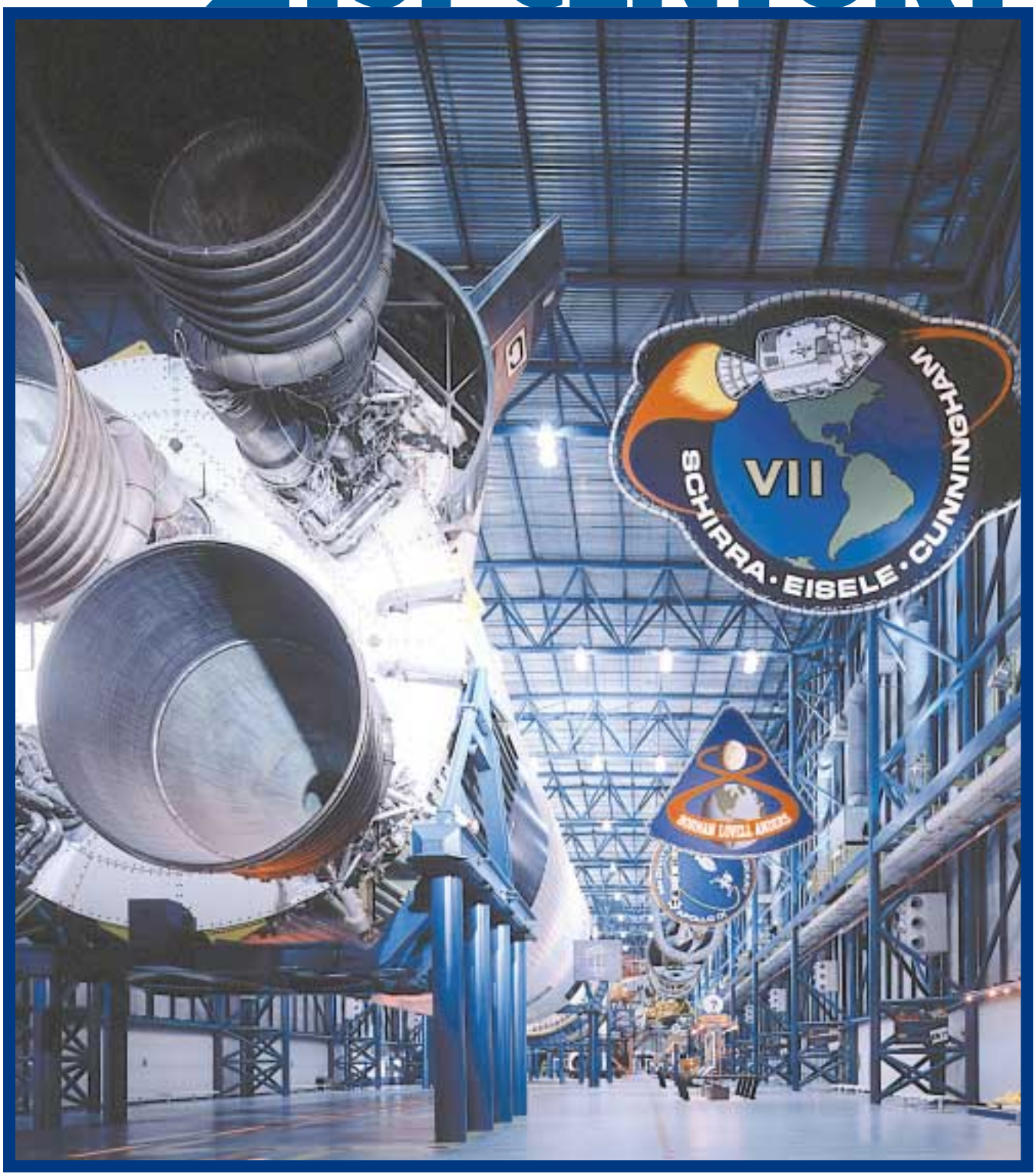
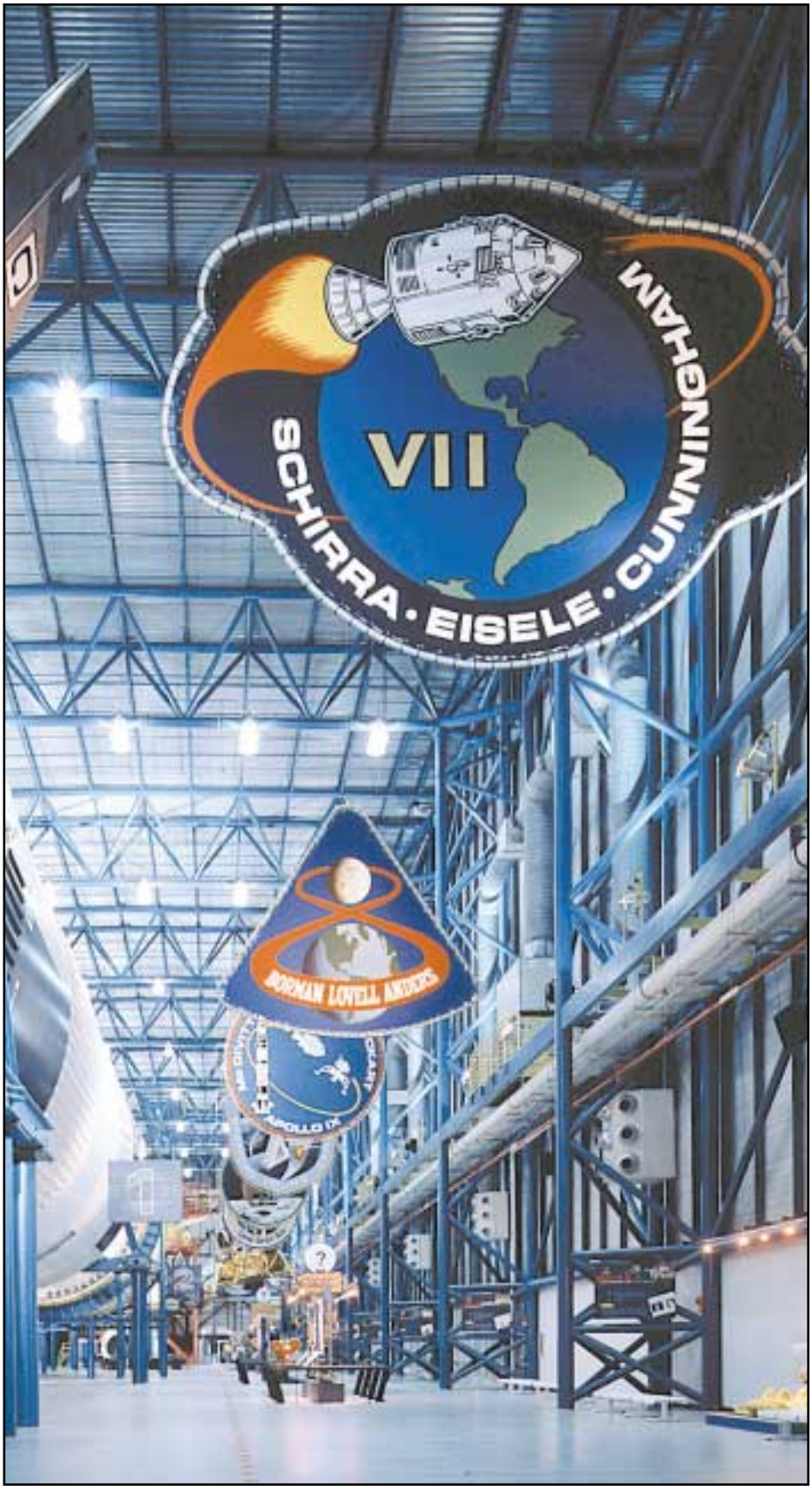
HSS: DESIGNS FOR THE 21st CENTURY



Apollo/SaturnV Visitors Center

STRENGTH, APPEARANCE OF HSS HELP DESIGNERS CREATE AN ENCLOSED SPACE TO HOUSE TRAVELERS FROM OUTER SPACE



670 Tons of HSS Form Sturdy Framework for Apollo Visitor Center

It's been more than 30 years since the Apollo astronauts thrilled the world by walking on the surface of the moon. While the emphasis has shifted to space shuttle exploration, the moon walk, for many, remains the defining moment of America's space program.

The Saturn V rocket that carried the astronauts to the moon has been a popular attraction at the Kennedy Space Center for many years but, because of its size, was displayed outdoors. Today it's the centerpiece of a 100,000-square-foot Apollo/Saturn V Visitors Center opened in 1995 which utilizes the strength, appearance and cost effectiveness of steel Hollow Structural Sections (HSS).

The heart of the Visitors Center is a 45,000-square-foot enclosed monumental plaza in which the Saturn V is displayed. It also includes two 400-seat theaters and exhibits displaying a number of artifacts from the Apollo era. The $23.5-million facility is located on a waterfront site and also serves as NASA's VIP observation point for launches.

Morris Architects of Orlando, Florida, was the architect of record for the Visitors Center, working with the design architect, Architectura of Vancouver, B.C. Another Orlando firm, Tilden Lobnitz Cooper, was the structural engineer and also provided mechanical, electrical, plumbing and fire protection engineering.

Huge Size of Rocket a Structural Challenge

"Our challenge," says Gerald Koi, Managing Principal for Morris Architects, "was the extraordinary height and breadth of the structure needed to house the huge rocket and withstand the hurricane-force

winds that periodically strike Cape Canaveral. We wanted to design a building that would historically display the rocket, lunar landers and other artifacts. We chose a concept based on the vertical assembly building at the Cape—the warehouse-type structure where rockets were put together and made ready for transport to the launching pad."

The resulting structure is 500 feet long, 90 feet wide and 90 feet high, enclosing 3,375,000 cubic feet of space. It required a frame with the strength to support the structure's roof, with no center columns to interfere with the display of the Saturn V, but within the cost guidelines established for the project.

Triangular Configuration Lowers Trusses' Costs

The answer was what Koi describes as a "space framed truss-and-column structure." The initial design called for four-post column trusses, but cost constraints caused by the high construction costs in central Florida at that time sent structural engineers back to the drawing board. They developed a three-post design and added cross bracing at the first grade level clear span that lowered costs and was more efficient from a bracing standpoint.

The structure's frame utilizes 670 tons of HSS. Its major truss columns are 12" round HSS with a wall thickness of .375", connected by a web of 8" and 6" round HSS with .280" walls. Two chords of each column abut the building's outer wall, with the third chord inboard. Roof trusses were of the same HSS sizes and triangular configuration, with two upper chords and one lower chord. The truss columns are placed on 45-foot centers and are diagonally cross braced.

One end of the structure has an inverted U-shaped frame composed of triangular HSS column assemblies on either side supporting a HSS truss assembly. The wall is largely glass, affording a panoramic view of the Saturn rocket displayed within.

The HSS columns supporting the structure's walls became the main frame structure to which catwalks, piping, chilled water lines and other services were attached in keeping with the concept of an industrial assembly warehouse.

Hurricane Exposure a Major Consideration

"From a structural standpoint, the biggest challenge was to meet hurricane wind design criteria," says David Griffith, Division Director and a Principal for Tilden Lobnitz Cooper. "We had to come up with a structural scheme that would be architecturally pleasing and would be stiff enough to handle the deflections and movements from the high winds that could be anticipated." The HSS truss column design proved ideal in both regards.

"The configuration of the columns and roof trusses gave us good rigidity," Griffith says, "and this was further bolstered by the fact that all connections were welded. So we had a very rigid tubular steel frame that became very much a part of the bracing design."

The structure is designed to meet wind loads of more than 120 mph, surpassing the code requirements of that time which called for 110 mph.

Referring to the HSS column trusses, Griffith notes that "architecturally I think they're quite attractive. Once they've been painted, they're pretty much maintenance free. Their strength was certainly tantamount in keeping the member sizes down. They'd have been considerably larger if we had used some other type of structural member."

Truss-and-Column Design Cost-Effective

Koi adds that the cost of the truss-and-column structure was compared to other systems including a conventional space frame and proved more cost-effective. "It also let us keep the column spacing to 45 feet, which was required to provide adequate exit from the Firing Room

Theater to the dramatic Saturn V Plaza and other adjacent parts of the Visitors Center."

Griffith points to one other way that HSS is used—as cribs and cradles to support the massive Saturn V. The rocket's fuel section rests on cribs supported by 20" and 14" round HSS with .500" walls. "Corrosion and weather had so weakened the command and service modules that we had to devise a cradle suspended from the roof structure in which we could lay them." That cradle utilized 6" x 8" rectangular HSS with .312" walls.

In addition to Morris Architects, Architectura and Tilden Lobnitz Cooper, other principal participants in the Visitor Center project included the civil engineer, McFerrin/McCrone, Inc. of Titusville, FL; the geotechnical/technical engineer, Professional Service Industries of Winter Park, FL; the landscape architect, Glatting Jackson Kercher Anglin Lopez Rinehart of Orlando, FL; the general contractor, W & J Construction Corp. of Cocoa, FL; and the show and exhibit designer, BRC Imagination Arts of Burbank, CA.

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