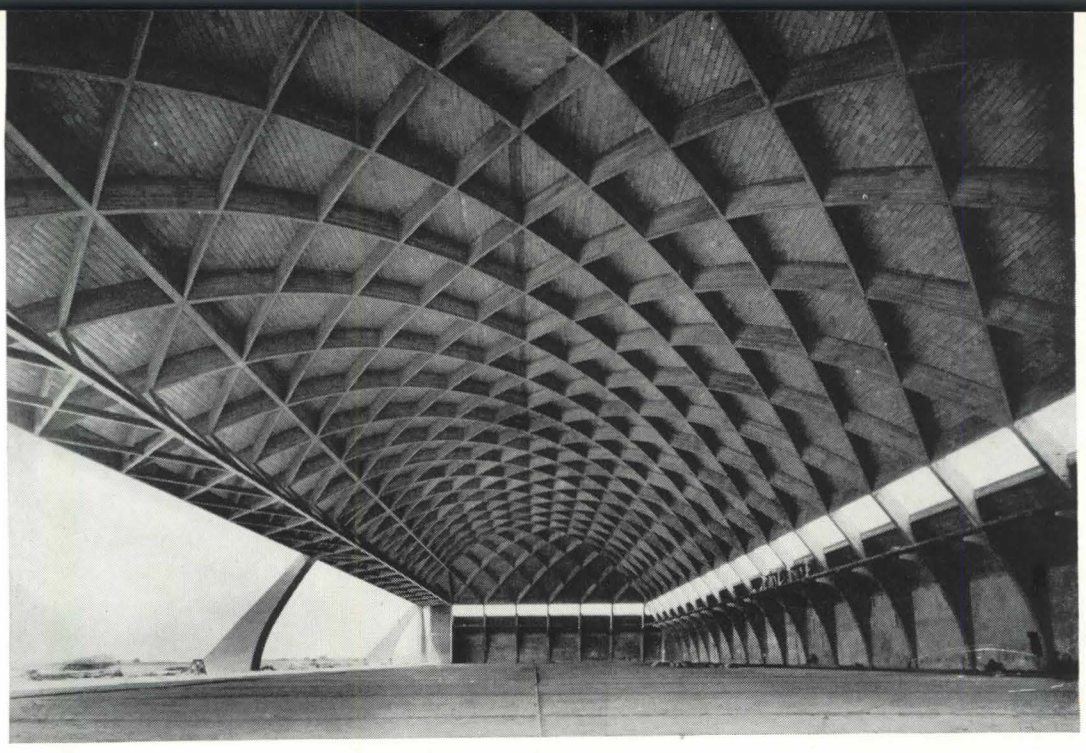

*Figure 1—airplane hangar near Rome, Italy (1938).*

## geodetic and plastic expressions abroad

## ITALY: Pier Luigi Nervi

**by A. L. Huxtable**

Pure engineering, in the hands of an artist, has created some of the architectural masterpieces of our age.

It is seldom, however, that the engineer's instinct for esthetic calculations is as sure as his knowledge of mathematical formulas. When this happens, as in the hangars and warehouses of Pier Luigi Nervi, structures of dramatic beauty result. Because Nervi's feeling for form equals his almost uncanny understanding of the complex structural possibilities of reinforced concrete, he has produced a series of buildings that are of equal importance to the science of engineering and to the art of architecture.

Nervi's engineering contribution has been the covering of great open spans with ingeniously ribbed, reticulated or corrugated systems of reinforced-concrete vaulting. New constructions have resulted in completely new building forms — curved monolithic shells, tent-like shapes, undulating roofs, and angled supports—all striking departures from the rectilinear principles that have been symbolic of construction since man's first efforts to build. From Paxton's Crystal Palace in Victorian London to Nervi's Exposition Hall a century later in modern Turin, engineers have pioneered the revolutionary constructions that have created the new architecture.

If the 19th Century was the Age of Iron, then the 20th Century is the Age of Steel and Reinforced Concrete—and Nervi one of its greatest prophets and pioneers. The last 20 years have produced important developments in reinforced concrete that indicate revolutionary architectural possibilities in the framing of space. Concrete construction has been growing lighter, due to improvement and standardization of the material and to developments in vibrating, precasting, and prestressing. New structural forms have shifted the emphasis from monumental masses to the space-enclosing shell. To Nervi's credit is his contribution to the development of ferro-concrete and the integrated use of a metal-armature skeleton with concrete, providing a greater strength and a greater range of structural possibilities than could be achieved by ordinary techniques.

The record of Nervi's achievements covers an important 20-year period. The first of his large projects was the community stadium of Florence, built in 1932. Shortly after this, in 1935, studies began for two airplane hangars outside Rome, the first erected in 1938, the second in 1943. These spectacular structures cover the same span, 328′ x 131′, but differ in design. The first (*Figure 1*) is a classic example of a lamella-type roof, in-filled with brick tiles covered with asbestos cement and supported by evenly spaced buttresses on three sides, with a single additional support in the center of the entrance span. The later hangar, using a roof of prefabricated lattice members with stiffening beams along the edge and only six buttresses supporting its span, is an audacious solution of a great visual and technical excitement.*

In 1947, a competition was held for a new exhibition hall to replace the bombed area of the Palazzo Esposizione in Turin (*Figure 3*). The requirements were speed, size, economy, and facility of erection. Since the problem could not be solved by existing techniques, Nervi won the com-

*This article is based on a section of an exhibition, "Modern Italian Architecture and Design," prepared by the author for the International Program of the Department of Circulating Exhibitions of the Museum of Modern Art, New York.*

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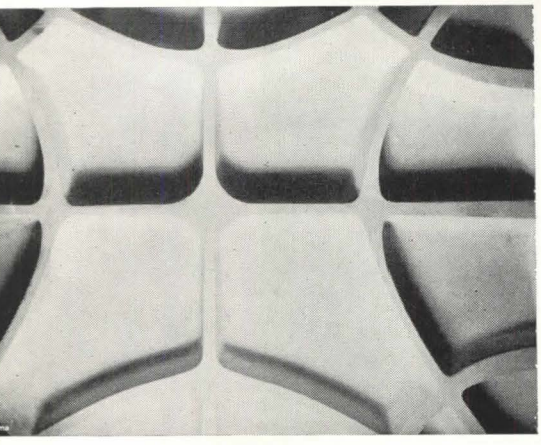


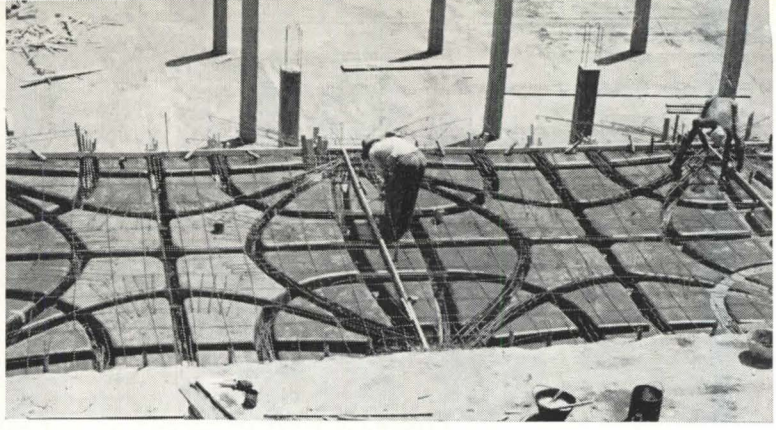


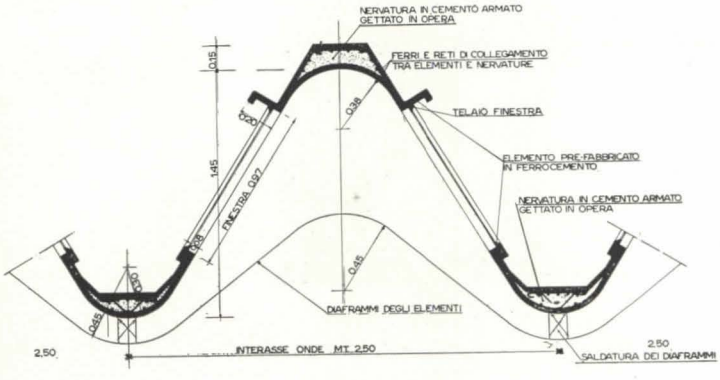
*Figure 2—Lanificio Gatti factory, Rome, Italy (1951). Nervi has devised numerous roof systems of precast or poured-in-place, flat-ceiling slabs joined by intricate stiffening networks for distribution of stresses. Ceilings of the Lanificio Gatti factory were poured continuously in place with the forms* (above right) *set on movable scaffolding. Removal of the scaffolding left a smooth upper surface at floor level and a reticulated ceiling surface underneath, with stiffeners collecting the load at column heads* (above and right).

mission by the invention of a system of prefabricated units which would form a corrugated barrel-vault and which could be mounted and joined in a minimum of time. Each day, approximately 30 of these units were set in place on a tubular scaffolding; and as each quarter of the construction was completed the scaffolding was lowered, moved forward, and the process repeated. Precast stiffeners add a rhythmic emphasis to the undulating pattern of the ribs. The forces are gathered into groups of four converging ribs at the sides of the hall, transmitted to widely-spaced, sloping abutments, and then to concrete masses below ground. There are two lateral galleries and a rotunda 132′ in diameter at the far end, covered with a half dome. The ribs of this dome are used as stiffeners rather than for carrying stresses and form a decorative element indicative of some of the design freedom of the engineer.

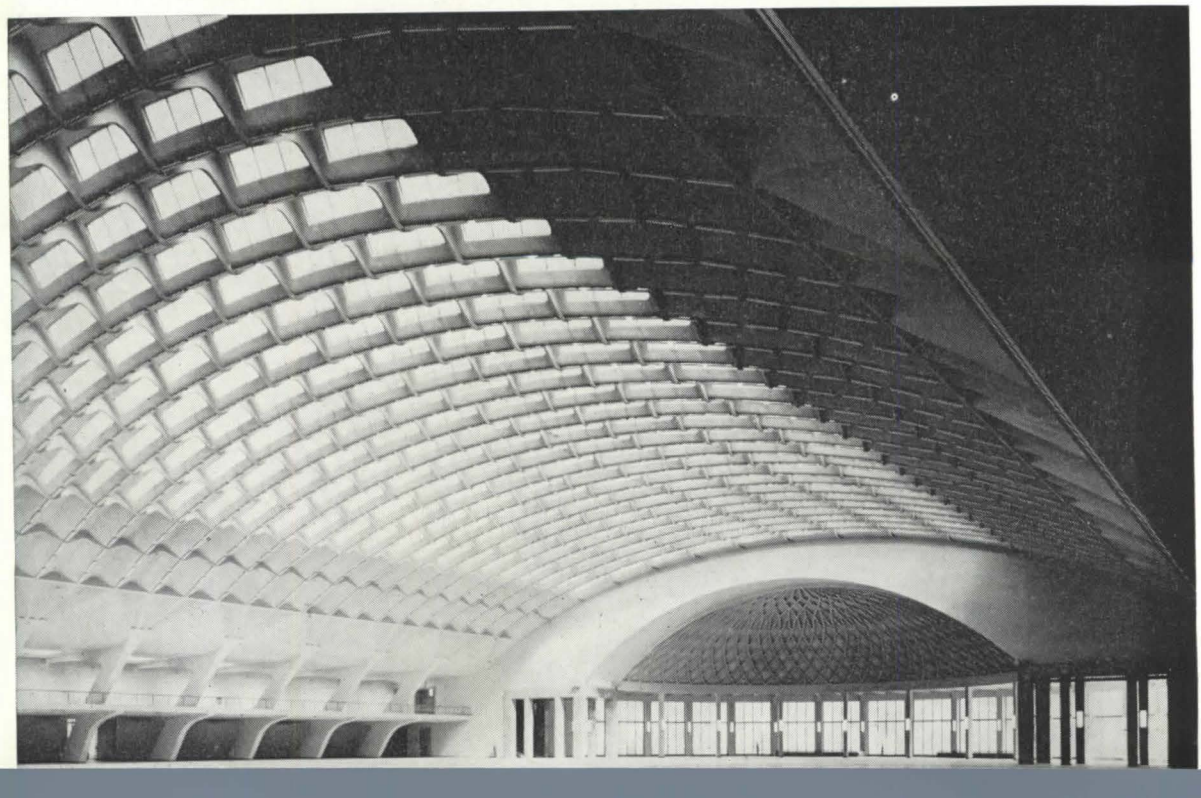
There is, unfortunately, a too generally accepted division between scientist (engineer) and artist (architect), and too little realization of the enormous choice that is open to the engineer in his development and use of structural elements. In 1950, Nervi and his partner, Bartoli, added another salon to the Turin exposition building, this one approximately 213′ x 180′, and completed a handsome salt warehouse at Tortona, both utilizing lamella-type ceilings. Since 1950, he has been developing a series of flat-slab ceilings for factories and warehouses; notable among them the Lanificio Gatti factory of 1951 (*Figure 2*) and a tobacco factory in Bologna (1952). Reinforcing networks of intricate mathematical design stiffen and separate reinforced-concrete slabs, accepting and distributing weight and stresses to make possible large spans and simple monolithic enclosures.

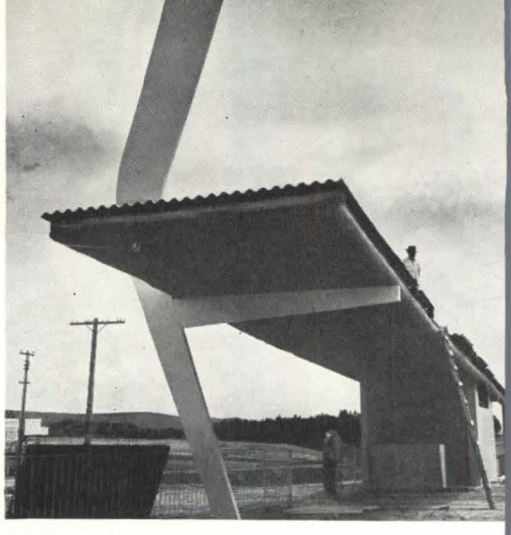
These factories, warehouses, and hangars are indisputably among the most stimulating buildings of our day and represent two noteworthy directions in contemporary work: a new concept of construction, and a new sense of space. The resultant fusion of structure and form may prove to be more significant for the architecture of the 20th Century than the much-discussed integration of the traditional arts.

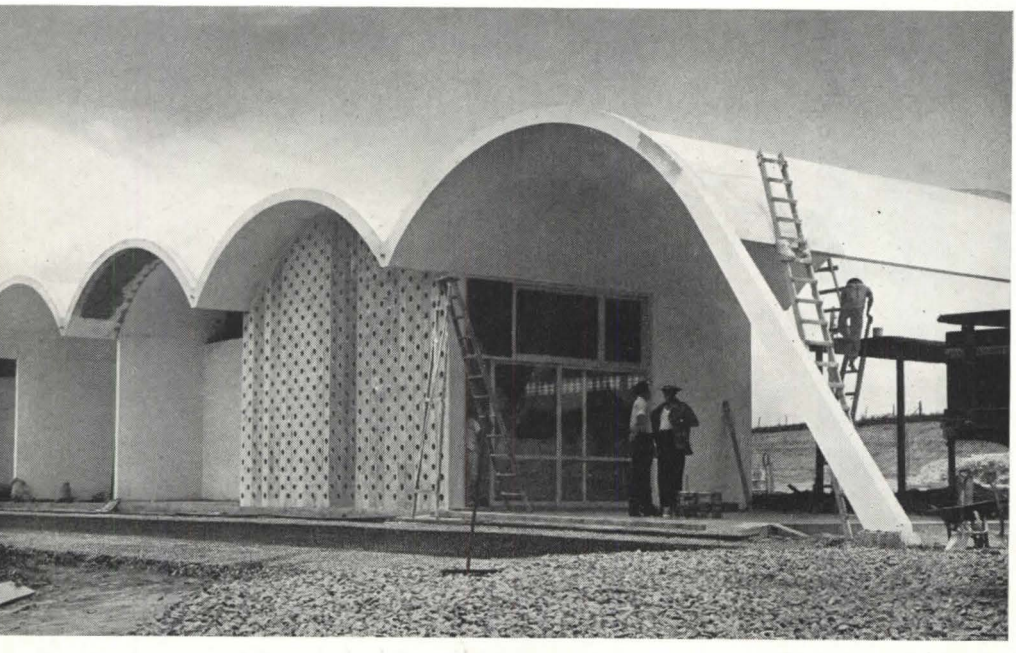
*Figure 3—Exposition Palace, Turin, Italy (1947). Prefabricated units* (right) *of the corrugated roof were consecutively mounted on a tubular scaffolding, fitted together, and joined with poured concrete. Exterior view of roof with elements in place* (below). *Section of element* (below right) *is width of one wave, 14½′ long and slightly more than 1½″ thick.*



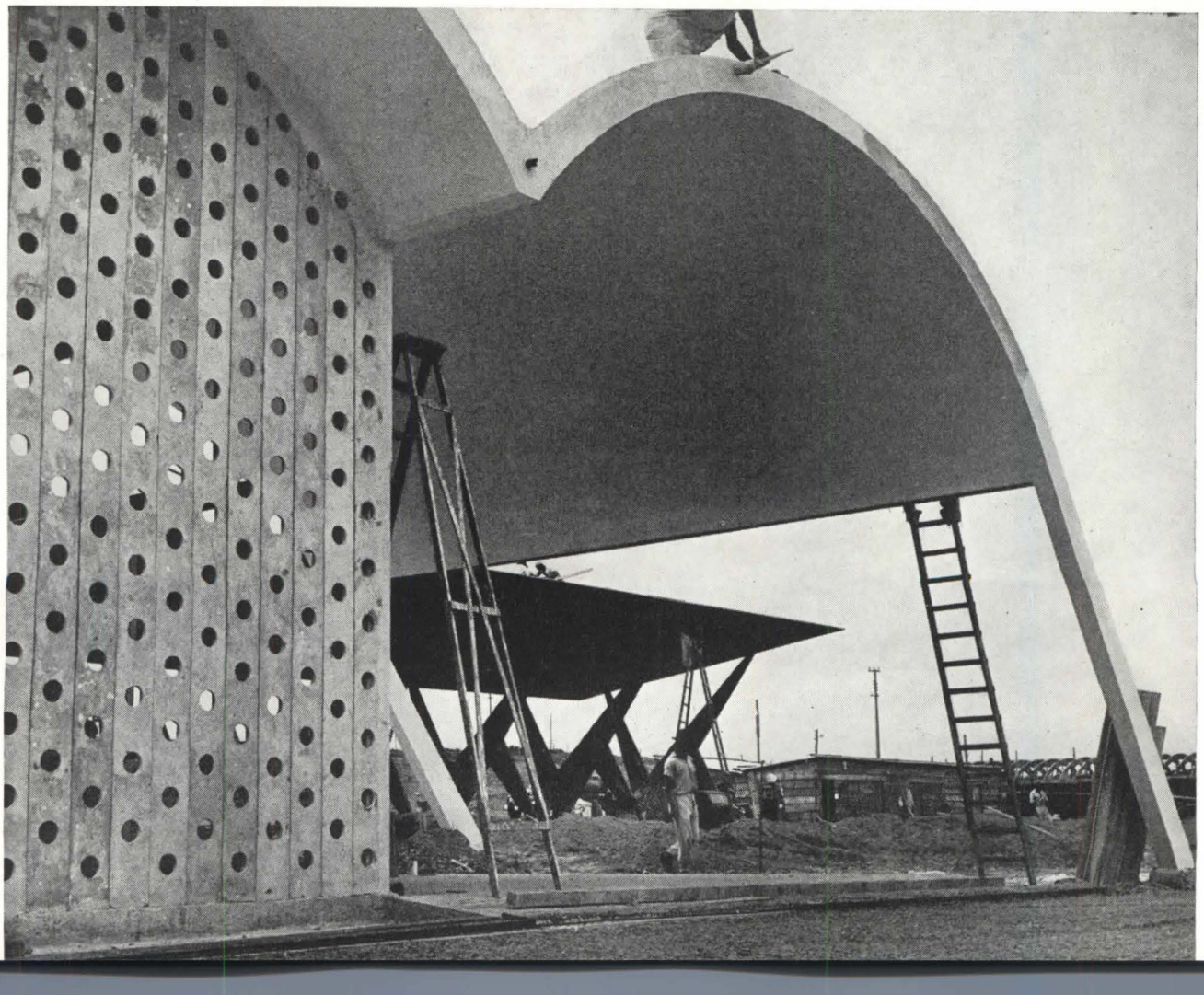

*The abutments* (left) *receive the full load of the 320′ span at an angle that makes possible a sharply cantilevered balcony. The finished hall* (below) *shows clearly the completed effect of the ingenious system of construction, and equally important, an architectural design of great esthetic success. The vast interior space is modeled and controlled by a structural shell that provokes an immediate sensuous and emotional response by its rhythmic patterns and dynamic curves, its coloristic effects of light and shade.*







Club dos 500, *São Paulo (an automobile service station). "Customer-attraction" pylon* (above); *details of repetitive barrel-vaults over administrative area* (left and below); *two views of service area* (acrosspage). ***Elements of the plan are: (1) portico; (2) office; (3) rest rooms; (4) offices; (5) storage; (6) pumps; (7) lubrication pits.***



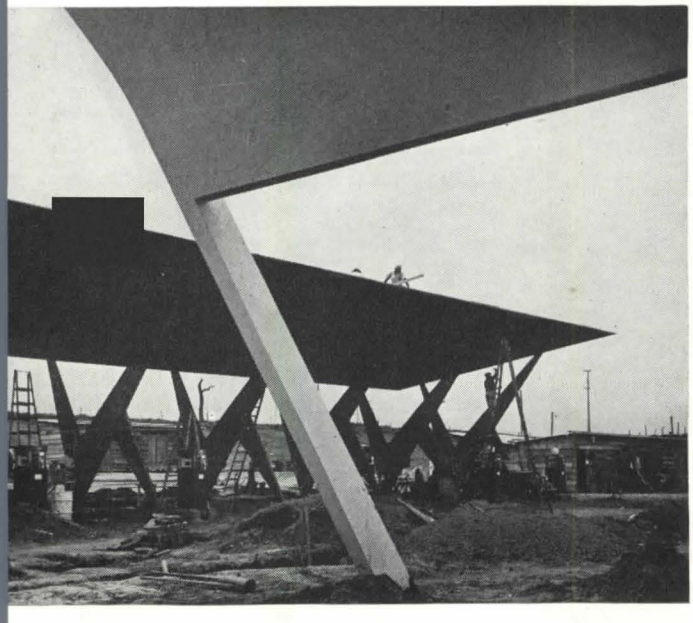
## BRAZIL: Oscar Niemeyer

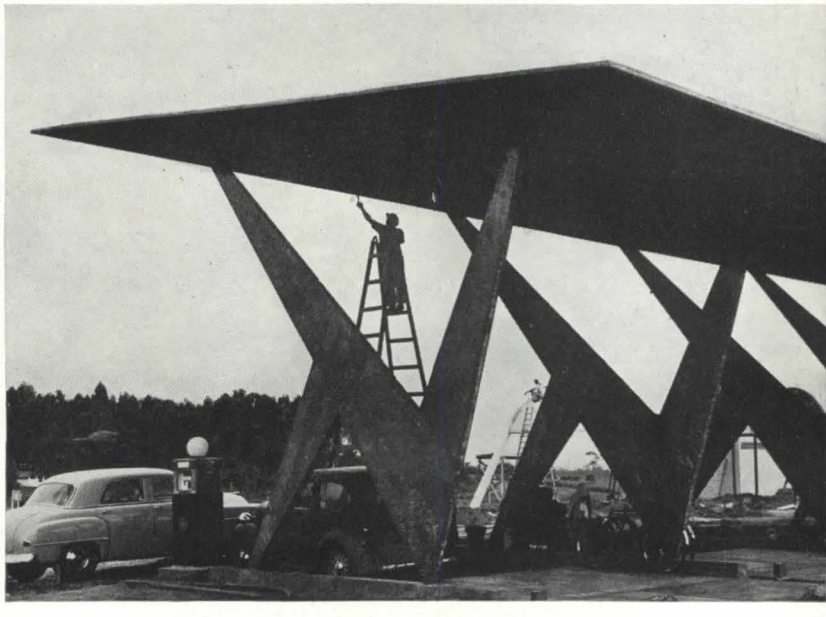
Niemeyer has written that architecture must express the spirit of the technical and social forces of a given epoch. While his own design complies with this dictum, it is also curiously influenced by the vestiges of colonial baroque as well as the climatic and physical aspects of his native Brazil. His abundant use of plastic structural expressions clearly displays his affinity for the baroque, while his work unquestionably embodies contemporary technology creatively applied to the solutions of spatial problems.

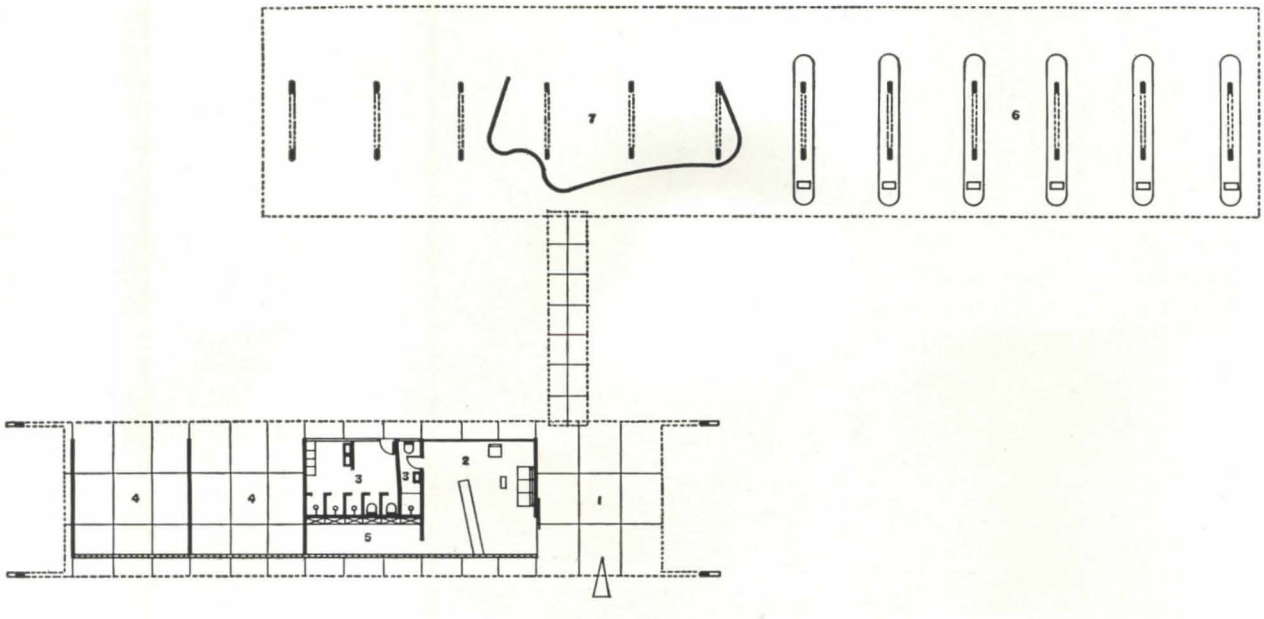
*This brief but visually exciting examination of two reinforced-concrete structures in Brazil has been staff prepared.*

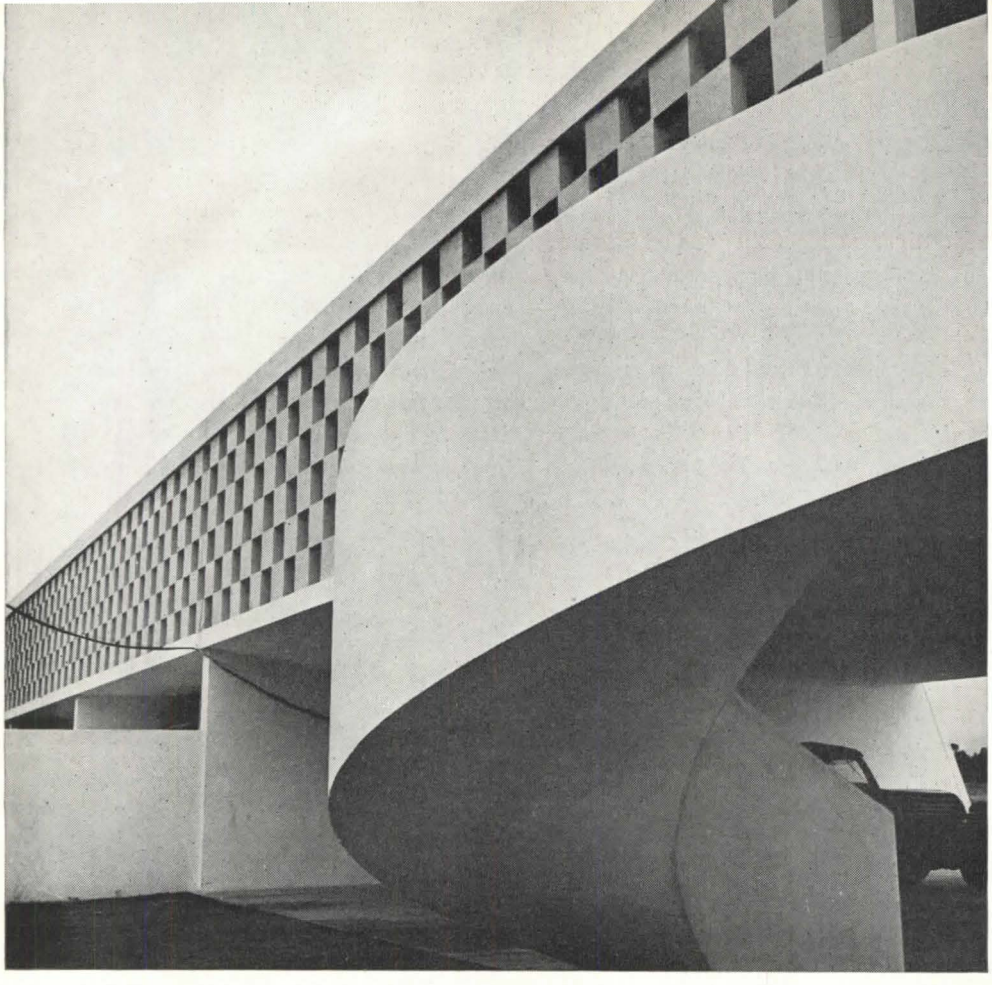
To document a few of these observations, this architect's *Club dos 500*, an automobile service station in São Paulo, is presented (*acrosspage and below*) together with two row houses at the Aeronautical Training Center, São Jose dos Campos (*overpage*).

In the service station, note how the repetitive barrel-vaulting over the administrative areas clearly displays Niemeyer's love for the curved form and in execution how it compliments the geometric vigor of the vertical supports in the open service area. Also, note that the boomerang-like "customer-attraction" pylon (located in front of the station near the main road)









*Differing methods of providing privacy and sun control are found in the north elevations of two row houses at the Aeronautical Training Center, São Jose dos Campos.*

leans in defying contrast to its rigidly perpendicular counterpart that is so abundantly found in shopping centers, supermarkets, and other commercial developments in the northern hemisphere of America.

If one were not told where this station had been constructed, he could make a fairly accurate estimate of the climatology of its location by the appearance of the structure alone. Note the length of the overhang integrally formed by the extensions of the barrel-vaults; the general lack of doors and windows in the administrative units; the openings in the precast-concrete vertical panels along the front façade of the office area; the magnificent, shading concrete-roof panels over the service area.

Essentially the structural system is simple: barrel-vaults are supported at their springings by the concrete walls sepstating individual offices. Live loads and dead loads acting on the concrete panels over the pumps and lubrication pits are carried to earth by members whose design reflects the pattern and location of both existing and potential static forces.

Different row houses at the Aeronautical Training Center exhibit two of Niemeyer's methods of obtaining privacy and sun control for northern exposures. Checkered pattern of blocks affords protection for a second-floor exterior corridor (*left above*) while wood louvers in a frame pitched 70 degrees from horizontal protect two-story living rooms (*left below*). In the design of both buildings, load-bearing brick masonry and reinforced concrete were specified. See how the grid pattern of the sun control (*in upper photo*) is softened by the baroque character of the circular stairway.