VOLUME X / NUMBER 4 / FOURTH QUARTER 1970

MODERN STEEL CONSTRUCTION

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Steel

MODERN STEEL CONSTRUCTION

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CONTENTS

STRUCTURAL DESIGN IN STEEL

In the belief that engineers, architects, and public officials would like to become familiar with the practical aspects of designing using the 7th Edition of the Steel Construction Manual, the American Institute of Steel Construction is sponsoring this series of lectures.

Each lecture will include a series of design problems and solutions based on the design aids in the Manual. The theoretical background of the solutions will be explained, but the major emphasis will be on practical considerations.

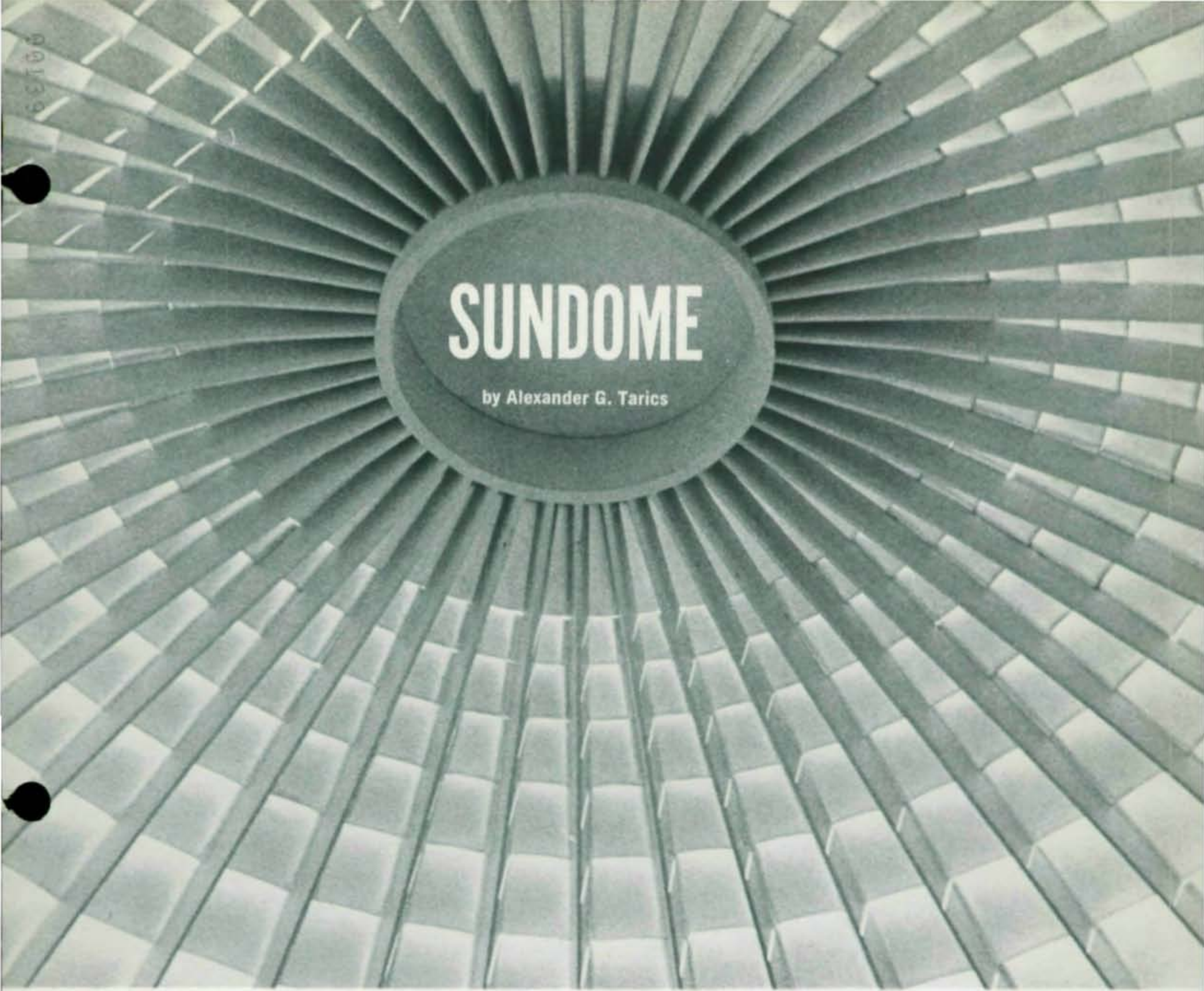
Time and place of the lecture series in your area will be announced.

1971 FELLOWSHIP AWARDS

Entries are invited for AISC's Ninth Annual Fellowship Awards Program. These awards serve to encourage expertise in the creative use of fabricated structural steel.

Four $2,500 fellowship awards will be granted to senior or graduate students enrolled in a structural engineering program at an accredited engineering institution. Additionally, the head of the department where each Fellow will undertake his study will receive a further grant of $500 for unrestricted general administrative use.

Students interested should contact the Chairman of the Civil Engineering Department at their institution for Rules and Instructions for Applicants, or write directly to AISC, 101 Park Avenue, New York, N. Y. 10017 for this information.



SUNDOME

by Alexander G. Tarics

In response to a growing public need for large clear span structures, capable of accommodating tens of thousands of people, the firm of Reid & Tarics Associates has developed a unique structure with natural interior illumination. Because of its potential size this structure can be used to house large sports events, conventions or exhibitions, expositions, fairs, concerts or festivals. The structure can also be used to span and enclose existing uncovered facilities. The interior may be enclosed by walls at or near its periphery or left open to the surrounding environment, depending upon the local climate and the specific functions of the building.

Dr. Tarics of Reid & Tarics Associates, San Francisco, Cal., is the principal in charge of design.

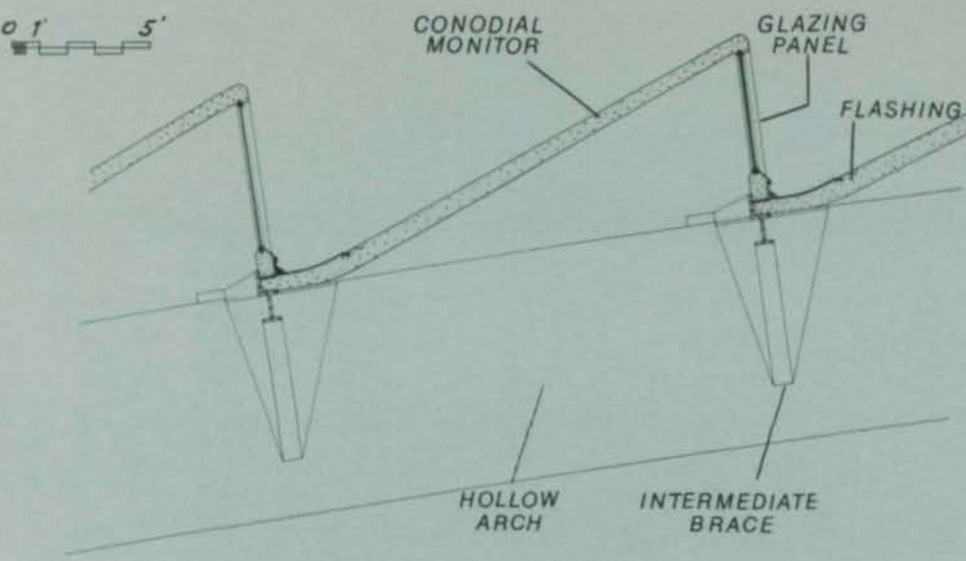
The structure is an assembly of hinged arches roofed with conoidal monitors which provide natural lighting to the building's interior. The mechanical ventilation system may be integrated into the structural steel frame, by using the arches, which are hollow, as ducts for air distribution.

Both the configuration and size of such a structure can vary to accommodate its specific needs and functions. The plan of the enclosed space can be circular, rectangular, or a combination where a rectangle is sandwiched between two semicircles. The potential maximum span, which well exceeds 1000 ft, is defined only by the practical limits of contemporary construction technology.

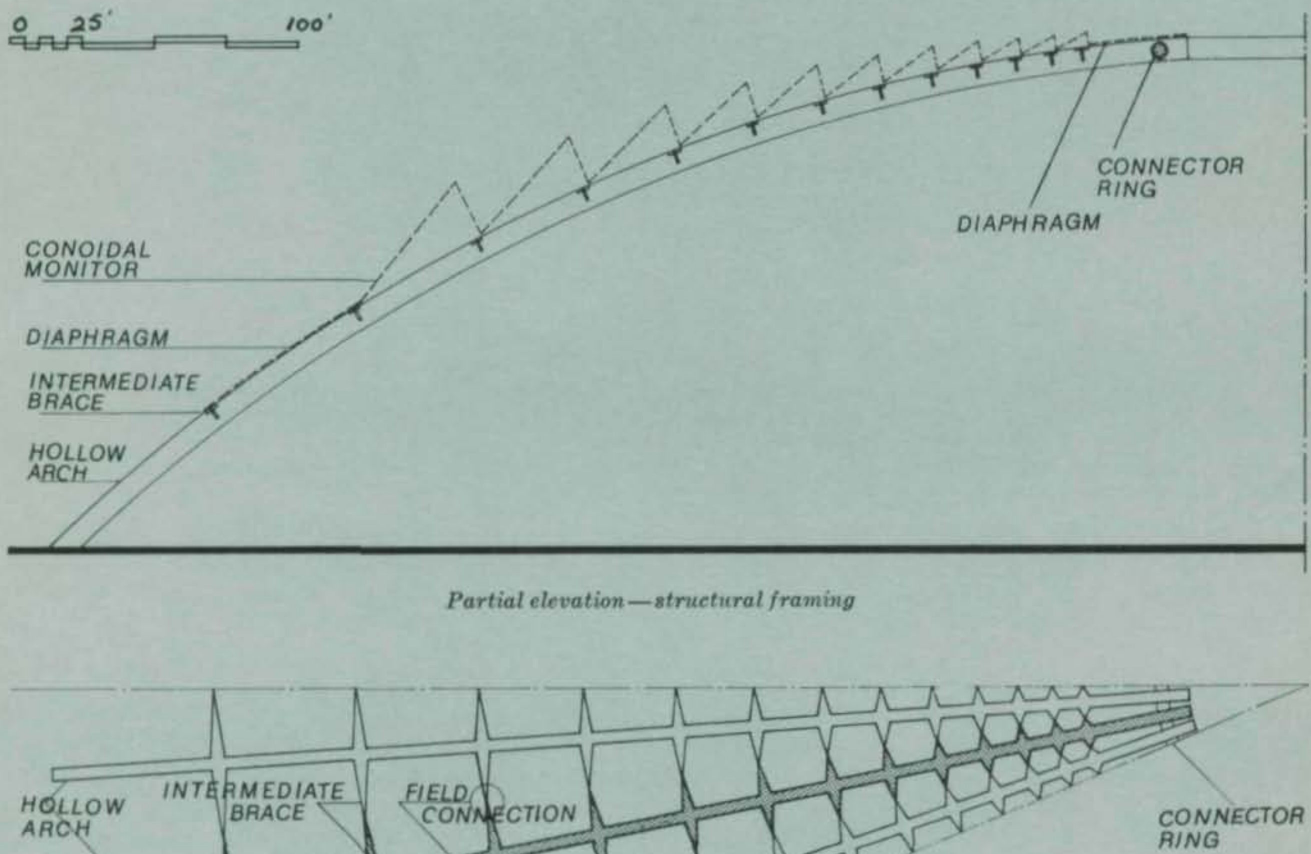
A 750-Ft Dome

For purposes of illustration, consider a circular dome with a roof diameter of 750 ft to be used as a stadium for athletic events. It will seat approximately 45,000 for baseball and 50,000 for football. If used for conventions, concerts or other events, the seating capacity may be increased.

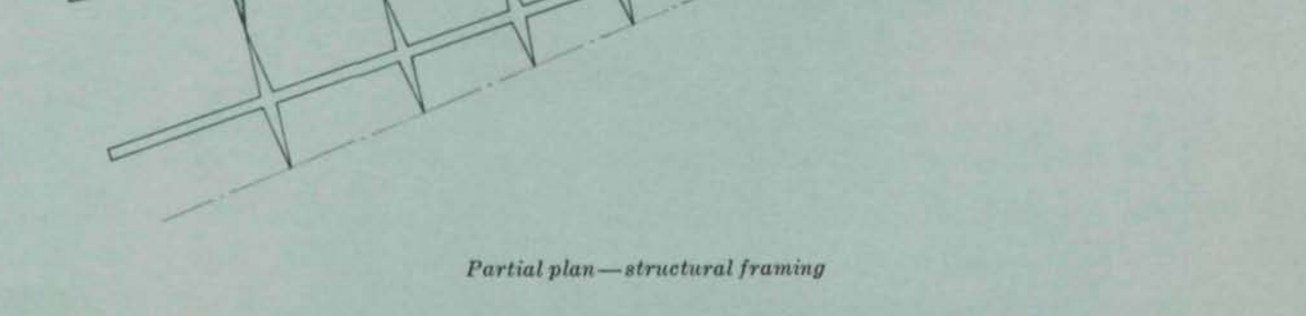
In this particular example, the seating surrounds a central open space or playing field, and is in three tiers with some movable seating in the lowest tier. The movable seating provides the necessary flexibility to rearrange the playing field from a football field to a baseball diamond or to other configurations which may be desired.



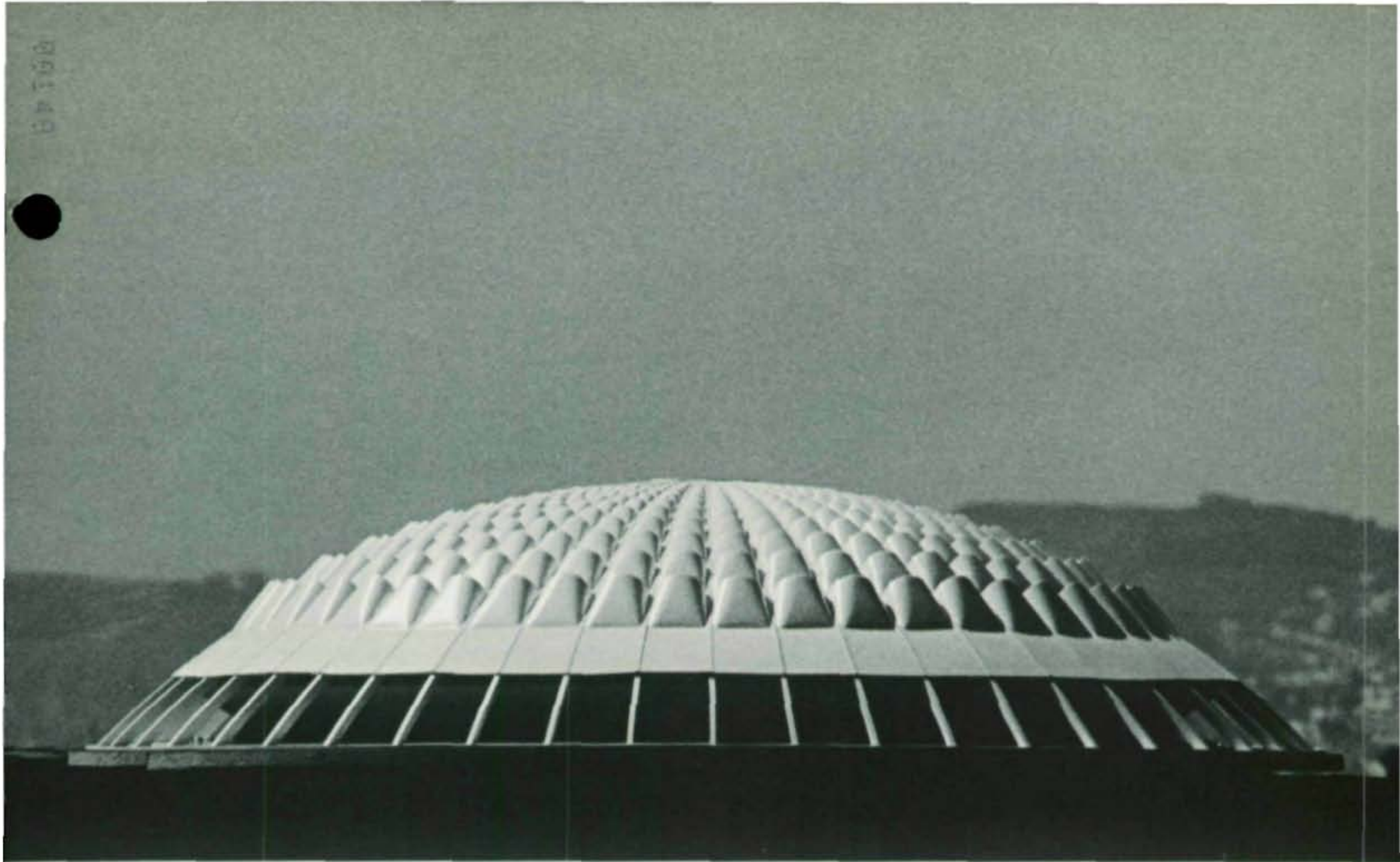
Longitudinal section through monitor



Partial elevation—structural framing

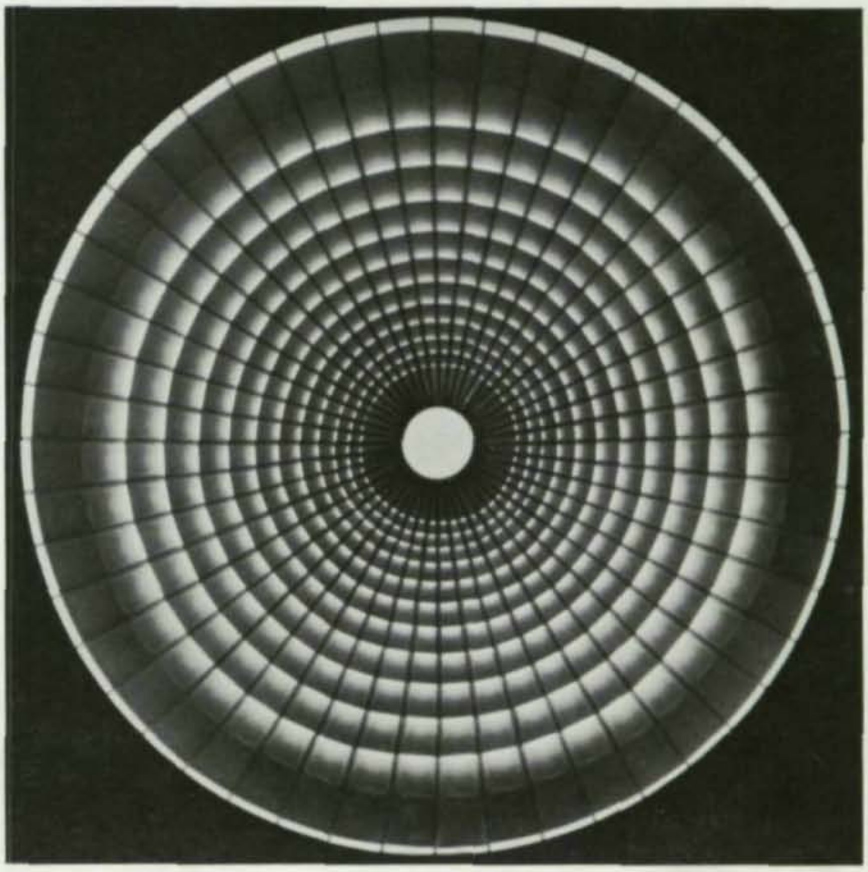


Partial plan—structural framing



Elevation

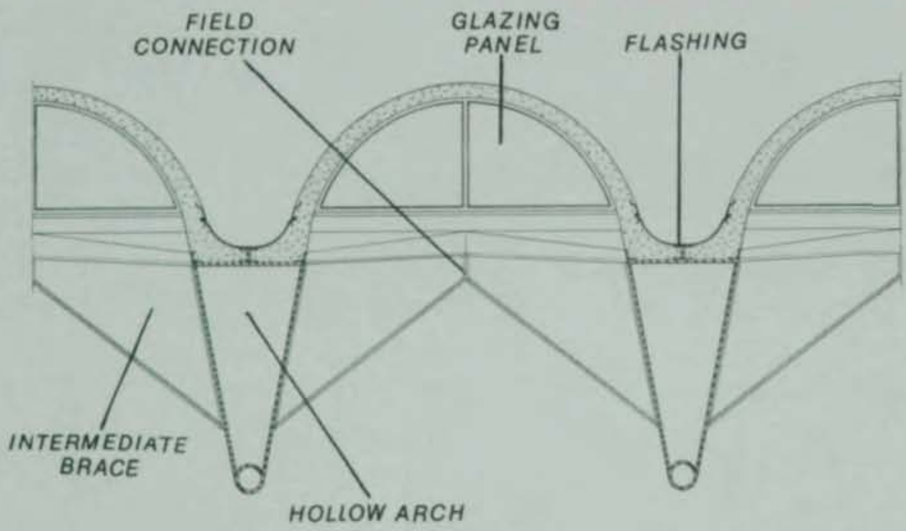
Interior view (exaggerated outside lighting)



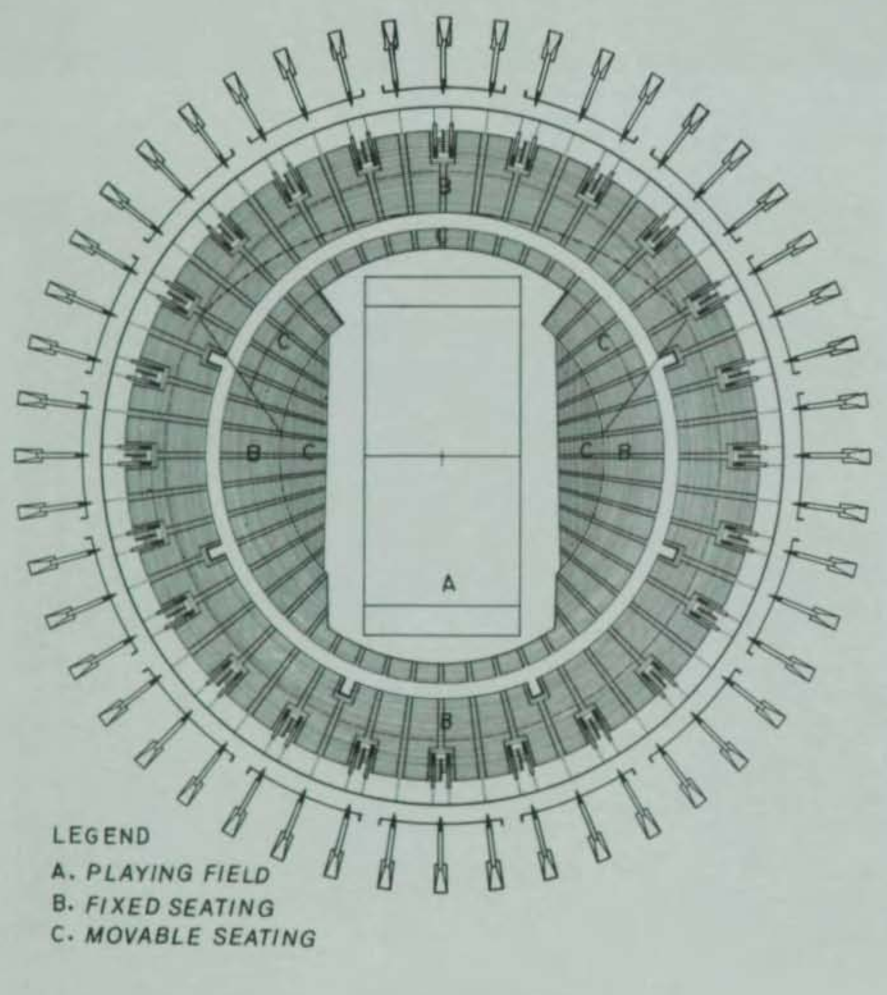
Structure

For a dome of this size the structural frame consists of 48 identical trapezoidal shaped hollow steel arches, spanning from buttresses at the base to a ring connector near the apex. The arches are interconnected by 12 concentric rings of intermediate steel braces. These braces are fixed to both sides of every arch and field connected at mid-points between arches.

To cover the frame, 11 concentric rings of conoidal monitors are located between the top and bottom bracing rings. Each ring has 48 identical conoids. The conoid is a geometrical form generated by moving a straight line over another straight line and curve. In this application the curved end is a glazed arch and the curved surface, being constructed of straight lines, can be fabricated from a variety of standard building materials, such as concrete, steel, wood, or reinforced plastic. To stiffen and roof the remainder of the frame, a diaphragm following the curvature of the arches extends above and below the top and bottom bracing rings. Both diaphragms also have 48 identical panels.



Cross section through hollow arch and monitor



Seating arrangement for football games

Economy and Construction

In the consideration of such a project, cost is of particular concern. Economy of construction would be accomplished by a combination of the repetitious use of identical building components, prefabrication, simplicity of details, and ease of erection.

During the construction of the buttresses and foundation work, the large hollow arches with their intermediate braces can be shop-fabricated in portable sections. They would be delivered to the site, assembled to full size, and raised into position. Elsewhere on the site the conoids and diaphragms would be prefabricated. While on the ground they would be weatherproofed and glazed. Upon completion of the frame, the conoids and diaphragms would be lifted into place like giant shingles. Waterproofing the joints would complete the structure.

Lighting

Traditionally, monitors and skylights have been used in various building types to provide direct natural interior illumination. Due to visual discomfort and vision interference resulting from direct glare, the quality of this light has often been unsatisfactory.

Here, conoidal monitors are employed to provide a glare-free natural light wash over the dome's ceiling. The curvature of the conoid provides a continuous low contrast surface over which light can wash evenly. The glazed walls of the monitors face the center of the dome; for this reason, the light sources are hidden from direct view. Furthermore, through the use of translucent glazing panels, the light from the few visible sources will be diffused and glare-free. The resulting interior effect is that of medium brightness indirect illumination, with a relatively even glow over the entire ceiling.

Against this background, a baseball player, for example, will be able to follow a hit or thrown ball without losing it in the glare of exposed skylights, or in the maze of structural network above.

In addition to the natural light, supplemental artificial illumination would be included for localized spot lighting where required. Also, by installing high intensity light fixtures in the monitors, an effect similar to that of natural illumination may be reproduced artificially for twilight and evening events.

A Better Buy for Buick

Architect: Sachs Associates Inc.
Southfield, Michigan
Structural Engineer: Harold R. Wright
Livonia, Michigan
General Contractor: Perfection Building Co.
Southfield, Michigan

Sometimes imposing design criteria can work as well for an architect as being given carte blanche. A case in point is the Tamaroff Buick-Opel auto dealership in Southfield, Michigan. The facility, which includes display, sales, and service areas for new and used cars, is an attractive departure from the conventional dealership complex.

Design Requirements

The architect was faced with site, design, and budget limitations.

First, the site was located on a high speed, busy major highway directly across from the main entrance to a regional shopping center mall.

Next, the program included the following:

- Initial construction programmed for delivery of 800 new cars per year with provisions for expansion to accommodate up to 1,200 new cars per year.
- A master development plan comprising display, sales, and service facilities for new and used cars. (A separate used car sales office to be built therein, but at a later date.)
- Minimum space requirements for the various activities to be housed were predetermined by General Motors standards.
- A pre-designed, free-standing dealership sign package (part of the national dealership program) to be incorporated into the design regardless of other dealership identification.
- Approximately 175 new cars (with no two alike) would be kept in stock. Design should allow the display of as many of these cars as possible.
- Automobile display should be available to the general public at all hours of the day and night, whether the dealership is open or closed.

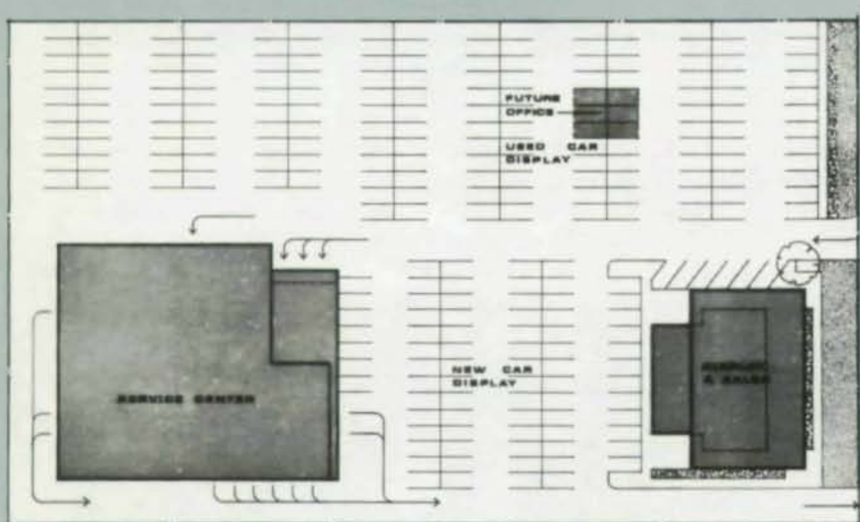
Finally, the plant, site development, and architect's fees could not exceed \$13.50 per square foot of building area.

Site Development

Program studies and the owner's management considerations indicated that a complete separation of the Display-Sales Building and Service facility would be desirable. This would provide the additional benefit of the creation of a prominent space between the buildings for automobile display. The space so created would be visible from the Display-Sales Building and through the glass wall front of the write-up area and customer lounge of the Service Building. Customers waiting for service would then be exposed to the displayed new cars.

Building Development

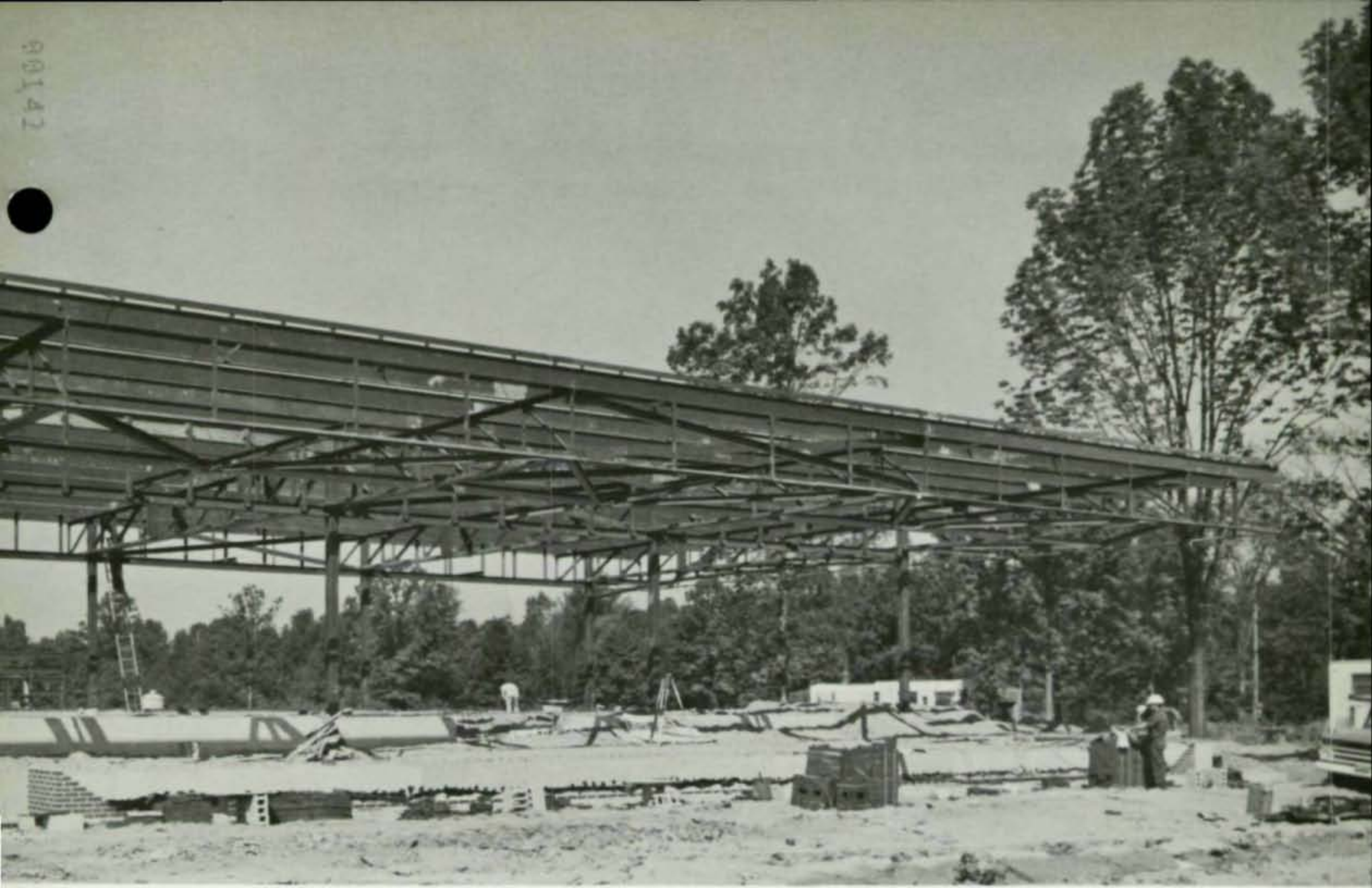
The idea of establishing an outdoor display area available to the public for the full time viewing of automobiles was carried over to the Display-Sales Building itself by creating an outdoor patio to surround the indoor showroom, the roof of which would completely cover the display area providing a means of protecting the customers from the weather while housing the necessary lights and infra-red heaters. To reduce competition between the automobile display (the primary function of the Display-Sales Building) and the building itself, a simple cantilevered rectangular "floating" form was elected as the roof shape.



Site plan

This shape was considered strong enough to attract attention, provide a background for a dealership identification sign (that could be read from the mall entrance across the highway) and protect the customers from the weather, while remaining simple enough to avoid competition with the display beneath it. At the same time the building serves as a frame or a backdrop for that display.

In order to provide maximum viewing of the display automobiles from the highway and the mall, parking of customer cars was prohibited (by design) from the front of the Display-Sales Building. The outdoor display patio itself was raised 30 in. above the street level while the indoor showroom was raised an additional 18 in. above that. Structural decisions and finishing material selections were made in accordance with the dictates of the economic considerations of the development in terms of the requirements of the elected design.



Steel Framing

The desired results could best be realized by employing a structural steel framing system that would allow a maximum flexibility of interior and exterior display spaces while maintaining economy in construction. Supported by eight slender columns, the roof of the Display-Sales Building appears to float in space. The inside showroom, measuring 85 ft x 41 ft and containing 3,485 sq ft, is completely column free. The roof cantilevers 24 ft in front and 12 ft on each side of the building creating a protected outdoor display area of an additional 3,600 sq ft.

The Service Building was to be designed for maximum flexibility as the methods and practice of automobile service and repair will probably drastically change in the next few years. The ever-increasing cost of labor; the advent of electronic engine diagnosis; the creation and use of disposable, component-type ignition, electric, heating, air conditioning, etc. distribution and control systems (as opposed to the current use of individual parts) would soon replace the present time-consuming, "handicraft" procedures. As many provisions for accommodation of these changes as could be incorporated into the structure were to be included therein, including column free interior space, extra high bays, extra electrical and lighting capacity, and consolidation of all utility entrances at the front of the building so that the rear can be expanded at will, with little or no inconvenience or shutdown time in the operation of the facility.

Steel again was considered the obvious answer to the framing problems and a series of 70 ft long by 5 ft deep roof trusses were employed on 24 ft centers (providing two 12 ft auto stalls between trusses) as the main framing system. A rigid bent bracing system was used instead of the more traditional cross bracing in order to more effectively utilize the space between the trusses for servicing cars on repair lifts. This device, incidentally, provided an immediately rigid structure during the construction process which completely eliminated the sway hazards normally encountered by erection crews.

The original design of the Service Building contained 24 maintenance and 10 bump shop stalls. The facility can be readily expanded by extending the column and truss construction at the rear of the structure. The wisdom of incorporating features that would facilitate expansion has already been proven by the fact that, having been open for business less than a year, a 20,000 sq ft addition is already being planned.

There are 200 kips of structural steel in the complete project.

Cost of all structures, site improvements, and architect's fees was $12.60 per sq ft of total enclosed building area (excluding exterior display patio) or $11.40 per sq ft of total enclosed and covered building area (including exterior display patio).

U.S. Steel Looks to the Future

Architect: Frank L. Whitney
New York, N. Y.
Structural Engineer: Walter Kidde Inc.
New York, N. Y.
General Contractor: Mellon-Stuart Company
Pittsburgh, Pa.
Steel Fabricator: American Bridge Division,
U. S. Steel Corporation
Pittsburgh, Pa.

In addition to being a functional research facility, U. S. Steel's Chemicals Research Building and Pilot Plant, in Monroeville, Pa., is aesthetically the focal point for displaying the client's number one product.

The challenge of the project was the proper blending of site and function — and the aesthetics of rhythm, proportion and scale — into compositional harmony with the existing buildings. The structure itself was required to transmit a feeling of innovation.

A hilltop location, undermined by years of coal mining operations, made it necessary to set the lower floor of the building below grade so that the amount of material excavated would equal the weight of the structure.

The three-story structure therefore presents the appearance of a two-story building when viewed from the main entrance and approach road.

The office/laboratory building, designed as an envelope of transparent and opaque solids and voids, is wrapped in a skin of steel and glass. It is sheathed in a curtain wall of both painted and stainless steel, with windows of gray-tinted heat-absorbing glass set in black moulded elastomeric gaskets.

In strong contrast with the mirrorlike envelope is the deep, rich, earthy color and textured oxide patina of exterior beams, girders and columns of weathering steel. These members, which are bold in character, economical and maintenance-free, further accentuate the peripteral structure of the building.

The quadrilateral peristyled structural frame becomes the visible expression of structural steel.

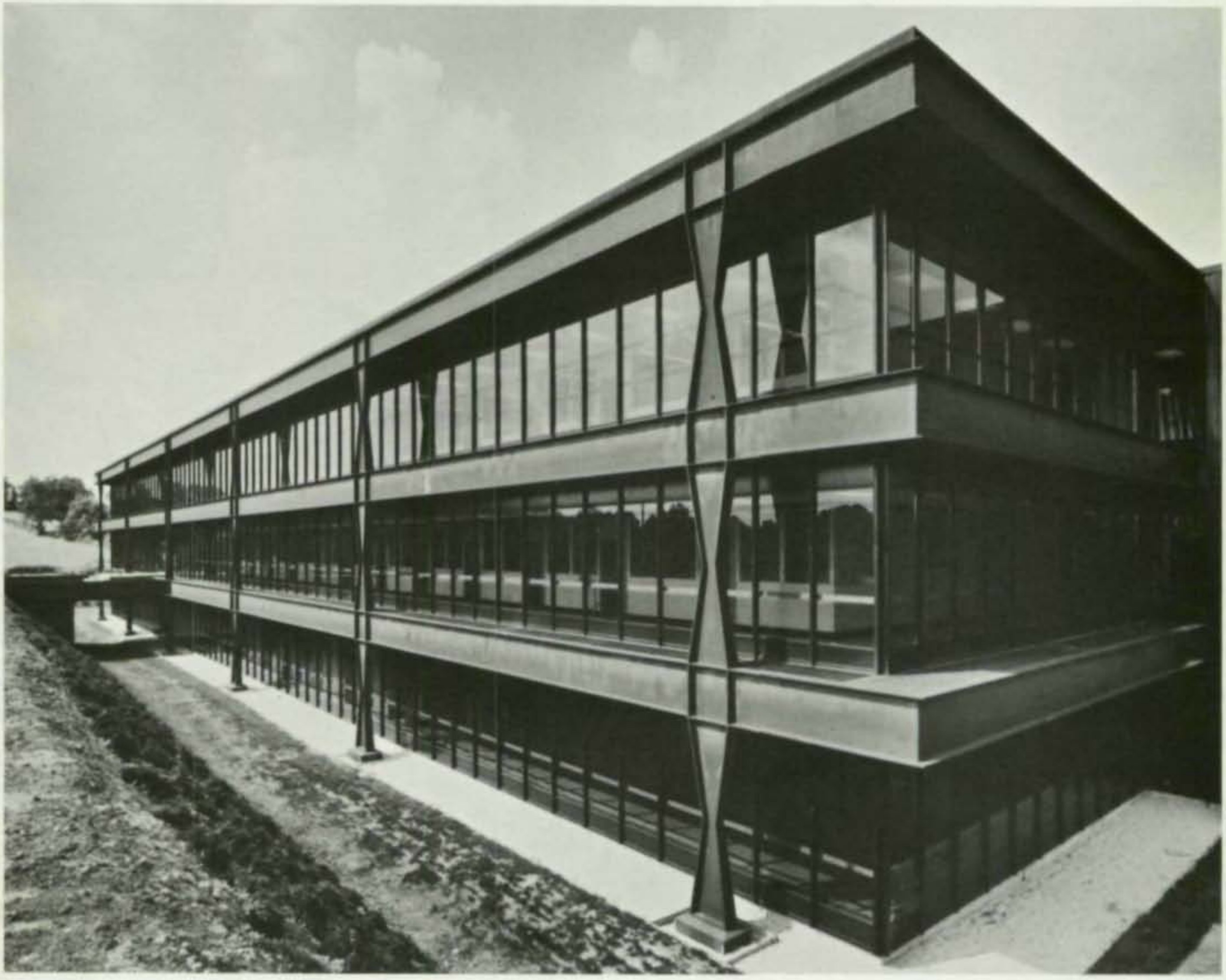
Column configurations reflect an aesthetic rationalization of the engineered wind and eccentric vertical load analyses.

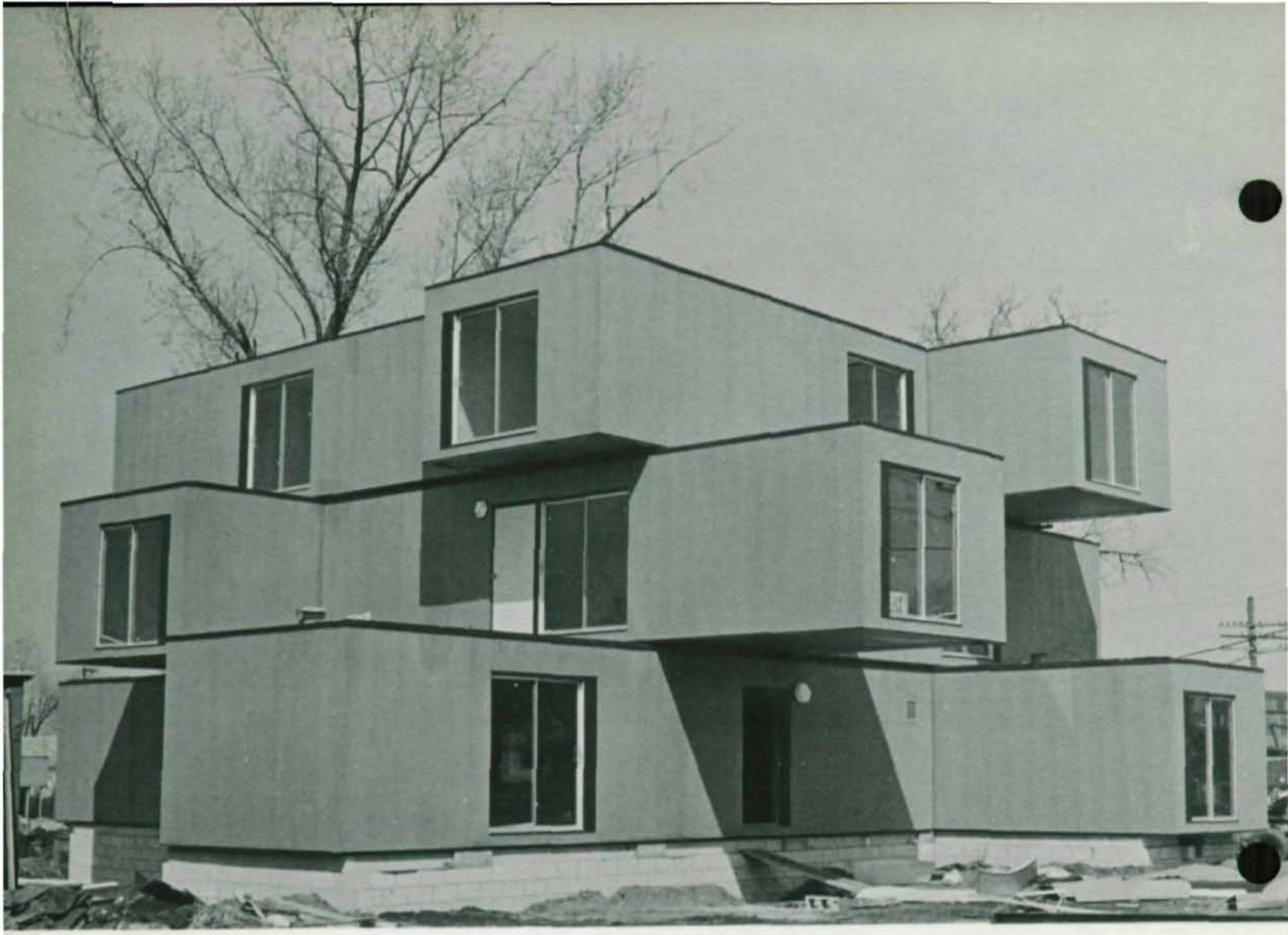
A 12-ft laboratory module and a nonrestrictive building code helped to set up the design criteria expressing a 24-ft interior structural bay of non-protected painted steel columns. The exterior features 48-ft bays of non-protected weathering steel superstructure.

Perimeter personnel corridors, visually open to panoramic views, encircle the inner core of office and laboratory modules. The 8-ft wide passageways, functionally serving as a zoned weather buffer, create a "commons area" — conducive to discussion and interchange of ideas — desirable and necessary in today's research facilities.

A skin of ribbed-steel sandwich-wall construction encloses the sparsely populated Pilot Plant. Here, where the major internal functions change and more restrictive building code requirements specified explosion release walls and protected superstructure members, the architectural expression changes from open to solid and from transparent to opaque.

In the overall concept, rich black ribbed-steel siding was used to complement, by contrast, the weathering steel.





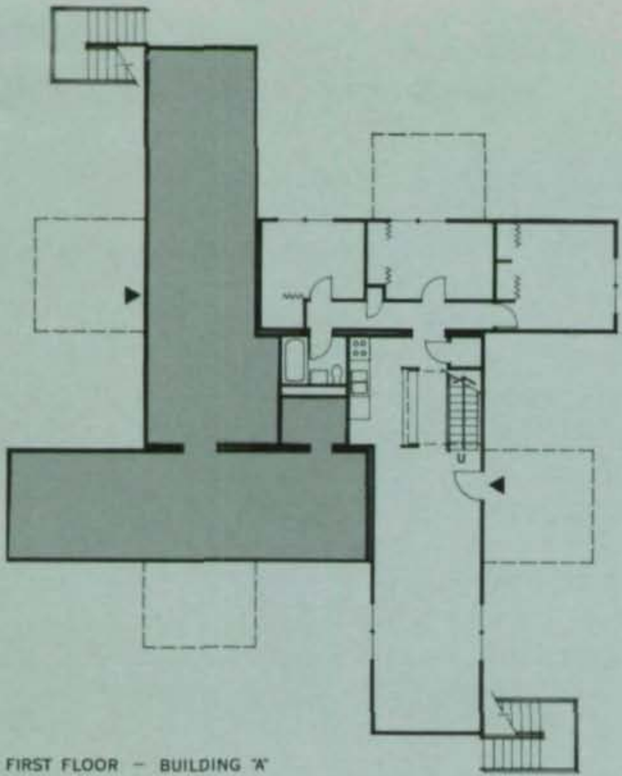
Modular Building Blocks

Architect: Office of Ronald Goodfellow
Michigan City, Indiana
Structural Engineer: Jorge N. Avila
Michigan City, Indiana
General Contractor: Tonn and Blank, Inc.
Michigan City, Indiana

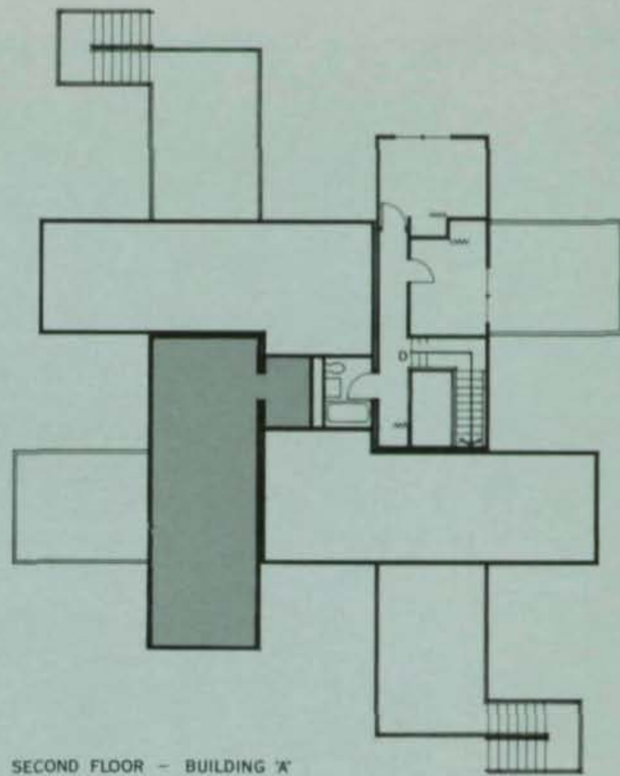
Earlier this year the Department of Housing and Urban Development moved to revive the staggering housing industry by supporting experimental building projects. Government interest spurred designers and builders to produce a diversity of concepts in housing demonstration projects.

One project in Michigan City, Indiana demonstrates the application of modular building techniques to the construction of multi-family dwelling units. Six apartments comprise the experiment: two 3-bedroom, two 4-bedroom and two 5-bedroom units.

Both the structure and the enclosing shell were designed for the characteristic assembly line procedure used by mobile home manufacturers. The three



FIRST FLOOR — BUILDING 'A'



SECOND FLOOR — BUILDING 'A'

FIVE BEDROOM APARTMENTS

for Low Cost Housing

primary manufactured components are a 12-ft square core unit containing kitchen, baths, and utilities, a rectangular living-dining and bedroom unit, both adjacent to the core.

Steel Framing

Steel was chosen as the structural and enclosing material for its high strength to weight ratio, applicability of mass production techniques, and non-combustible properties. The structural qualities of steel permitted the modular units to be designed as independent structural elements allowing cantilevers of up to 12 ft. This system allows for private outdoor patios for each apartment, protected by the overhanging cantilever of the units above.

To meet the requirements of the BOCA Basic Building Code type 2B construction, a protective, non-combustible ¼-in. intumescent coating was used to obtain the required fire rating. The module enclosure consists of non-combustible steel panels used for walls, floors, and ceilings. The shell system has substantial capacity for load bearing and membrane action.

Each module is a completely finished, independently structured, and enclosed element. The only connections between adjacent modules not part of the same apartment are at the column bearing points and at lateral connections with the core. Other than this, each is structurally and acoustically isolated from the others.

Construction Time Reduced

Finished modules were hauled by truck to the construction site where the bedroom and living-dining modules were assembled around the cores in pinwheel arrangement. By reversing the pinwheel, decks were created at the upper levels.

On-site work was reduced to a simple sequence: preparation of foundations, installation of utilities in trenches to the point of connection at the utility cores, positioning and connecting the manufactured dwelling components, installation of exterior stairs, walks, and drives. The economy of the system derives from assembly line fabrication and minimum on-site construction time.

1970 ARCHITECTURAL AWARDS OF EXCELLENCE

▲ **WELLESLEY OFFICE PARK BUILDING NUMBER FOUR,** Wellesley, Massachusetts
Architects: Pietro Belluschi and Jung/Brannen Associates Inc.

▲ **TEMPLE B'NAI JESHURUN,** Short Hills, New Jersey
Architects: Pietro Belluschi and Gruzen & Partners

▲ **GRT CORPORATE HEADQUARTERS BUILDING,** Sunnyvale, California
Architect: Brown/McCurdy/Nerrie

▼ **MANUFACTURERS HANOVER TRUST CO. OPERATIONS BUILDING,** New York, New York
Architect: Carson, Lundin & Shaw

▼ **CURRIGAN EXHIBITION HALL,** Denver, Colorado
Architects: (Joint Venture) Muchow, Associates, Architects
Haller & Larson, Architects
James T. Ream

▲ **NEW ENGLAND CENTER FOR CONTINUING EDUCATION**
Durham, New Hampshire
Architect: William L. Pereira Associates

▲ **KNIGHTS OF COLUMBUS HEADQUARTERS**
New Haven, Connecticut
Architect: Kevin Roche John Dinkeloo and Associates

▲ **HAZEL HOTCHKISS WIGHTMAN TENNIS CENTER,** Weston, Massachusetts
Architect: Sasaki, Dawson, DeMay, Associates Inc.

▼ **BANK OF AMERICA WORLD HEADQUARTERS**
San Francisco, California
Architects: Wurster, Bernardi and Emmons, Inc., Architects
Skidmore, Owings & Merrill
Pietro Belluschi (Consulting)

▼ **FIRE STATION NO. 30,** Kansas City, Missouri
Architect: Seligson/Eggen, Architects, Planners, Designers

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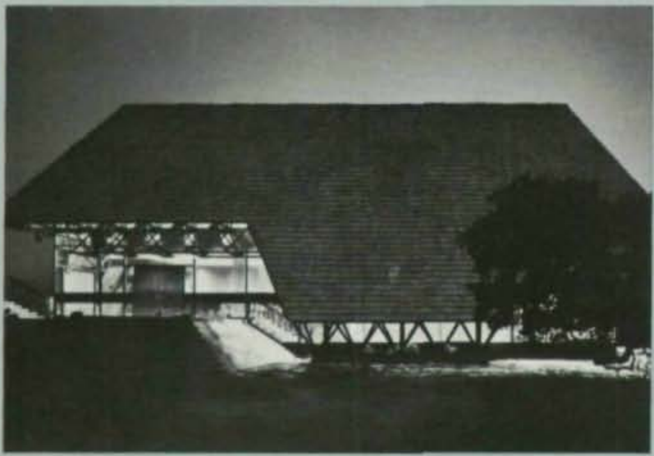

▲ **FRANK C. BISHOP LIBRARY,** Monterey, California
Architect: Smith Barker Hanssen

▲ **JADWIN PHYSICAL LABORATORY, PRINCETON UNIVERSITY,** Princeton, N. J.
Architect: Hugh Stubbins and Associates

▲ **FARM CREDIT BANKS OF SPOKANE,** Spokane, Washington
Architect: Walker/McGough/Foltz

▲ **PERFORMING ARTS CENTER,** Milwaukee, Wisconsin
Architect: Harry Weese & Associates