the concrete.*