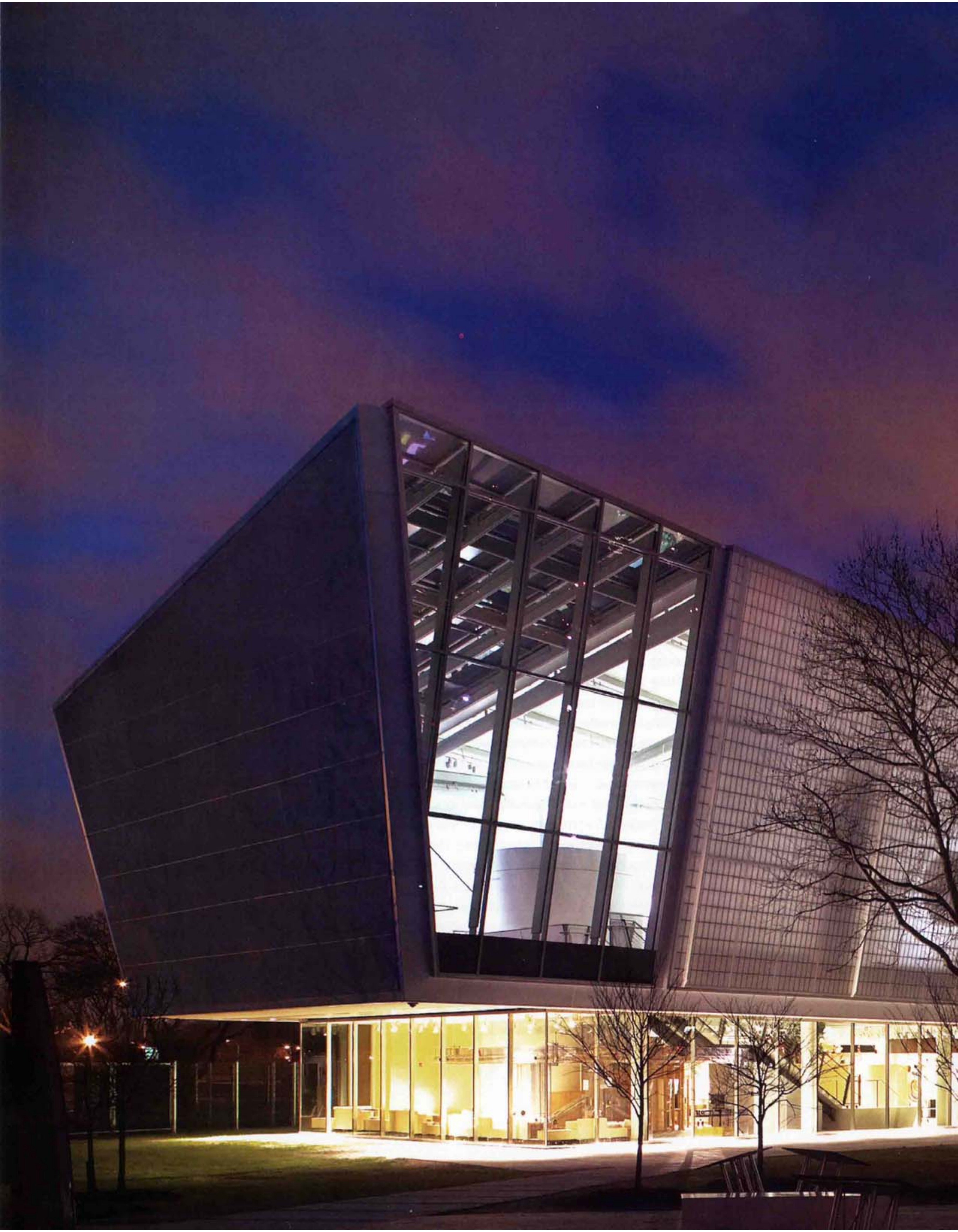


NEW YORK HALL OF SCIENCE EXPANSION

A Steel Structure Becomes Part of the Exhibit

When the Hall of Science, a hands-on science museum in Queens, hired Polshek Partnership to expand their cramped facility, the architects were faced with a series of challenges both design oriented and logistical. "The directors of the Hall of Science wanted to leverage the expansion as a science lesson," notes Guy Maxwell, Polshek Partnership project architect, "Our answer was to reveal everything—mechanicals, lighting, structure, everything." While deciding on a structural material that would fit in well with this "building as exhibit" concept, the designers arrived at steel, which would allow a tight integration between architecture and structure. In addition, the architects wanted to create a juxtaposition between the new building and the museum's iconic Harrison & Abramovitz Great Hall. Originally built for the 1964 New York World's Fair, the Great Hall is a tall, undulating, cellular concrete frame structure, in-filled with dark cobalt-colored shards of glass. To both contrast and echo the existing structure, Polshek designed a long, low shed-type building with an exposed steel structure enclosed in Kalwall—a fiberglass panel system that resembles a giant shoji screen. "Both facilities let light in," continues Maxwell, "but the Great Hall is a dark, cathedral-like space, whereas the new addition is much lighter and brighter."

Logistically, soil conditions on the site were very poor; and since it was a public project, developed jointly by the museum, the City of New York Department of Design and Construction, and the City of New York Department of Cultural Affairs, the budget was minimal. Erection of the addition needed to be completed on a rapid schedule and there was no time for the major excavation needed to reach bedrock. So, from this perspective, the choice of structural material was obvious: Steel offers

a structural system light enough to handle poor soil conditions without extensive foundations and can be erected more quickly than other alternatives, such as reinforced concrete construction.

The 225-foot-long-by-50-foot-wide expansion, known as the Hall of Light, hovers above the ground on a glass-clad first floor whose walls are set back from the floor plate of the main, Kalwall-clad volume. "The structure of the Hall is basically a moment frame construction turned on its head," comments structural engineer Daniel Sesil, Leslie E. Robertson Associates' (LERA) principal-in-charge of the project. Columns are bolted into the Grade 50 18W119 girders—spaced on 20-foot centers—that comprise the floor and support cantilevers created by the first-floor setback. At its end, the Hall hangs 25 feet off its base and at this point the girders are replaced by much larger members, 40W227s and 40W436s.

To introduce dynamism to what would otherwise be a rectangular box, the designers created a pitch in the roof that runs diagonally down the length of the building and creates a series of skewed planes. This generated varied wall heights so each column had to be custom fit. In response to this need, Polshek and LERA developed a steel member fabricated from cut 50 ksi 30W124 wide flange beams with 4-inch 36 ksi steel pipes welded to the cut web edge. "Every member is the same size," mentions Maxwell, "which saved money in fabrication, only they're cut at a different places along the bottom, depending on the height of the roof at that point." Furthermore, these members reinforce the structural "lesson" of the building. "Each column is moment connected to the girders on the floor," says Sesil, "and that's where most of the bracing against wind resistance takes place. That's why the columns taper as they go up."

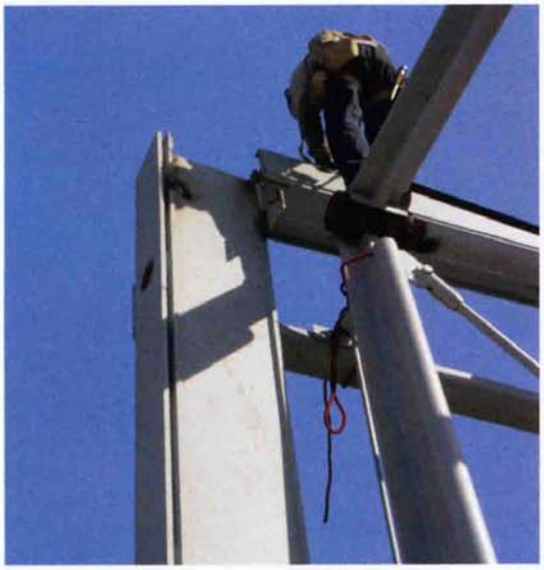
King post trusses, composed of wide flange top chords, 4-inch pipe posts, and 1/4-inch diameter rods for bottom chords, support the roof. The top chords of the trusses are similar in form to the columns—a cut wide flange with a pipe welded to the web—except they're cut from lighter beams: 27W129s. As with the columns, this allowed for a more affordable fabrication, with each top chord fabricated from the same geometry, only cut at a different place to meet the diagonal pitch of the roof. The rods that run from the king post back to the wall also add to the flexibility of the system. They are high-strength rods, the same material often used as rock anchors in concrete construction, but smooth and fretted at the ends. Says Sesil, "We used this material because you could get them in lengths of up to 50 feet," or the exact width of the Hall. The rods thread into receiving couplers at the edges and are anchored through the top chord of the truss by means of a sheave. To make the roof structure more robust, a 1 1/2-inch structural strand cable catenary runs the length of the Hall through the bottom of each king post, providing an alternate load path between pieces.

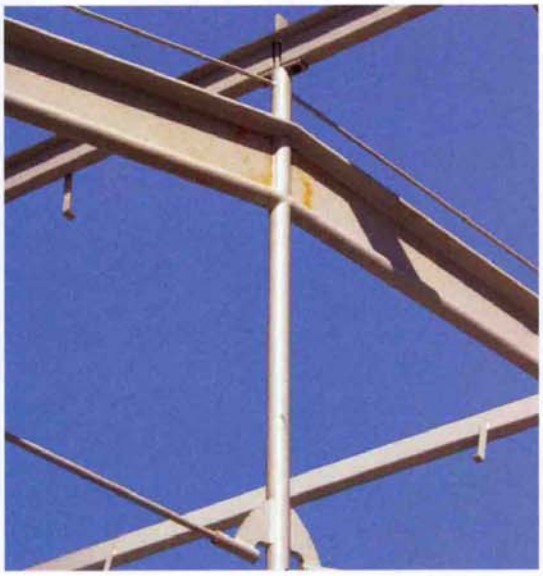
PREVIOUS The addition's expressive steel structure and translucent cladding give the Hall it's name.

ABOVE Custom columns and king post trusses fabricated from the same geometry accommodate the addition's varied wall heights and skewed ridgeline.

Steel offers a structural system light enough to handle poor soil conditions and can be erected more quickly than reinforced concrete construction.

ABOVE Where the addition cantilevers 20-feet off it's base on steel girders, a system of steel plate bents takes over the framing.



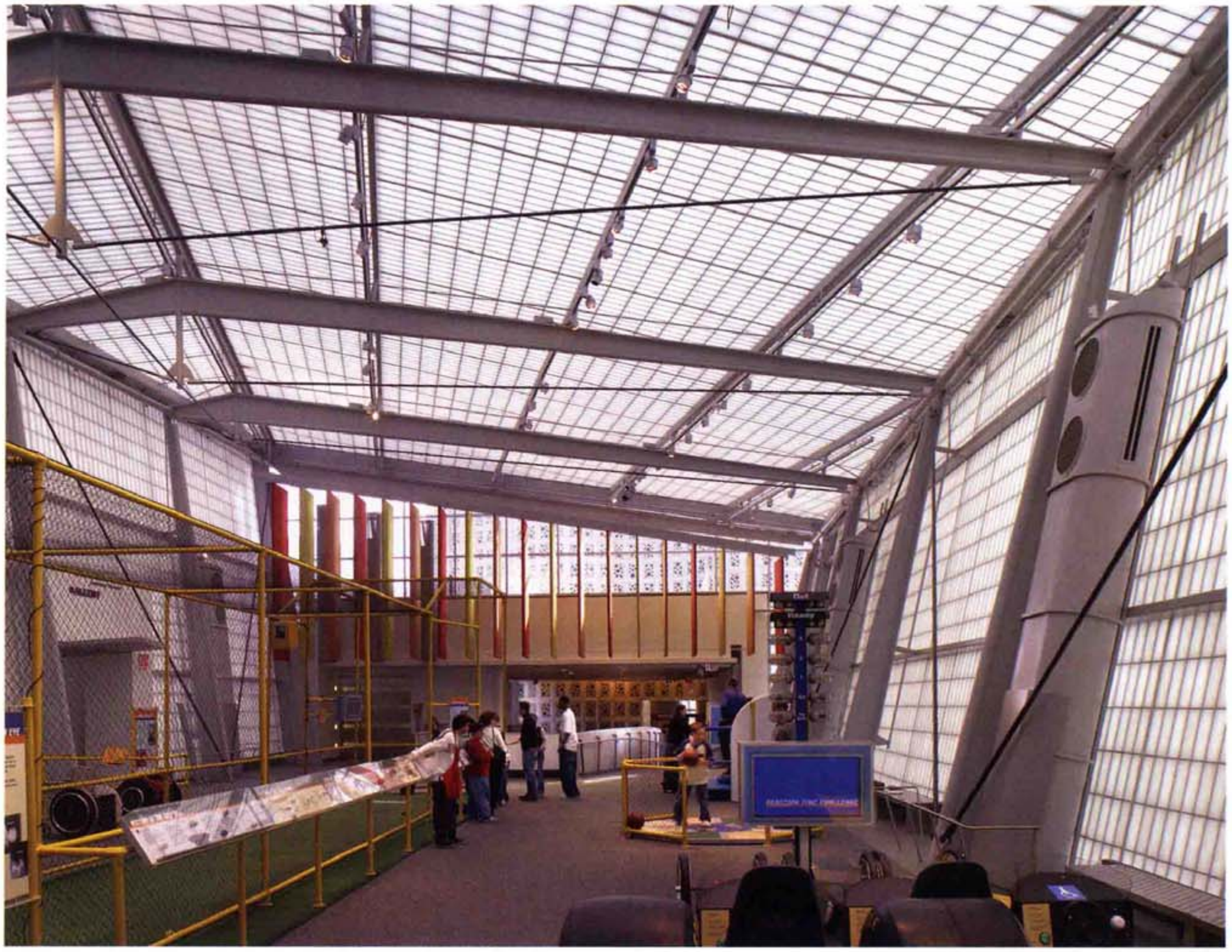


TOP AND MIDDLE LEFT Trusses were site welded to 8-inch pipes running along the top of the columns.

MIDDLE RIGHT The king post trusses are composed of cut wide flange beams, 4-inch pipes, and 1/4-inch-diameter high-strength rods.

BOTTOM The structure's primary bracing against lateral forces takes place at moment connections between floor girders and column bases.

OPPOSITE The Hall's exposed steel structural system presents a visible lesson on structure.



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The trusses were fabricated in one piece and then craned into place on site. The connection between truss and column consists of a box at the end of each truss that, like a hand, rests on an 8-inch tube at the top of each column and is then welded. Since there are no bolts in the connection, an adjustable base was needed to meet construction tolerances: During erection, each column was rested on a rocker plate in a steel box, after which the top of the column was adjusted to meet the tolerance demanded by the truss, and then it was bolted down tight. "That way we didn't need any sliding bolt connection up above," says Sesil.

At the entrance end of the Hall, above the cantilever, the Kalwall cladding gives way to glass and the structural system changes as well. The cut wide flange beams and king post trusses are replaced by steel plate bents, each vertical built up out of two 7/8-inch plates. The glass, Viacrom VE1-2M, highly insulated performance unit, connects to mullions over each vertical. This prismatic end to the Hall lets in direct sunlight to activate a glass sculpture by James Carpenter and allows views to the nearby restored rocket park.

The Hall of Science has always been a place where children and adults alike have learned about science and the world around them in an interactive and fun environment. Now with the Hall of Light expansion, the museum has added a bright and inspiring space whose steel structure embodies the institution's ideals and invites visitors to understand the marvels of modern construction. "The choice of material," says Sesil, "is a reflection of our time." ■

NEW YORK HALL OF SCIENCE EXPANSION

Owner **New York Hall of Science** *Flushing Meadows, NY*
Developers **NYC Department of Design & Construction** *New York, NY*
Department of Cultural Affairs *New York, NY*
Architect **Polshek Partnership Architects LLP** *New York, NY*
Structural Engineers **Leslie E. Robertson Associates, RLLP** *New York, NY*
General Contractor **Bovis Lend Lease** *New York, NY*
Structural Steel Fabricator and Erector **DCM Erectors, Inc.** *New York, NY*
Ornamental Metal Fabricator and Erector **Burgess Steel LLC** *Englewood, NJ*
Curtain Wall Erector **W&W Glass Systems, Inc.** *Nanuet, NY*
Metal Deck Erector **Solera/DCM Erectors, Inc.** *New York, NY*