

# METALS IN CONSTRUCTION

THE STEEL INSTITUTE OF NEW YORK  
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# METALS IN CONSTRUCTION

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FALL 13



CLAIRE TOW THEATER / EMPIRE CITY CASINO AT YONKERS RACEWAY /  
NATIONAL SEPTEMBER 11 MEMORIAL MUSEUM ENTRY PAVILION FAÇADE + STRUCTURE /  
JOHN F. KENNEDY INTERNATIONAL AIRPORT TERMINAL 4 / 51 ASTOR PLACE /  
FORDHAM UNIVERSITY GABELLI SCHOOL OF BUSINESS /  
CAMPBELL SPORTS CENTER AT COLUMBIA UNIVERSITY

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Above Claire Tow Theater at Lincoln Center by H3 Hardy Collaboration Architects.

Cover The ETFE porte-cochère of Empire City Casino at Yonkers Raceway by Studio V Architecture.

## EDITOR'S NOTE

Institutes Sponsor Design Competition

THIS FALL, THE STEEL AND Ornamental Metal Institutes of New York, publishers of Metals in Construction, together with *Metropolis* magazine, are proud to sponsor LIVING CITIES: RESIDENTIAL TOWERS FOR THE 21ST CENTURY, a design competition whose focus is New York City's need to accommodate a projected urban influx of 1 million new residents by 2040. (See this issue's centerfold insert for more information about the competition.) Propelled by societal and economic changes, this dramatic surge in population will create demand for hundreds of thousands of new housing units, many of them envisioned in what are now industrial waterfront neighborhoods. With rising water levels, greenhouse gas emissions, and resource depletion ever-growing concerns, the approach to this challenge is by necessity part of the environmental debate. Buildings today must be more adaptable, resource efficient, resilient, go up faster and last longer, in order to minimize the impact of construction on communities. Increasingly, steel-framed buildings are meeting these requirements when it comes to high-rise commercial, institutional, and office projects. Recognizing its use for sustainable high-rise residential projects outside of New York City, the competition asks submissions to employ a structural steel frame. Design competitions usually have

as their subject a major project that is explicit in its site and program requirements. Since housing an increase of city dwellers of this scale will require constructing scores of projects throughout the five boroughs, no specific site is being identified and only the outlines of a program are drawn. At issue is how to go about this without consigning our streets to unending construction or our environment to harmful carbon emissions. The winning team will unravel this challenge, addressing all the issues and integrating their unique elements to provide a harmonious, inter-related solution. In doing so, it will demonstrate the interdisciplinary knowledge and collaborative skills that underpin innovation in the 21st century. Are you that team?



*Just,*

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# Claire Tow Theater

To bring downtown theatrical innovation onto Lincoln Center's dignified uptown campus, Hugh Hardy's H3 and Severud Associates executed a tricky high-wire act atop the roof of Eero Saarinen's iconic building. With a prominent framework of steel trusses and an elegant aluminum grille, the new Claire Tow Theater is riding high.

THE LINCOLN CENTER ARTS complex has done many things superbly over the decades, including upgrading its own form. But there's one thing it is not renowned for, at least not yet: developing fresh talent. Productions at Lincoln Center Theater (LCT), either the 1,080-seat Vivian Beaumont Theater or its downstairs neighbor, the 290-seat Mitzi E. Newhouse Theater, are generally works by playwrights and directors who have already arrived. For those on the way up, downtown's black boxes have been the traditional incubators. This uptown-downtown gap, LCT's artistic director André Bishop and executive producer Bernard Gersten have long realized, also separates older and younger audiences and raises the question of where tomorrow's subscribers will come from.

The 2008 launch of the organization's new-talent division, LCT3, addressed this problem, staging new works offsite at first until its permanent home was ready. That venue, a two-story, 23,000-square-foot addition hous-

ing the Claire Tow Theater and situated on the roof of LCT's respected 1965 building by Eero Saarinen, opened last year. Designed by H3 Hardy Collaboration Architecture with structural engineering by Severud Associates, the LCT3 facility represents a careful balancing act on multiple levels. "What we didn't want to do," says H3 principal Ariel Fausto, "was build something up here that would call so much attention to itself that it fought with the existing building."

LCT3 resides within Lincoln Center's 16 acres, yet it is not quite of Lincoln Center. In a sense, it is an outpost of downtown that expands Lincoln Center's definition, requiring a different aesthetic; yet it cannot be as overtly bohemian as its East Village or Williamsburg counterparts without creating untenable visual and social friction. It optimizes the campus's tight real estate footprint by occupying roof space, adding majestic and unprecedented views as well as sorely needed office space for LCT3's operations, yet it needed to avoid compromising the integrity of Saarinen's base building either structurally or aesthetically.

In addition, since that hybrid, multifunctional building—which includes not only the two older theaters but the book stacks for the New York Public Library for the Performing Arts and connects to Gordon Bunshaft's structure for that institution—needed to remain open, construction logistics had to include painstaking work-arounds. Staging was impossible on the public plaza and was confined to the roof and the street, reports Severud principal Cawsie Jijina. "There were actually zero construction disruptions," he



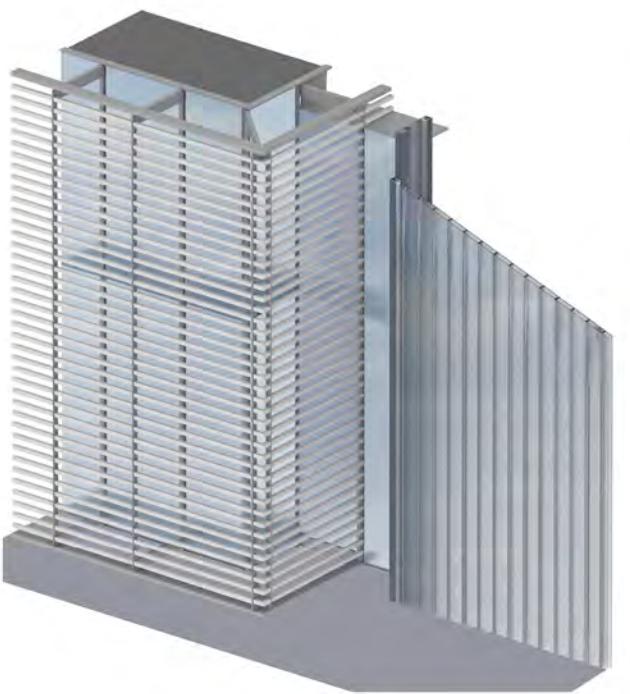
**"There's a real structural authenticity and integrity to what happens here."**

Ariel Fausto, H3 Hardy Collaboration Architecture



This page and facing top A brise-soleil of square aluminum bars shields the theater's north, east, and south sides, contributing to its LEED Silver rating and helping it blend with the Saarinen-designed structure below.

Facing bottom A corner detail of the facade's glass curtain wall and aluminum brise-soleil.



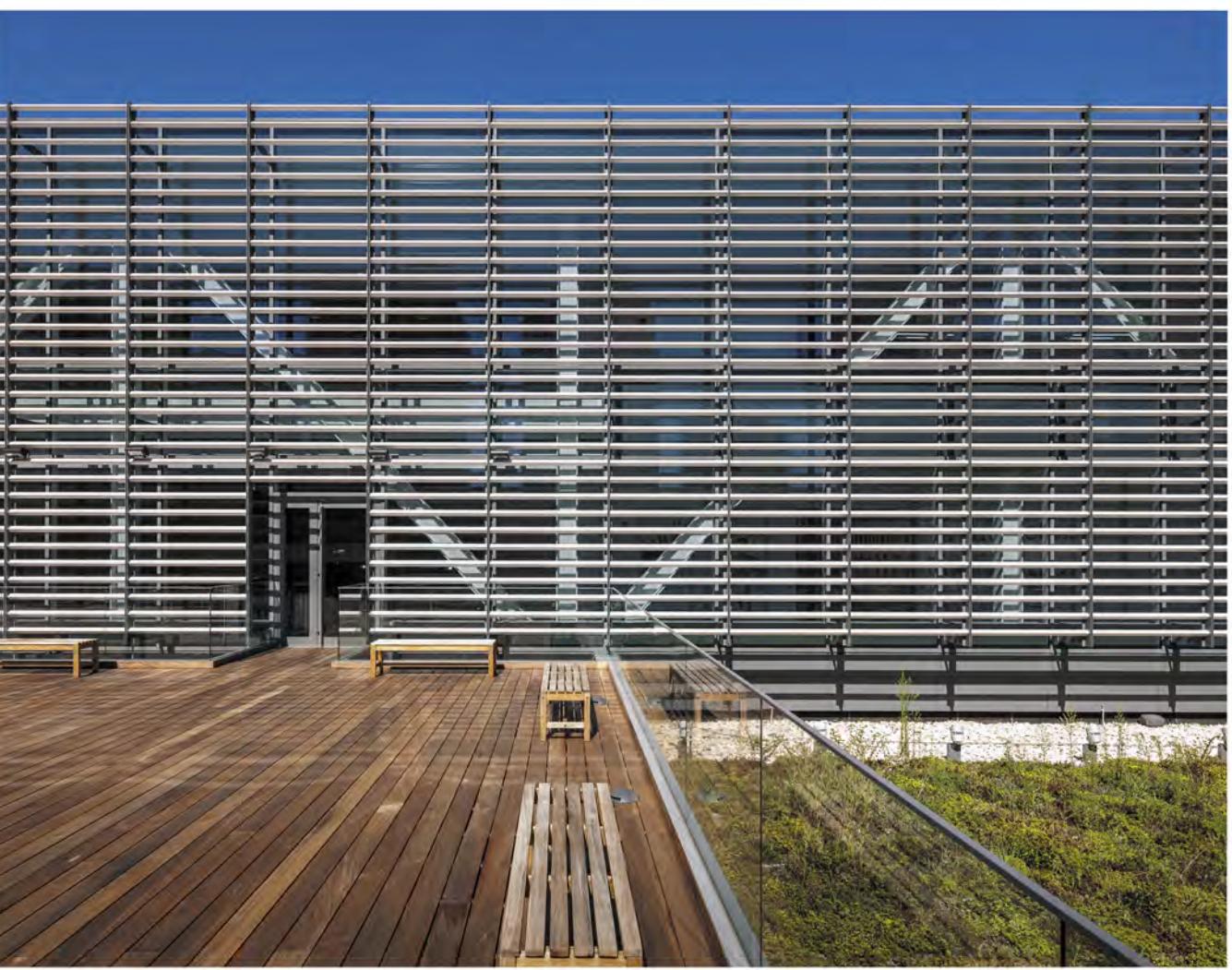
notes. "Our charge was, 'You cannot interfere with the operations of the building.'"

Initially conceived as what Fausto calls "a packing-crate idea, a throwaway theater" that might have occupied concourse space, then planned for the rooftop when that option appeared more viable amid the wider renovations underway around the campus, LCT3 responds to the challenges of its site through fresh variations on some of the themes Saarinen had established. A chief reason Saarinen's building strikes such a memorable profile is structural: it avoids internal columns and load-bearing walls by relying on external columns for support. The 175-foot span from north to south relies on massive Vierendeel trusses: 18-foot-high I-shaped girders of cast-in-place concrete, transferring loads to the columns at pyramidal steel connection points and creating the impression that a large travertine-clad volume hovers above a light Miesian glass box. "There's a real structural authenticity and integrity to what happens here," says H3's Fausto. "Everything is exposed, the concrete, even the gymnastics they're playing with the little pin connections from the column up to the plinth: it's all very elegant."

In planning the new structure, Fausto and colleagues posited two key questions: "One, how are we going to do it up there? Second, what would be the relationship of that new construction to the existing?" Deciding that a complementary relationship between Saarinen's LCT and the new LCT3 would be preferable to an exaggerated contrast, H3 housed the 112-seat Claire Tow Theater, lobby, rehearsal room (with sprung floor for dance), dressing rooms, back-of-house offices, and technical space within a new glass box, caged by an aluminum brise-soleil and supported by its own system of steel trusses. The addition is set back enough to be unobtrusive from the plaza level, striking its own distinct profile with a contrasting presentation of visible structure.

Top and opening spread: Francis Dzikowski/ESTO; left: H3 Hardy Collaboration Architecture

The solutions devised by H3 and Severud not only bridge the project's disparate needs metaphorically but employ a literal bridge. Severud's engineers, reports Jijina, determined that a steel frame with lightweight concrete on a composite metal deck would be preferable to any loading on the roof. The existing concrete girders lacked the capacity to support a standard column layout without risky de-



This page: Francis Dzikowski/ESTO

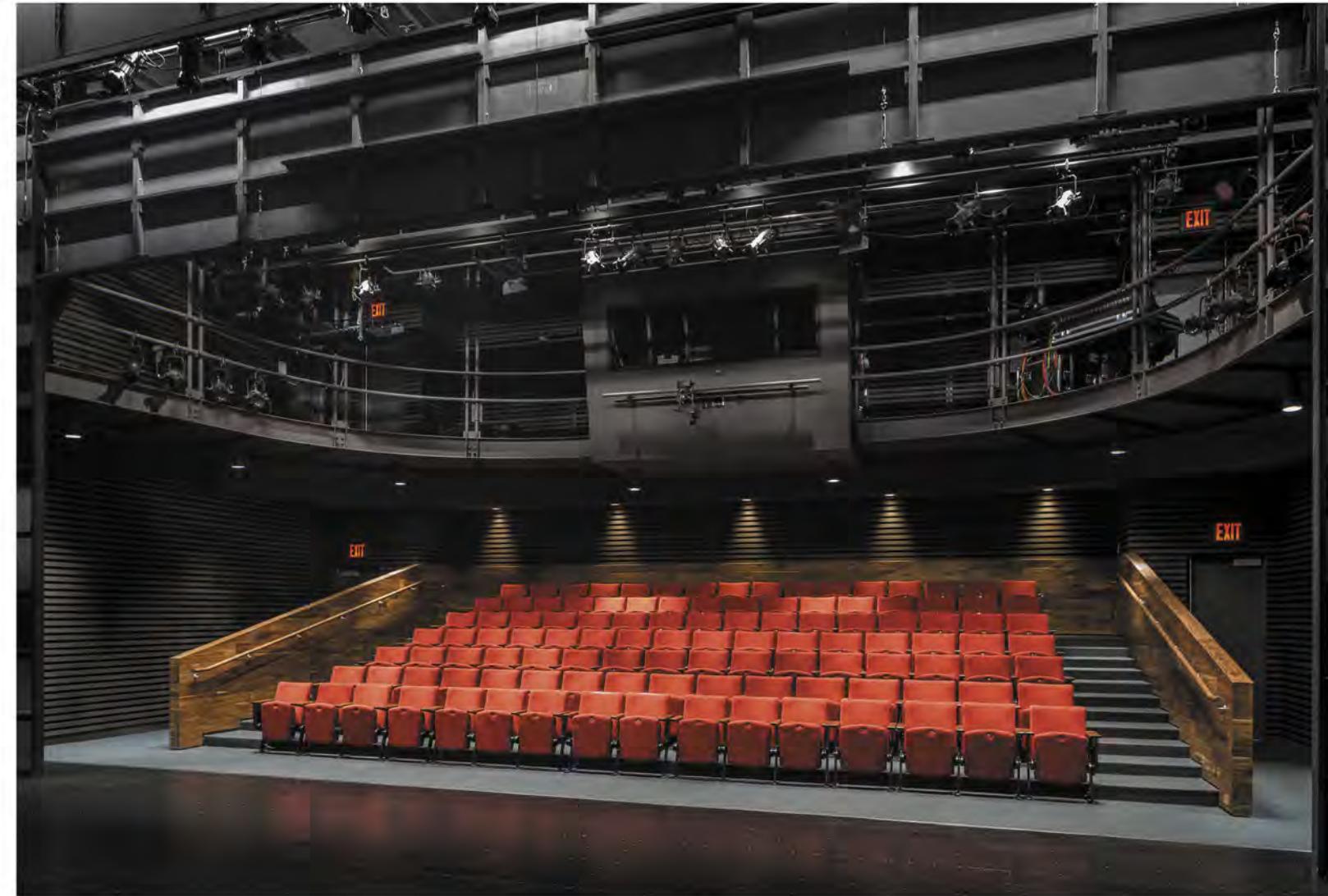


flection under additional loading. Instead, four of the LCT's exterior columns support the LCT3's two main wide-flange steel longitudinal trusses, weighing about 65 tons each, 175 feet long and 30 feet deep with 75-foot cross trusses, cantilevered an additional 15 feet at each end.

Thorough structural studies and nondestructive material-strength tests determined that the existing columns' reserve capacity would support the load delivered by the truss system, which forms an independent bridge by passing the existing roof structure entirely. The steel assembly, too large for trucking as a whole, was fabricated off-site at Capco Steel, cut into parts, craned into place, laid out on the roof, reassembled, and hoisted into place. Exposed trusses were welded with complete joint penetration welds, according to Severud associate Alvaro I. Castaño; interior trusses were all bolted. ("We were trying to minimize the welding, because it's an occupied building," Jijina recalls; fire marshals had to stand guard during welding, "an expensive proposition.")

The three main trusses are composed of W14 shapes, ranging from W14x61 to W14x211; top and bottom truss chords are W27 and W30, the heaviest being W30x261. The two short trusses are composed of W10x54 diagonal elements with W24x55 top and bottom chords. Filler beams are W14x22, W16x26, W18x40, W18x40, W21x44, W24x55, and W30x90; girders are W30, W33, and W36, with heavy W33 beams used to bring the load path from the end of the truss to the centerline of support. The floor spanning between the trusses is picked up by girders and filler beams, ranging from a high of W36 to a low of W18. The top and bottom chords, Jijina reports, weigh about 300 pounds per linear foot, with about 250 pounds per linear foot for the diagonals.

With headroom clearance requirements calling for the use of Vierendeel panels, concealing the trusses was impossible; the architects turned necessity into a purposeful design strategy and made the steel members a signature element of the building, painting them bright white. This is one of several features that or-



This spread A system of steel trusses creates column-free space in the black-box theater, rehearsal space, and public areas.

ganize appearances and visitors' movements around proudly foregrounded structural components. Access to LCT3 is exclusively by elevator; fortunately, in the coffered ceiling of the original LCT's exterior above the plaza, three coffers perfectly fit two passenger elevators, making it possible to knock out these coffers to accommodate the elevator bank without compromising the structure. The elevator chamber of translucent Bendheim channel glass is the only element deviating from the symmetry of Saarinen's building. Visitors emerge from the elevators into the upper glass box to see a small patch of green roof to the right, a dramatic rooftop terrace straight ahead (overlooking the

Paul Milstein Pool and Terrace and parallel with the top floor of Avery Fisher Hall), the café area to the left (with Kiki Smith's sculpture *Overture*, a nest of silvered planks occupied by birds, overhead), and the theater entrances on either side of the bar. A larger green-roof area appears beyond the terrace; the sections of green roofing, the low-maintenance extensive variety using 2-foot-square trays of sedum, create continuity with Diller Scofidio & Renfro's tilted patch of lawn atop the Hypar Pavilion and Lincoln restaurant.

On three sides of LCT3 (all but the west face, which borders on the upper stage tower), the horizontal screen dominates the exterior view. This brise-soleil of square aluminum bars, rotated 45 degrees and painted matte white (standing out from the gray mullions), performs multiple functions. Along with

shading the interior against heat gain, it gives the structure what Fausto calls "a homogeneous veil" that contrasts purposefully with Saarinen's ground-level glass box and harmonizes with the white steel beams, softening their starkness and bringing order to the facade. By night, lit from within but with the screen also up-lit, "the screen wins" and serves as the chief visual feature, contributing to a clean, non-flashy industrial aesthetic suiting the adventurous programming. (Ironically, Jijina notes, aluminum was a second choice here when the engineers decided the initial idea, terra cotta, would be too heavy. "Sometimes when you force the issue, you think more out of the box, and it comes out to be better.")

The Claire Tow is one of the city's only LEED-certified theaters, with a full comple-

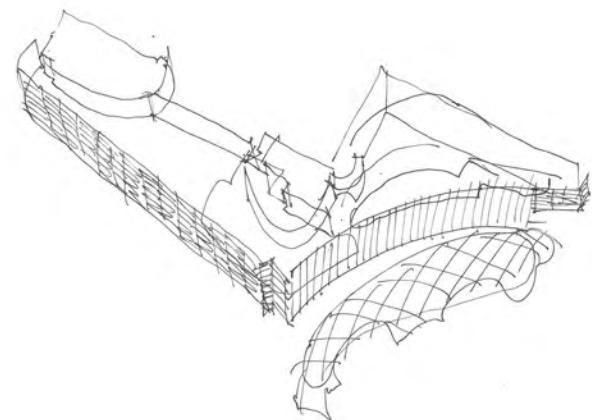
ment of energy-conserving technologies: an enthalpy economizer, variable-air-volume HVAC, variable-frequency drives for hot water pumps, daylight and lighting-occupancy sensors, and other features expected to earn a Silver ranking. Severud won a 2012 Diamond Engineering Excellence Award in Structural Systems from the American Council of Engineering Companies of New York for the LCT3 project. "I've never had a more cooperative building process than this one in 30 years," Jijina says. "Everybody set aside their egos, and it was like a team for the first time." In the long run, the winners also include the leading edge of the performing-arts community and all of New York's diverse theatergoers who are open to experimentation, even when it takes place on—or above—hallowed ground.

This spread and following spread: Francis Dzikowski/ESTO



#### CLAIRE TOW THEATER

Location: 150 West 65th Street, New York, NY  
Owner: Lincoln Center Theater, New York, NY  
Architect: H3 Hardy Collaboration Architects, New York, NY  
Structural Engineer: Severud Associates Consulting Engineers, PC, New York, NY  
Mechanical Engineer: Arup, New York, NY  
Construction Manager: Yorke Construction, New York, NY  
Structural Steel Fabricator and Erector: Capco Steel, Providence, RI  
Miscellaneous Iron Fabricator and Erector: Ment Brothers Iron Works, New York, NY  
Architectural Metal Fabricator and Erector: A-Val Architectural Metal Corp., Mt. Vernon, NY  
Ornamental Metal Fabricator and Erector: A-Val Architectural Metal Corp., Mt. Vernon, NY  
Curtain Wall Erector: Neversink Glass Corp., White Lake, NY



## Empire City Casino at Yonkers Raceway

A sculptural entrance canopy reinvents the historic track's image with an 11,000-square-foot, LED-lit lattice structure covered with transparent ETFE film.

FOUNDED IN 1899, YONKERS RACEWAY is a historic track with a storied past—at the turn of the century, auto racer Barney Oldfield set a one-mile record there, and in 1936 the champion horse Seabiscuit galloped away with a victory there as well. Currently, the five sons of Pittsburgh Steelers football legend Art Rooney own the raceway. But its president, Timothy J. Rooney, isn't one to rest on the track's laurels. When it came time for the venue to expand several years ago, he approached Studio V Architecture, a New York-based firm founded by Jay Valgora in 2006. "He wanted to create an iconic and contemporary solution to change the image of his property," says Valgora. "This is especially exciting, as he is a wonderful gentleman who owns 19th-century houses in Ireland and old Virginia horse farms."

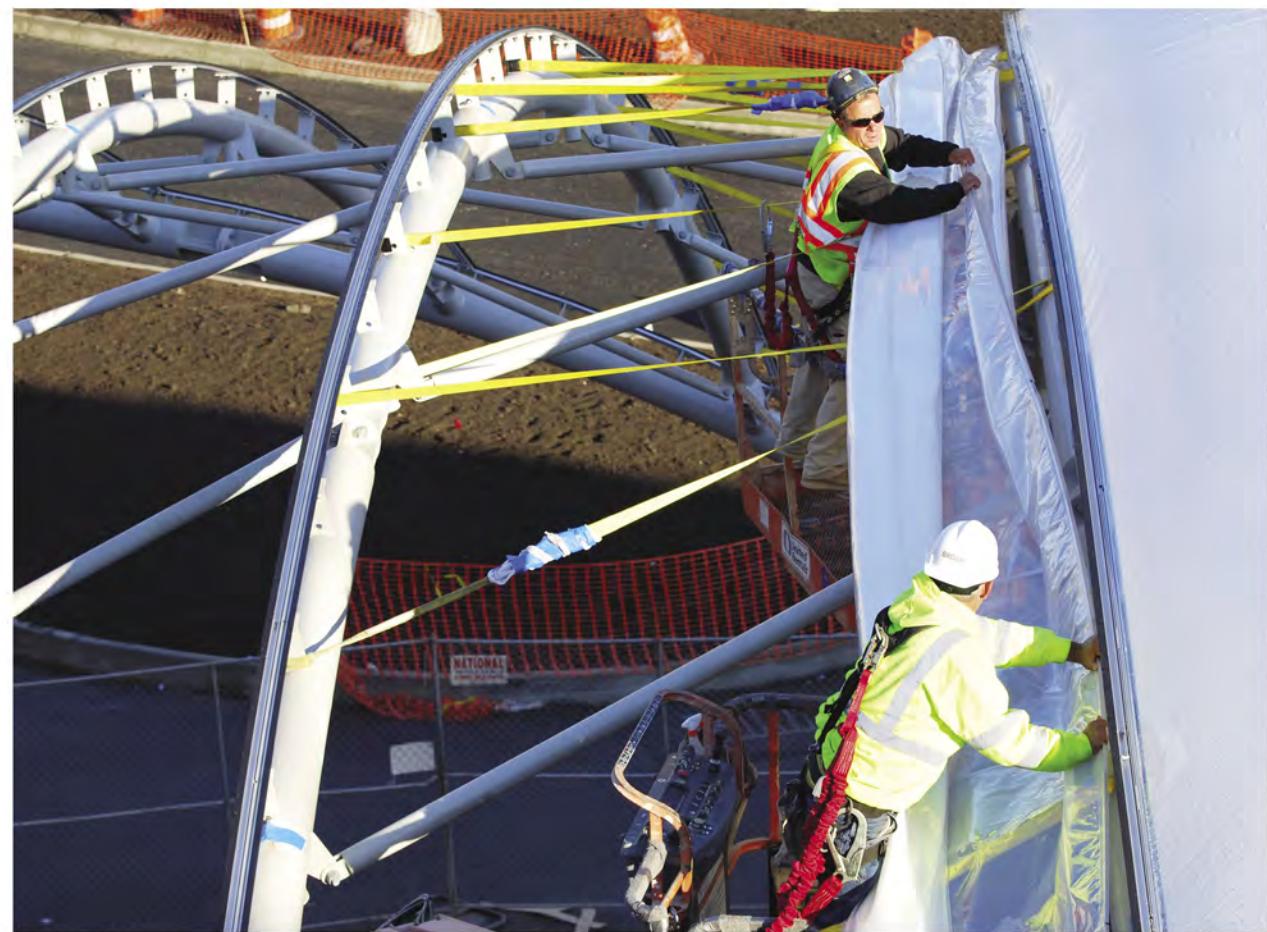
"We wanted to re-invent the casino with extraordinary architecture instead of shallow spectacle," he continues. The casino's hilltop site immediately lent itself to a sculptural form that took the shape of a porte-cochère—initial sketches pull the forms of the landscape into a curved, organically shaped canopy. "I have been fascinated for years with the expressive potential of grid shells, the dynamic structural system pioneered by Frei Otto nearly a half century ago,

and Vladimir Shukov before him. These amazing structural forms are so rarely used in architecture, and especially in the United States—the open nature and topography of the Yonkers site were perfect for this, while the program of a casino building required an expressive idea."

Studio V was only two years old at the project's start. The canopy's unique form presented the team with an opportunity to experiment with material technology—but it was an ambitious goal. After developing the fundamental architectural concept, Valgora asked Nick Goldsmith of FTL Design Engineers to help realize the idea of a lattice shell structure; the two have collaborated for years, and Goldsmith worked for Otto early in his career. Together, the teams developed physical and digital models, forms, and details of the casino's new entrance.

The 11,000-square-foot porte-cochère is a steel lattice shell structure covered with ETFE, or ethylene tetrafluoroethylene, a transparent film that is lightweight, flexible, and sustainable. According to Birdair, Inc., a lightweight, long-span roofing contractor, the material can last more than 20 years without losing transparency or strength. Due to its nonstick surface, ETFE also resists airborne pollutants, making it chemically resistant and naturally self-cleaning.

The lattice shell has three primary structural components: arches, purlins, and a complex curved perimeter beam. "We started an even grid, but quickly determined that it would be much more efficient to differentiate the members into a series of



This spread: Ornamental Metal Institute of New York; opening spread, photo: Paul Warchol; opening spread, illustration: Studio V Architecture



**This spread** The 11,000-square-foot porte-cochère is a steel lattice shell structure covered with ETFE, a transparent film that is lightweight, flexible, and sustainable. Installers feed the edge of the ETFE film into the clamp bar of a 6-inch steel extrusion designed to hold the material in place.





**Above** A system of 8-inch-diameter steel arches and 4-inch-diameter purlins created efficient geometric connections, reducing construction costs.



**Below** The shell is made of ribbons of ETFE cushions; these are continually inflated by air pipes that feed individual cushions from air handling units. Energy required to maintain pressure within the cushions is minimal.

slightly larger arches and smaller purlins that were slightly offset from one another," says Valgora. This design was more efficient and easier to construct than a geometry of overlapping forms; because it allowed for more efficient connections, it also reduced costs.

The team worked to keep the steel members to the smallest sizes possible to create a delicate appearance and increase cost efficiency, reducing the size of the arches to only 8 inches and the purlins to a slender 4 inches. The edge beam received the most scrutiny, but ultimately required only an 18-inch diameter to allow its twisted-torus form to absorb and transfer many of the structure's forces, while relating in scale to the other members. To resolve structural and form issues together, Studio V and FTL created a digital version of an upside-down "chain model," similar to Antoni Gaudí's physical models for the Sagrada Família basilica in Barcelona. The model allowed them to find the most efficient forms, and work backwards and forwards between ideal sizes and geometries to best understand the realities and economies of fabrication.

This form-finding approach to structure led the team to create an asymmetrical design with emphasized diagonals in two opposing directions. These sweeping diagonals established the geometry of the ETFE foil, and the lighting system. Once they developed the structure, it became the basis for a series of architectural design decisions to integrate the structure, foil supports, and lighting into a series of overlapping lattices that create a delicate play of light and shadow.

Erecting the lattice shell involved arranging the structure's arches, then infilling the purlins to support each one. Installers took great care to locate the first partial arch, the precise placement of which dictated the exact geometry of the entire assembly over hundreds of feet.



This page: Ornamental Metal Institute of New York; facing page and following spread, top: Paul Warchol; following spread, bottom: Studio V Architecture



**Above** A four-story facade of frameless, low-iron glass forms the 300-foot arching facade of the new casino.

"As with many steel jobs, the project progressed rapidly once the initial geometry was confirmed and the installation crew hit its rhythm," says Valgora. "I think the ironworkers who installed the components were astonished by the form and how it developed, as the pieces were so individual and complex, and it changed dramatically and quickly over the course of the installation."

The structure proved so massive and complex that scaffolding could not be erected to install the ETFE foil and its 6-inch extrusions on top of the steel arches—it would have been too complex itself. But without scaffolding, each ribbon of foil pillows blocked access to the next one as it was installed. Birdair solved the challenge with a carefully coordinated series of articulated man lifts that granted access to the extrusions and pillows from several different points. To give access to electricians installing lighting above the canopy's

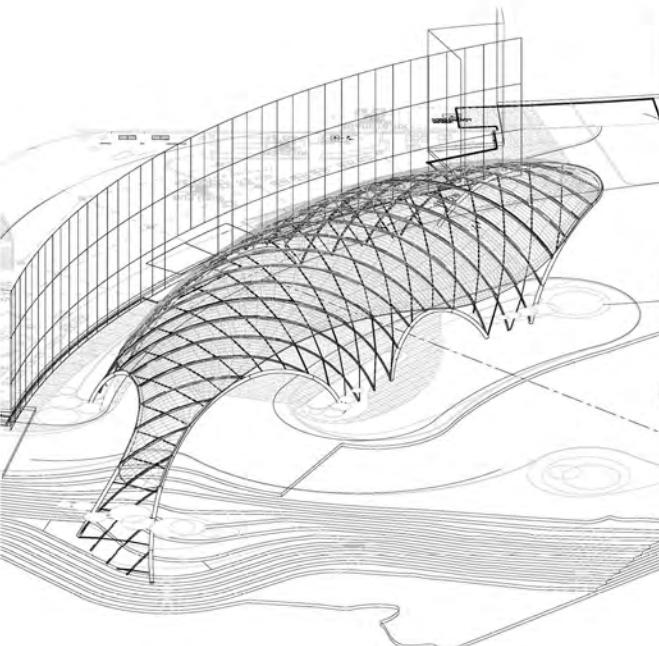
extrusions (without having them balance on the extrusions, which are up to 40 feet in the air) the company used a system of "surf boards," elongated, elliptical working platforms covered with soft material to bridge between the pillows and allow safe access. The canopy's custom LED lighting, by Tommy Voeten of 212 Studio, has a constantly changing pattern of light and color developed in conjunction with Tillotson Design Associates.

Because sprinklers would have interfered with the delicacy of the steel members and with the lighting design, the project team worked with local fire and code officials to review material testing reports and facilitate approvals for a sprinkler-free structure. (ETFE foil is not fireproof or resistant—but in the event of a fire, it vaporizes on contact with flame without residue or other safety concerns.)

Behind the canopy, a four-story facade of frameless, low-iron glass in a 300-foot arc gives visitors a

**"As with many steel jobs, the project progressed rapidly once the initial geometry was confirmed and the installation crew hit its rhythm. I think the ironworkers who installed the components were astonished by the form and how it developed, as the pieces were so individual and complex."**

Jay Valgora, Studio V Architecture



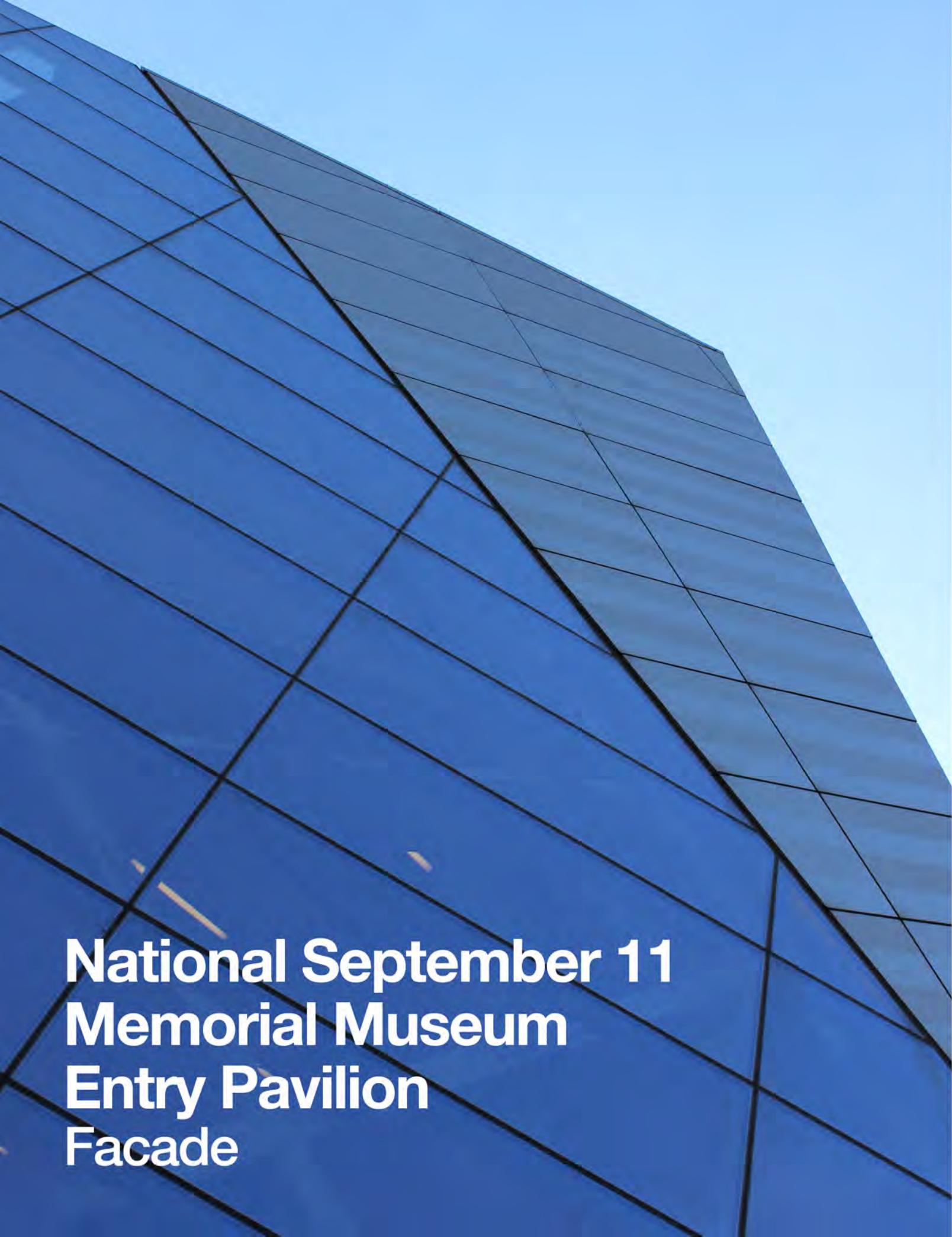
**This spread** The lattice-shell porte-cochère and 45-foot-tall glass curtain wall create a dramatic visual identity for the new casino.

window into the casino before they ever step from their cars. The curtain wall acts as a delicate membrane that divides and connects the casino's new vertical atrium with the broad forecourt that makes the new entry, and identity, for the casino.

The design and detailing of the curtain wall reinforce this concept at every level: massive sheets of low-iron white glass have minimal seams and frameless connections, and dramatic "fly-bys" soar into space on either side of the building as the facade joins the roof with a continuous frameless skylight. The glass has a gradated frit pattern to create a delicate veil between inside and out, framing views of the porte-cochère for those inside. The view of the casino has changed immensely for motorists on the New York State Thruway as well—if new crowds at the venue are any indication, many are stopping for a second look. Innovative architecture has proved a good bet.

#### EMPIRE CITY CASINO AT YONKERS RACEWAY

**Location:** 810 Yonkers Ave., Yonkers, NY  
**Owner:** Yonkers Raceway and Casino, Yonkers, NY  
**Architect:** Studio V Architecture, New York, NY  
**Structural Engineer:** DeSimone Consulting Engineers, New York, NY  
**Porte-cochère Engineer:** FTL, New York, NY  
**General Contractor:** LP Ciminelli, Buffalo, NY  
**Curtain Wall Consultant:** Israel Berger & Associates, New York, NY  
**Structural Steel Erector:** Berlin Steel, Kensington, CT  
**Architectural Metal Erector:** Custom Exterior Systems, Sloaburg, NY  
**Ornamental Metal Erector:** Birdair, Amherst, NY  
**Curtain Wall Erector:** Birdair, Amherst, NY



# National September 11 Memorial Museum Entry Pavilion Facade

**The pavilion's stainless steel and glass enclosure incorporates transparent and reflective properties while maintaining a connection to the rest of the World Trade Center development.**

FROM ITS CENTRAL POSITION IN the midst of the new buildings at the 16-acre site of Manhattan's World Trade Center, the diminutive National September 11 Memorial Museum Pavilion has a big role to play in the site's function. In addition to being the key point of public entry into a new subterranean museum on the diverse site, it is at the same time one of the most highly visible additions to the area—with millions of square feet of office space now looking down on the 47,000-square-foot pavilion, architects at Snøhetta had to conceive a building envelope that maintained its own presence while complementing the rest of the site. "The quality of the pavilion that is most significant to me is that it reflects presence," says architect Anne Lewison, the pavilion's project manager for Snøhetta. "This is mostly significant relative to the 9/11 Memorial. The building reflects the present day and time, as well as the people you may have come with."

Originally, the architects proposed a wood-clad building with a central skylight and large expanses of vision glazing on each elevation. However, security requirements for the site, and the need to incorporate large ventilation shafts feeding its underground spaces, meant the facade had to become much more opaque—and stronger. Thus, much of the north, east, and south sides of the building's design were shaped by these security requirements. (The pavilion's structural steel design is detailed in a feature on page 22).

Lifting the upper envelope of the building provocatively above the storefront, the architects wrapped the building in stainless steel panels over the wedge-like structural mass that appears to narrow as it extends from east to west. Snøhetta chose a stainless steel envelope for its longevity and high quality of finish, but also because of the site's proximity to the Hudson River and its concomitant moisture and saltwater impacts on exposed metal (because tides from the Atlantic Ocean extend far into the river).

A series of 44-by-120-inch panels are assembled into mega-panels that are welded to double 2-by-8-inch steel studs on 12-inch centers, as well as to a metal diaphragm system. The panel faces, fabricated by A. Zahner of Kansas City, Missouri, are made with 3/32-inch stainless steel that has been bead-blasted to create matte stripes that alternate with semi-reflected stainless—the pattern's angle calls to mind the structural arrangement and surface pattern of the original World Trade Center towers. Using a technique it first developed to clad Apple stores, Zahner achieves the effect through what it calls its GB-60 (or glass-bead) process, which results in a matte finish that appears like glass beads under a

microscope. The architects specified sizes to take advantage of the 48-inch-wide steel coil used to cut the panels; a 2-inch folded edge significantly reduced waste from cutting the coil for the final 44-inch-wide dimension.

Each mega-panel's interior joints are indistinguishable from joints between individual panels, though some are perforated to accommodate air-intake locations. A secondary structure provides an armature that supports panels over the mechanical equipment on the roof, again a concern because so many eyes will view the pavilion from above. The steel panel system encloses the upper stories of the three-story structure, wrapping around to overhang a conventional storefront curtain wall system at the ground floor.

Aside from the front entrance at the northeast corner of the pavilion and the storefront along the southwest corner, the building's primary glazed component is an atrium at its northwest corner. Because it is located on the interior of the site, architects were able to increase the surface area of the atrium's glazing there to offer a view of two structural steel tridents salvaged from the former World Trade Center towers. Installed just north of a grand staircase connecting the ground floor to the sub-grade museum, the historic artifacts are also visible from the pavilion's exterior.

Structural engineers at Buro Happold's New York office and facade consultants from New York-based Front Inc. worked with Snøhetta to conceive the atrium's design. It features a conventional glass curtain wall system installed at an angle, to contrast from the exterior with the vertical tridents inside. The primary steel structure of 20x8 rectangular tubes installed at angles supports the curtain wall, and completes the enclosure of the pavilion's column and beam structural elements. Erleen Hatfield, Buro Happold's lead structural engineer for the project, says the tubes were spliced and bolted, rather than field-welded, in order to speed construction. "Since you can see those splices up close, we wanted those to be elegant and clean," Hatfield says. "The innermost tube is smaller and the outer tube works as a sleeve and splice plate." The quantity of bolts varies at each splice depending on local conditions, but the engineers kept the bolt size the same in order to reduce the possibility of mistakes.

Snøhetta worked with Viracon, which supplied the pavilion's glazing, to develop a double-glazed system with two layers of colored ceramic frit that appears to extend the matte stripes from the steel rainscreen panels onto the glazing. Gradated from 100 percent (or completely opaque) to zero frit, the pattern lends a shimmering quality to the structure, enhancing its changeability, and the moment of calm, it lends to the surrounding site and architect Michael Arad's memorial, "Reflecting Absence." "In certain lights it's hard to tell if you are looking at metal or glass," says Lewison. "Ultimately, it directs your eyes toward the Memorial's pools."

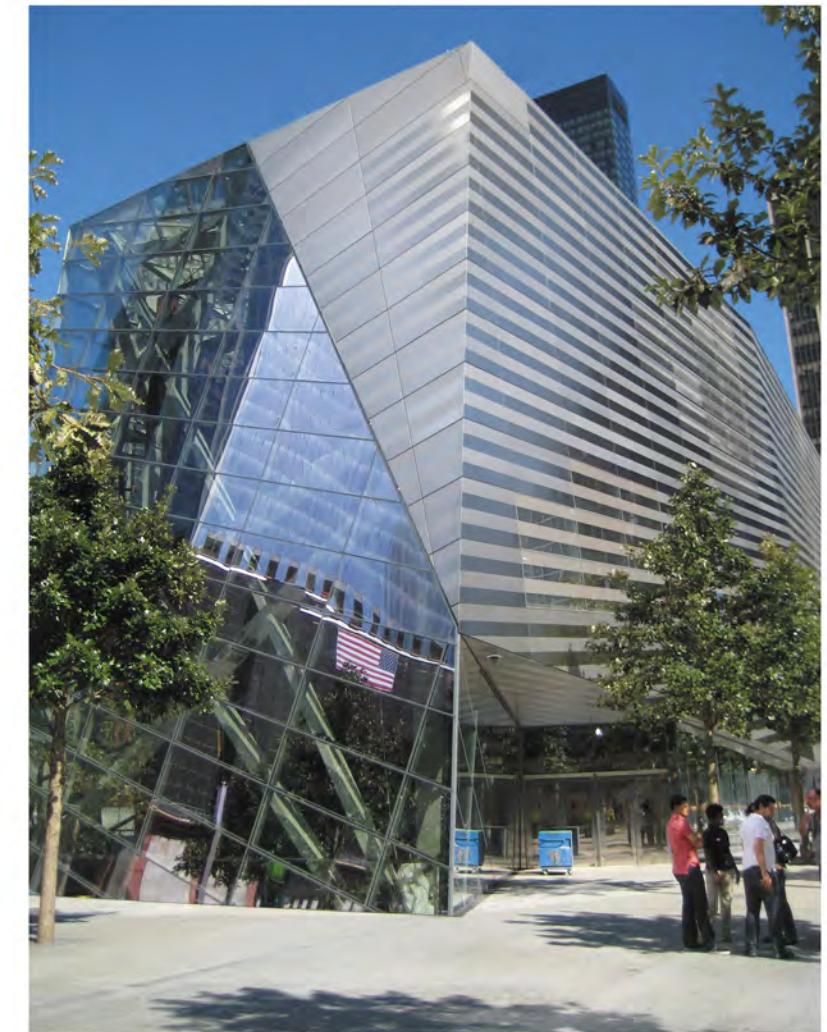


**"The quality of the pavilion that is most significant to me is that it reflects presence. The building reflects the present day and time, as well as the people you may have come with."**

Anne Lewison, Snøhetta

This spread: Snøhetta; opening page: Jennifer Krichels

**Clockwise from right** Stainless steel panels are bead-blasted to create matte stripes. Panels are installed at an angle. An interior steel structure of rectangular tubes supports the facade. **Facing** A double-glazed system wraps the pavilion's northwest corner, revealing two structural steel tridents from the former World Trade Center towers.



#### NATIONAL SEPTEMBER 11 MEMORIAL MUSEUM ENTRY PAVILION

Location: National September 11 Memorial & Museum at the World Trade Center, New York, NY

Owner: National September 11 Memorial and Museum at the World Trade Center

Architect: Snøhetta Architecture Design Planning PC (design architect), New York, NY; Adamson Associates (associate architect), Toronto, Ontario

Structural Engineer: Buro Happold Engineering, New York, NY

Mechanical Engineer: Buro Happold Engineering, New York, NY

Construction Manager: Lend Lease, New York, NY

Curtain Wall Consultant: Front Inc., New York, NY

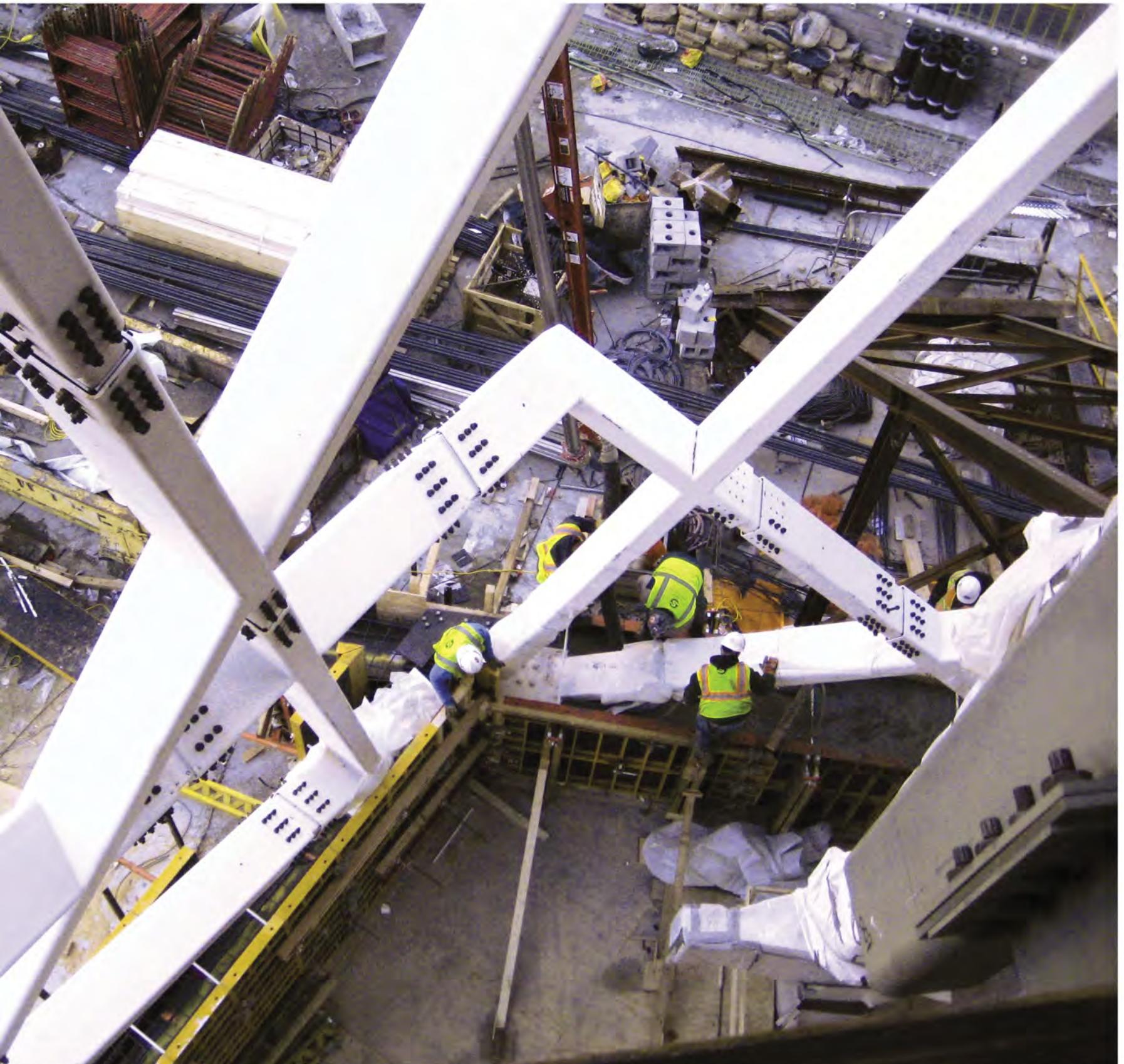
Structural Steel Fabricator and Erector: W&W Steel Erectors, Oklahoma City, OK

Miscellaneous Iron Fabricator and Erector: W&W Steel Erectors, Oklahoma City, OK

Architectural Metal Fabricators: A. Zahner Co. (cladding skins), Kansas City, MO; Post Road Iron Works (window frames), Greenwich, CT

Architectural Metal Erector: W&W Glass, Nanuet, NY

Curtain Wall Erector: W&W Glass, Nanuet, NY



Snohetta

# National September 11 Memorial Museum Entry Pavilion Structure

A 47,000-square-foot structure meets a diverse range of needs at the World Trade Center's complicated building site; first and foremost, it provides a striking point of entry into the Memorial Museum for millions of visitors each year.

A SEEMINGLY SMALL STRUCTURE at the redeveloped World Trade Center, the National September 11 Memorial Museum Pavilion must negotiate one of the most complex building sites in the world. Nestled within the ground-level plaza of architect Michael Arad's memorial, "Reflecting Absence," the pavilion shares a landscaped setting with Santiago Calatrava's new Port Authority Trans-Hudson (PATH) station, as well as existing New York City subway lines and secure parking facilities for the entire complex. The pavilion also introduces the below-grade museum, designed by Davis Brody Bond, and neighbors the four glass towers, including the 104-story One World Trade Center, designed by Skidmore, Owings and Merrill, that add millions of square feet of office and retail to the site.

For most of the visitors to the World Trade Center site, the diminutive 47,000-square-foot pavilion designed by international architecture firm Snohetta will act as the front door to the development. Though the overall site is largely owned by the Port Authority of New York and New Jersey, which reviewed all design documentation for the pavilion, Snohetta's client is the National September 11 Memorial and Museum.

The pavilion's program is modest, but vital to the site. The ground floor includes a lobby for security screening and exterior ticket windows for the museum. A large ornamental staircase runs along the north side of the building, connecting the pavilion with the main entry hall of the museum below grade. The pavilion's second floor includes an auditorium, a small café, and a private room that overlooks both pools of the memorial and is reserved for family of 9/11 victims. The stair widens as it descends from the main floor to the lower level, where it forms the entry procession to the museum. As visitors descend the stair, they pass two large trident-shaped steel columns that were preserved from the remains of the original World Trade Center towers.

From above, a vantage point thousands of people in the sur-

rounding buildings will enjoy, the pavilion appears as a tilted wedge, clad in stainless steel panels and sloped upward from west to east, emphasizing the horizontality of the memorial and plaza. A secondary steel roof screen structure hides mechanical equipment from view, reinforcing the overhead appearance of the structure as a monolithic object.

On target to achieve a LEED Gold rating, the pavilion straddles both the PATH train station and the memorial museum. Roughly 85 percent of its columns are anchored to deep transfer girders extended from the system that supports the roof of the PATH mezzanine on the west side of Greenwich Street. The remaining 15 percent of the building is supported by the memorial museum, yet the two projects read as a unified plaza at grade, separated by a discreet movement joint.

The pavilion, whose structure was designed by engineers at Buro Happold, presented a number of challenges, one of which was accommodating concrete service shafts. These largely drove the location of internal stairs, elevators, and other facilities, creating a large core of concrete that was used as lateral stability for the pavilion building by transferring north-south



This page, clockwise from top The pavilion's north drag beam and south girder. The structure's north-side outrigger at the drag beam connection. The structure at the north plaza level. The atrium's grand staircase at the drag beam and south girder.



lateral loads to the PATH girders and onto the plaza structure at the south side. Standing adjacent to the newly reconnected Greenwich Street, the east facade conforms to the site-wide security requirements.

The pavilion core walls, however, did not extend below the plaza level, presenting challenges both for construction and lateral stability for the building. To accommodate these conditions, Buro Happold designed steel trusses spanning between the support girders below. These trusses provided support for the concrete walls, which were then cast around the trusses. To transfer lateral forces from the

base of the pavilion walls to PATH and memorial museum walls located elsewhere, the engineers designed 3-foot-wide by 7-foot-deep concrete members strengthened with structural steel wide-flange sections as "drag beams" around the perimeter of the pavilion. Anne Lewison, the project manager for Snohetta, says the structure is intentionally irregular overall given its elements are configured so that they could be supported most economically.

Due to the complexity of the site and the structures below, only twelve support points, in addition to the concrete core, were available to support pavilion columns. This resulted in a long-span steel



This spread: Snohetta

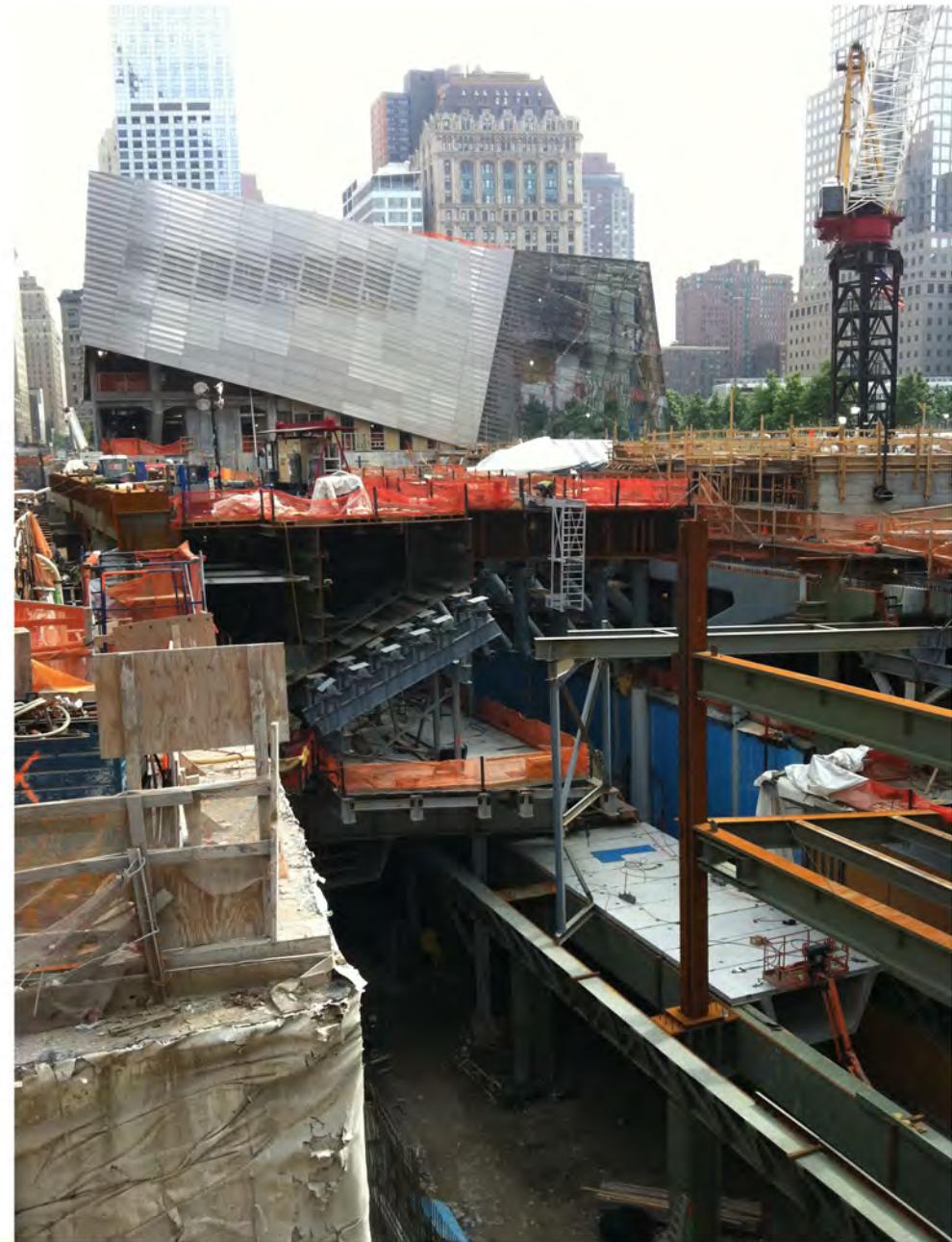


This page, clockwise from top A mechanical opening in the transfer girder. The memorial's northeast plaza and mechanical plant. Structural support for the mechanical floor.

building with only twelve steel columns, as large as W14x370, to accommodate the heavy loads caused by long spans to the limited support points.

Erleen Hatfield, Buro Happold's lead structural engineer for the project, says given the size and security requirements, the team had originally investigated using a concrete structure. "The heavy weight of the concrete was deemed inefficient because the majority of the building is carried on girders," Hatfield says. "Steel lightens the load and also gives the museum more flexibility for future changes." Even with a large concrete shear wall to the east, the engineers encased the primary structural steel columns in concrete as a further security measure.

Though it had twelve support points, the north edge of the building did not have sufficient support to cantilever while being completely isolated from the PATH structure below. Along the north edge, Buro Happold's engineers, who modeled the project in Tekla software, added a thirteenth column to support the westernmost girder. The column is a hanging column that extends to the roof and is supported by a 22-foot-deep, full-story steel truss constructed with wide flange sections located in the



## Call for Entries

# Design Competition

## Residential Towers for the 21st Century

**Submissions due January 3, 2014**  
**Prize – \$10,000**

### JURY

#### **Kai-Uwe Bergmann**

Partner, BIG (Bjarke Ingels Group)

#### **Craig Schwitter**

Principal, Buro Happold

#### **Sylvia Smith**

Senior Partner, FXFOWLE

### MODERATOR

#### **Susan S. Szenasy**

Editor-in-Chief, Metropolis Magazine

**[metropolismag.com/living-cities](http://metropolismag.com/living-cities)**

### CO-PRESENTERS

 Steel Institute of New York

 Ornamental Metal Institute of New York

METROPOLIS

### Project Brief

Like other urban areas around the world, New York City will face dramatic population growth in the coming decades. Demographers predict that New York alone will add one million more residents by 2040. Finding housing will pose a crisis for hundreds of thousands of them, unless new residential towers are built to house this urban influx.

As any planner and environmentalist will tell you, density is a much more preferred solution than sprawl. Increasing populations, followed by rising greenhouse gas emissions and resource depletion, seem inevitable, and require equal attention. But architects can find solutions.

Architects now know how to build environmentally sensitive commercial buildings that are resource efficient, go up faster, last longer, and have less impact on the community. Why not transfer this knowledge to residential buildings?

Structural steel, in particular, plays a prominent role in the city's sustainable commercial architecture. There is a growing interest in the material's viability, when enclosed with an energy efficient curtain wall, for framing high-rise residential projects as well. Structural steel's superior strength-to-weight ratio and long-span capabilities make it resource-efficient, requiring smaller foundations and fewer deliveries to the building site, factors important in reducing a project's carbon footprint. With overall emissions from its production well below the Kyoto standards and its ability to be recycled indefinitely without the loss of performance, steel has long been shrinking the impact of large-scale projects on nearby communities and businesses—while helping the

city keep pace with its competition in the global economy.

Beyond construction efficiency, steel buildings are readily adaptable to the needs of today's and tomorrow's changing social trends. Science and technology sectors are attracting young, mobile workers and powering more of New York City's economy, and families increasingly are leaving the suburbs for the efficiencies and cultural amenities of the city. By using forward-thinking structural steel framing systems and innovative, energy efficient curtain wall enclosures, today's architects have a unique opportunity to address changing demographics and housing needs by designing residential towers that emphasize efficient use of space for live-work lifestyles and family-oriented features.

### Design Challenge

The Living Cities: Residential Towers for the 21st Century Design Competition challenges architects and engineers (preferably in collaborative teams) to develop an original design for modern, urban residential living that makes use of structural steel framing systems. We challenge you to design maximum column-free floor areas with reduced floor assembly thicknesses (acoustical considerations are essential), enclosed with an energy efficient curtain wall system that emphasizes the frame's slenderness, strength, and transparency, as well as natural ventilation and the residents' access to fresh air. The winning design will demonstrate a high degree of expression and creativity in fulfilling the program requirements, in accordance with the specific design guidelines set forth here.



**This page** Steel tridents from the former World Trade Center are visible through the pavilion's west facade.

mechanical floor that cantilevers from the concrete core to the south. A support point existed for the easternmost girder along the north edge—but not at the right location. To accommodate this, the engineers designed an angled outrigger beam that extends from the supporting girder below to become a vertical column at the second floor.

Given the demands of the site, and the modest but crucial program, the Pavilion manages to smoothly connect important spaces—memorial, and museum—while creating a simple path for experiencing the site. Sitting at the nexus of so many megaprojects that will change Lower Manhattan forever, the small building's deceptive simplicity carries extra meaning, not only in the aesthetic contribution to the site, but also in the moment of tranquility it grants to the memorial's visitors.

**"Steel lightens the load and also gives the museum more flexibility for future changes."**

Erleen Hatfield, Buro Happold

This spread: Snohetta

Pavilion, which was fabricated by W&W Steel Erectors, a company based in Oklahoma City that also fabricated the building's structural steel frame. The only other steel connection to a structure that ties into the structure below is the grand staircase in the atrium, which rests on the structure of the largely underground museum space. (The atrium structure is explained more fully in this issue's related story on the pavilion facade on page 18).

This spread: Snohetta

**This page** The pavilion's south elevation at night.



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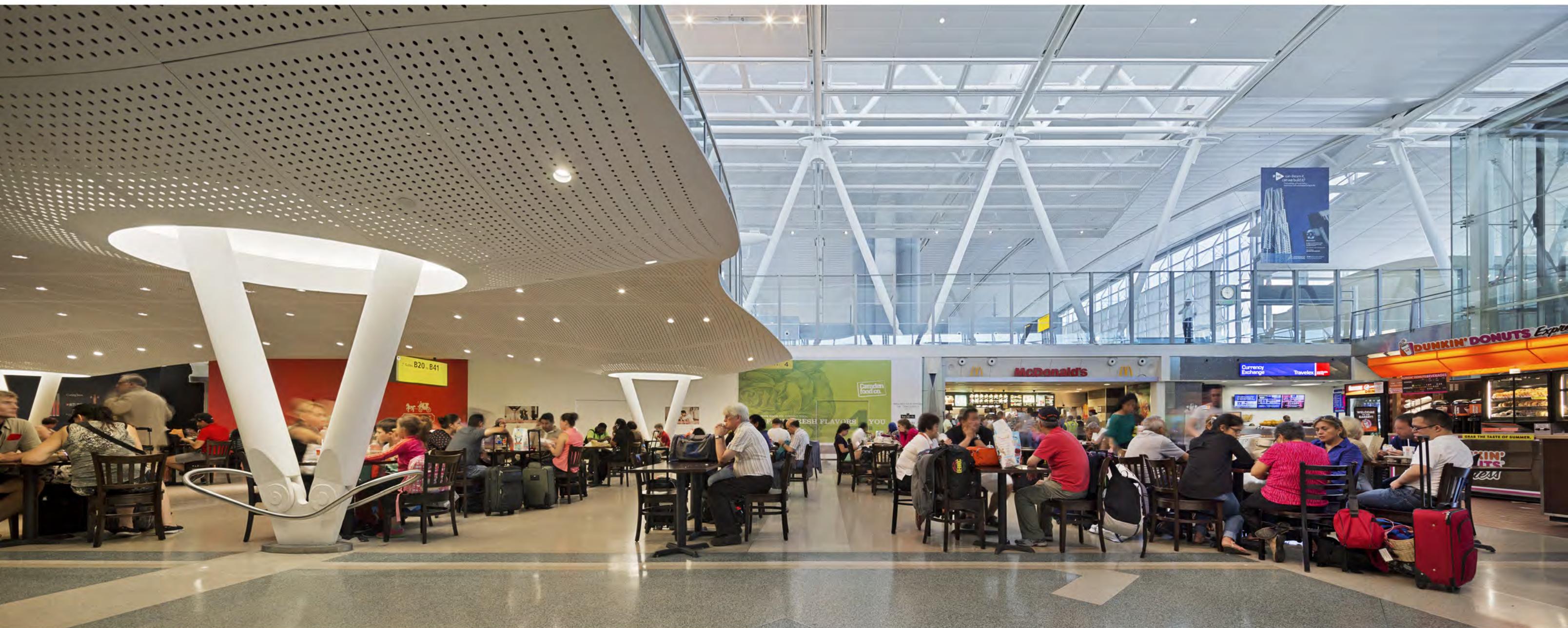
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Architectural Metal Erector: W&W Glass, Nanuet, NY

Curtain Wall Erector: W&W Glass, Nanuet, NY



# John F. Kennedy International Airport Terminal 4

**This spread** Twelve V-columns support the new terminal's soaring atrium and the security screening checkpoint above.

Edward Hueber/ArchPhoto Inc.

**The new terminal complex consolidates Delta's operations at JFK with a structural steel design that fulfills the original master plan for the terminal and improves the experience of the more than 11 million passengers who will pass through it each year.**

TO GAIN AN UPPER HAND in the competitive air travel market, carriers must adapt or die at the speed of sound. Whereas American Airlines and US Airways are merging, Delta Air Lines is betting on ground facilities to set it apart. The Atlanta-based corporation recently completed a \$1.2 billion redevelopment of Terminal 4 at John F. Kennedy International Airport, one of eight domestic hubs. "New York is the most competitive market in the world; we can never stop

investing in the customer," Gail Grimmett, Delta's senior vice president in New York, recently stated.

The project is a joint venture of architecture firm SOM and engineer Arup and dates to master planning that began in 2007. SOM associate director Mark Leininger explains that that process originally identified 19 sites where Delta could increase its gates, to service Latin America and other destinations. He adds, "Living up to the hub designation also means minimal transfer times."

Those criteria precluded reusing Pan Am Worldport, the 1960 pavilion that Leininger deems "too antiquated to ever put Delta on par with other carriers." Instead they favored Terminal 4, which boasted room to grow in flanking parking lots, as well as U.S. Customs and Border Protection facilities that could expand for quicker rechecks and transfers.

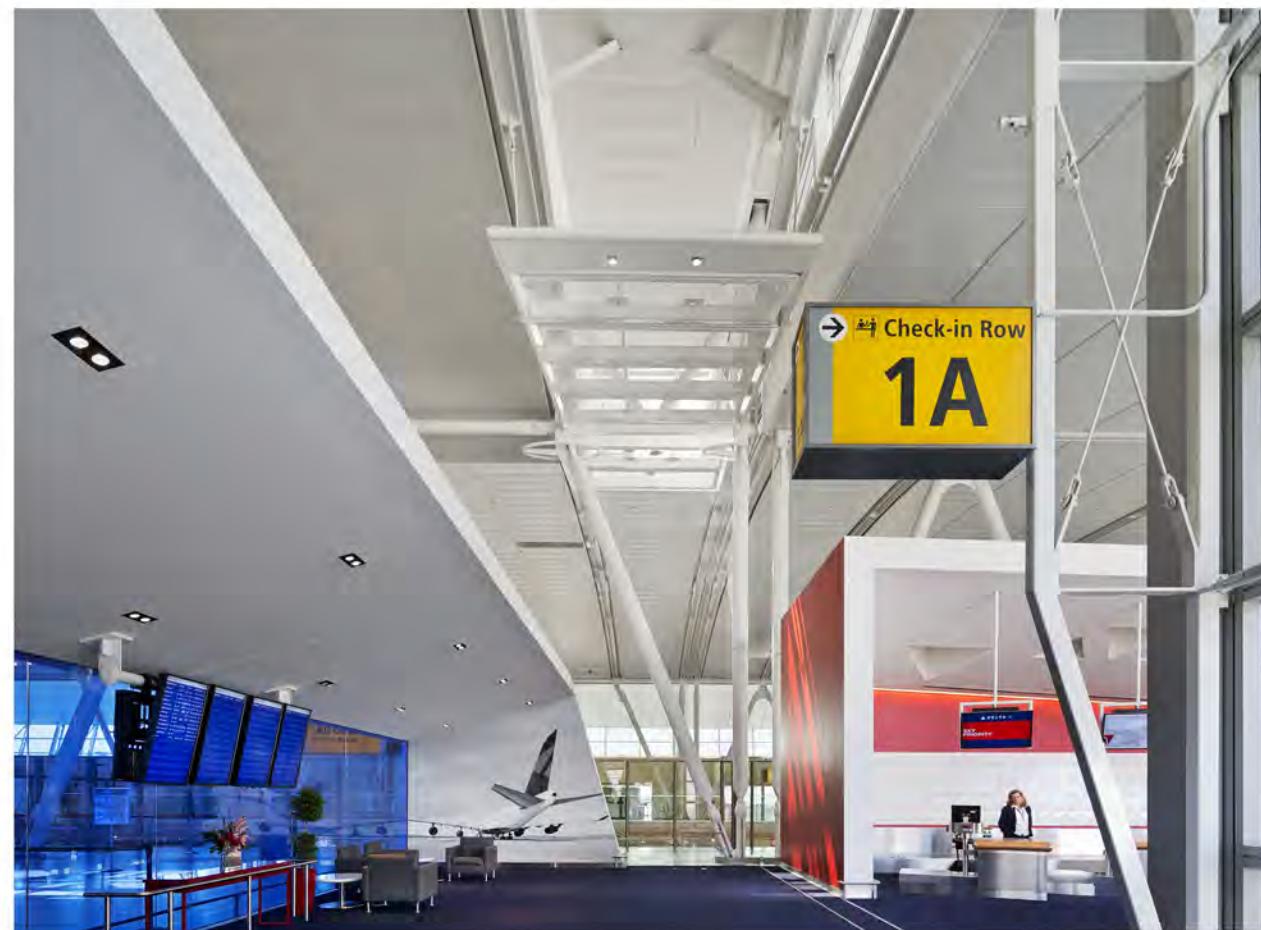
Yet even in Terminal 4, the ArupSOM team confronted obsolescence. The SOM design, completed



**Above** Check-in kiosks are located on the uppermost floor of the Terminal 4 headhouse.

**Opposite** One of eight domestic hubs, the terminal design aims to reduce transfer times with an efficient layout.

**Below** The building's structural steel design creates open, daylit spaces.



This spread: Eduard Hueber/ArchPhoto Inc.



keep the structural depth to an absolute minimum and maintain an inviting retail interior," says Arup associate Jenny Buckley. "It was the obvious choice, as other structural systems could not compete on constructability, minimizing disruption, and aesthetic compatibility."

Buckley explains that a study of existing columns supporting the retail hall showed additional capacity for this insertion, but that analysis of the beams of the check-in floor, which ring the atrium, indicated little reserve. Consequently, 12 V-columns support the SSCP floor structure. Each is a pair of HSS 10.75-diameter pipe columns splaying from a custom pin connection just above the top of the finished retail floor; a gusset plate extends from the base plate. Among other things, the V-columns reduce the span of the girders above, stiffen those girders against lateral loads, and visually lighten the SSCP structure. Leininger likens its geometry to a forest, while Buckley points out that the V shapes mirror the arrangement of 14-inch-diameter pipes in the existing roof. Both columns and pin

connections are detailed as Architecturally Exposed Structural Steel (AESS).

Directly underneath the retail floor, existing columns in the east-west direction are spaced on every other gridline. So W27-section primary girders were laid atop the V-columns in parallel—56 feet on center. The secondary structure then runs north-south with a middle span of 30 feet and approximately 16-foot cantilever lengths, which vary according to the curvature of the check-in floor. To minimize disruption to airport operations, the project team and building operator eschewed casting this intermediate structure *in situ* for a system of prefabricated steel-and-concrete planks. The typical plank cross-section comprises two W8x40 beams spaced at 2 feet on center, which structural steel fabricator Cives Steel Company welded to a 48-inch-wide Grade-50 steel plate that measures  $\frac{3}{8}$  inches thick.

A lightweight concrete slab completes the SSCP structure, and is secured to the intermediate plate via shear studs welded to its top face. The 4-foot gap between the girder line and the check-in floor

**Right** Construction of the new terminal was carefully choreographed to minimize disruptions on Delta's operations. **Below** Throughout the new building, raceways within the structure will allow conduits, such as those for power and sprinkler systems, to be reconfigured in case of new technology or security procedures.

**"Steel was the obvious choice, as other structural systems could not compete on constructability, minimizing disruption, and aesthetic compatibility."**

Jenny Buckley, Arup



This spread: Eduard Hueber/ArchPhoto Inc.

Introducing the gantry crane into the headhouse required removing and reinstalling IGUs from the south elevation of the 955,000-square-foot building.

Expanding Delta's presence at Concourse B required little such daintiness. Because the carrier's nine new gates were to be located post-security, the joint venture could "cordon off the expansion site like the Berlin Wall," Leininger says. The extended concourse comprises composite steel floor framing combined with transverse and longitudinal braced frames in four independent structures isolated by expansion joints; steel frames run 44 feet on center, and the typical floor beam sizes are W24x84 longitudinally with W12x35 intermediate beams.

In the less fastidious vein, for Concourse B the project team also could replicate structure that was already there. Passenger boarding bridges are modeled after existing gates, for example, with each bridge formed from a composite steel gravity system and braced and moment-frame lateral systems.

And it may replicate them again, considering that its property strategy has taken off. Among other recent initiatives, Delta is expanding recharging stations at 13 airports, and the company recently announced a \$229 million investment to upgrade Terminal 5 at Los Angeles International Airport as well.

#### JOHN F. KENNEDY INTERNATIONAL AIRPORT TERMINAL 4

Location: John F. Kennedy International Airport Terminal 4, Jamaica, New York, NY  
Owner: Port Authority of New York and New Jersey, New York, NY  
Architect: ArupSOM, New York, NY  
Structural Engineer: Arup, New York, NY  
Mechanical Engineer: Arup, New York, NY  
Construction Managers: Turner-Peter Scalambro & Sons, A Joint Venture, New York, NY (Concourse B); Lend Lease, New York, NY (Headhouse)  
Structural Steel Fabricator: Cives Steel Company, Gouverneur, NY  
Structural Steel Erector: Stonebridge Steel Erection, South Plainfield, NJ



# 51 Astor Place

A new multi-use spec building at the site of Cooper Union's former engineering school brings Fumihiko Maki's elegant design and Minskoff Equities' market divination to Manhattan's bohemian enclave. Its unfolding structure helps 51 Astor Place keep its different aims in productive tension.

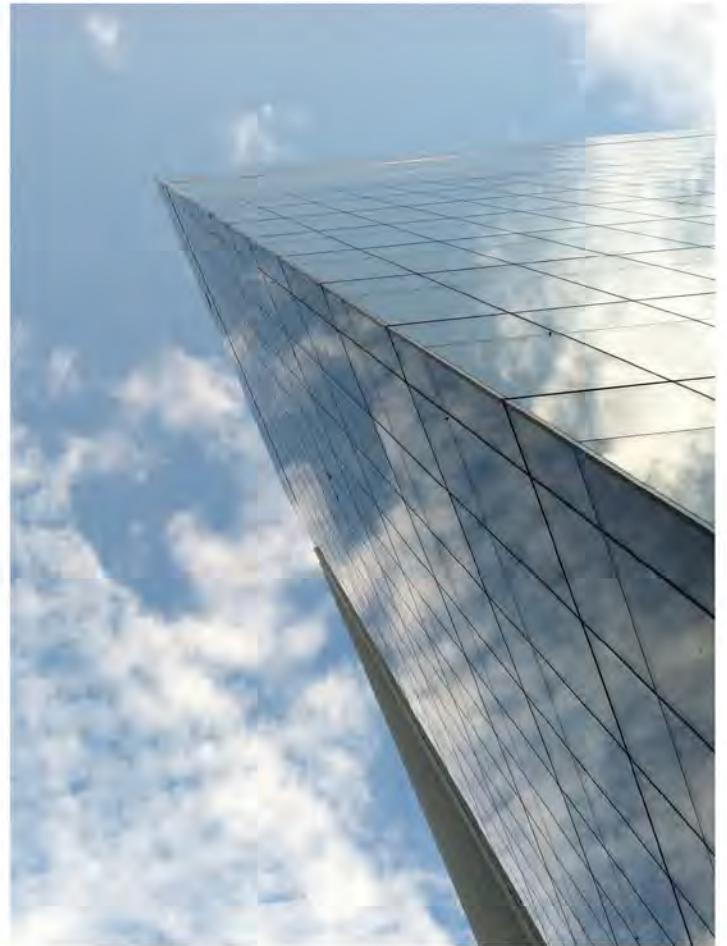
FEW TEARS WERE SHED around Manhattan's Astor Place when Cooper Union moved its engineering program into the futuristic Academic Building and vacated its former headquarters, a late-1960s-vintage tan-brick structure on a site that had hosted a variety of short-lived enterprises. As part of an effort to shore up its institutional finances, Cooper leased the land for 99 years to commercial developer Edward J. Minskoff Equities, which saw the site as a great opportunity with its easy access to mass transit and a neighborhood attractive to young, creative types. Demolishing the engineering building cleared the way for an adventurous mixed-use project by Pritzker Prize-winning architect Fumihiko Maki.

Maki's design presents contrasting facades that deliver different visual statements to each view. Seen from the west, the tower is all business, dark and stark, with highly reflective low-emissivity glazing that offers mirror images of Burnham's Wanamaker Annex; from the east and the southern corner, called the "prow," the podium presents a more exuberant geometry, supporting a fifth-floor roof garden and opening out welcomingly onto a landscaped ground-level public plaza.

Nick Zigomanis, a partner at architect of record

Adamson Associates, considers the chief design innovation to be elegant simplicity of form that serves a deceptively complex set of functions. The building comprises two linked volumes on a full city block, appearing in plan as a quadrilateral tower (three vertical masses around the concrete and steel core), with its longest edge running uptown–downtown along Fourth Avenue, and a roughly trapezoidal podium facing Third Avenue and Astor Place, making the ground-plane footprint irregularly pentagonal. The podium, says Susan Bacas, managing partner of project structural engineer Ysrael A. Seinuk, was designed to accommodate large tenants, with lighter columns than in the tower. The two volumes were constructed at the same time with separate cranes and teams to accelerate the schedule.

Though the architects did not plan explicit themes for each facade, Zigomanis recalls, they recognized that a monolith resembling the large west facade on all sides would be "far too oppressive for that site." The curtain wall brings contrast and high visual energy to the building's other elevations. Ribbed aluminum mullions wrap around the north, east, and southeast facades, and form a rectangular panel interrupting the west facade at its lower south corner and helping define the business entrance to the main lobby. The prominent mullions emphasize verticals and articulate the backdrop to the plaza. Michael Chen, an associate with building envelope consultant Israel Berger, describes these "fins" as 6-inch-deep asymmetrical elements extending the height of each building segment, designed with floor-to-floor splicing and alignment pieces between fins to allow for building movement due to either wind-induced sway or different gravity loads, tolerating movements of  $\frac{3}{8}$  inch vertically and  $\frac{1}{2}$  inch horizontally. The curtain wall also includes thin



**Top** The building's form serves a complex set of functions, including future educational and retail tenants.

**Above** A structural steel design with few right angles lends 51 Astor a unique shape as viewers encounter it from different directions.

**Facing** Diagonal separation between lighter and darker glass expanses, which also have contrasting glazing module sizes, emphasizes the east facade's structural volume.

granite elements around the entrances and the Astor Place facade, but it remains light enough to place a minimal load on the frame. Zigomanis cites the design-assist process, in which Permasteelisa was brought on early in design development, as a high-priority and effective strategy in ensuring precise detailing.

The most striking external feature is a diagonal separation between darker and lighter glass expanses on the tower's east facade, with contrasting module widths of 5 feet and 2 feet, 6 inches beneath and above the diagonal, respectively. Both surfaces comprise Viracon Insulating Glass Units: The dark glass below the diagonal is a VWP1-40 with a reflective pewter coating on the #2 (airspace-facing) surface and a low-e coating on the #3 surface, while the lighter, more reflective upper area is a VRE1-46 with a radiant low-e coating on the #2 surface. The combination of the coatings with a stainless steel diagonal spacer yields high thermal performance.

The two-segment curtain wall generates the optical illusion that this flat surface is actually faceted. The feature takes its angle from the podium's setback from the southeast curb plaza as seen in plan, says Zigomanis: "In effect, the transcribed angular line of the facade really is deriving itself from the same geometric massing display." At the prow, he says, "that corner of the building is almost a book in the way it unfolds: truly a brilliant move, and a simple one."

Structurally, the steel-frame-and-concrete-core building has solved problems that were anything but simple—the design has very few right angles for the structural steel layout—and did so on an accelerated construction schedule with a remarkable lack of onsite complications or delays, reports Seinuk associate principal Damian Monteiro, who oversaw the fieldwork for Bacas. The framework uses 1,900 tons of A572 Grade 50 structural steel, about 310,000 square feet of metal deck, and about 50,000 shear studs; steel member sizes ranged from W14x43 to W14x455.

The foundation reuses a segment of the old engineering building's basement wall under the tower along Ninth Street and the northern segment of Fourth Avenue, pouring a new wall underneath it to the sub-basement level; the sub-basement does not extend to the podium side. The tower-side team, with 13 floors and a higher piece count, started earlier, linking up with the podium floor at the fifth floor; erecting double-floor-height columns required constructing decks on top floors for overhead protection before coming back down to work on decks below. But coordinating the back-and-forth aspect of the steel erection with work on the concrete core's shear walls, built from the bottom up, was a timing challenge. Since the site "was at the point where wind overtakes earthquakes" as a source of shear-force concerns, Bacas adds, and the tower is eccentric to the podium, "the right-hand [east] side has a frame controlling the rotation of the building," with six tightly spaced, very heavy W14x455 columns and heavy beams adjacent to the property line.

The triangular southeastern plaza, with a steel dashed line embedded in the sidewalk to demarcate the historic Indian trail connecting Astor Place and Stuyvesant Street, connects the building to the East Village community, in harmony with the city's plan

This page: Claudia Giordano; facing page: Richard Ginsberg; opening spread: Joel Raskin



for linked landscaped plazas along Fourth Avenue. The terms of the lease require that 51 Astor include an educational tenant along with offices and retail; the southeast entrance is thus termed the "college entrance" as well as the "community facility entrance," and space on the lowest two floors will accommodate academic functions. Three double-height retail areas enliven the ground plane. Floor heights are generous: 14-foot slab-to-slab height on floors 3 through 11, 16 feet on the academic second floor, and 18 feet on the 12th.

Despite its disparate components and purposes, 51 Astor "doesn't come across as a building that's too fussy or complicated," Zigomanis says. Its design elements resolve with subtlety, amplifying variety as an observer walks around its perimeter. It strives for high performance both in its environmental impact—it meets the LEED Gold standard—and in tenant amenities, including a web-based service request system and bicycle storage with showers. It is a building that rewards prolonged study, one whose apparently straightforward features reveal increasingly rich complexities.

## 51 ASTOR PLACE

Location: 51 Astor Place, New York, NY

Owner: Edward J. Minskoff Equities, Inc., New York, NY

Architect: Maki and Associates, Tokyo, Japan

Associate Architect/Architect of Record: Adamson Associates International, New York, NY

Structural Engineer of Record: Ysrael A. Seinuk, New York, NY

Mechanical Engineer: WSP USA, New York, NY

Construction Manager: F.J. Sciame Construction, LLC, New York, NY

Curtain Wall Consultant: Israel Berger & Associates, New York, NY

Structural Steel Fabricator: Cives Steel, Gouverneur, NY

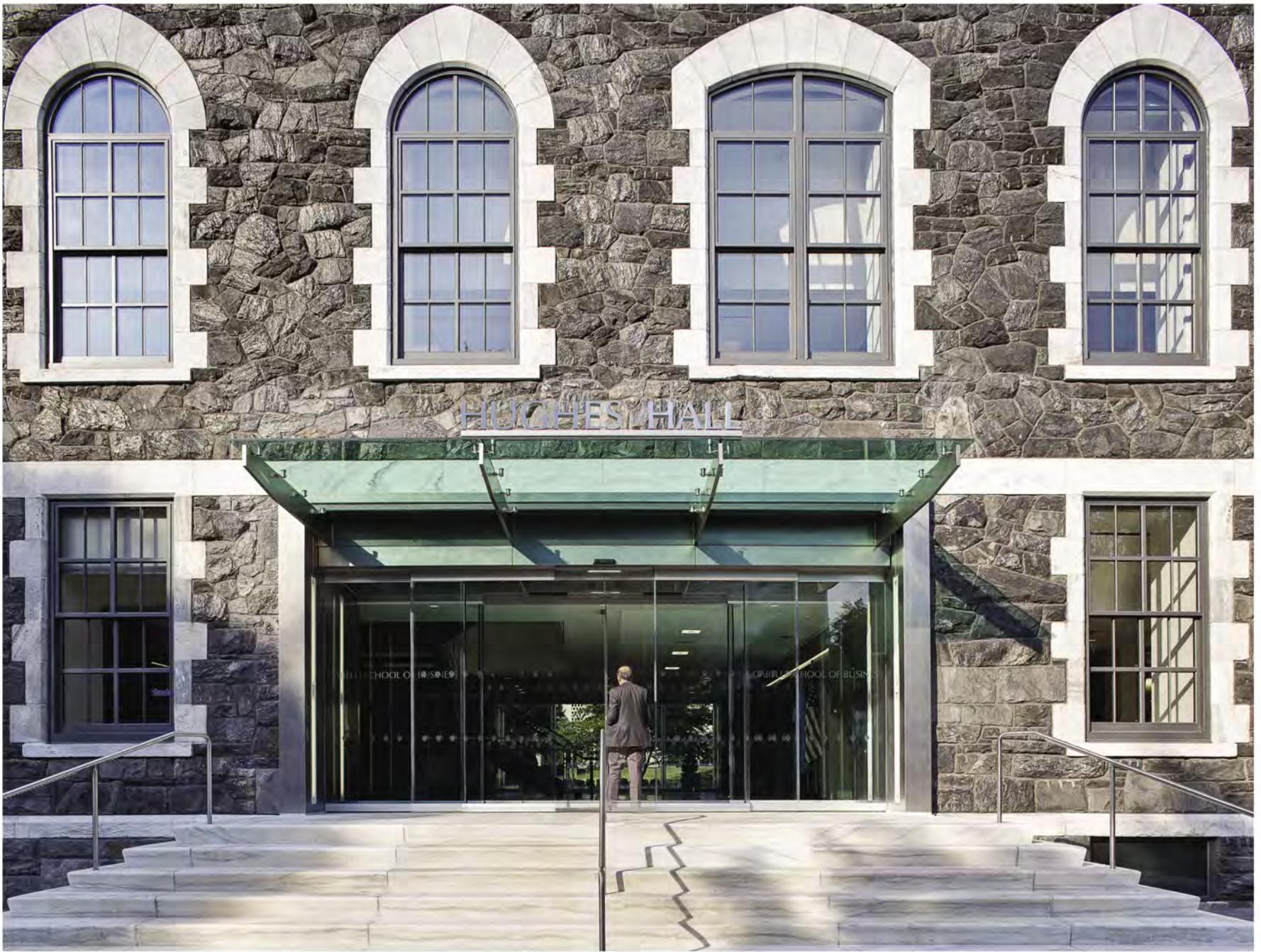
Structural Steel Erector: Stonebridge Steel Erection, South Plainfield, NJ

Miscellaneous Iron Erector: FMB Inc., Harrison, NJ

Ornamental Metal Erector: FMB Inc., Harrison, NJ

Curtain wall Fabricator: Permasteelisa North America, New York, NY

Curtain Wall Erector: Tower Installation, Windsor, CT



# Fordham University Gabelli School of Business



**Temporary and permanent steel structures make a 21st century program possible while preserving the heritage of the university's past.**

THE GREEN MANSARD ROOFS OF Fordham University's Rose Hill campus buildings are integral to the university's heritage, which dates back to 1840. They symbolize stability and longevity, cornerstones to the culture of the school. When it came time to transform a 120-year-old, 40,000-square-foot dormitory with a prime campus location into a new state-of-the-art facility for the Gabelli School of Business, the mansard roofs became integral for another reason: they served to connect the building's conservative, revivalist-style granite facade, its stone quarried from the campus grounds, with the business school's new high-tech program inside.

Project architect HLW's proposal to use a two-story glazed structure instead of a traditional copper mansard roof was responsible for making the connection, says John Gering, managing partner. "We knew the president

wanted a mansard roof," Gering adds. "But we were certain that the solution would bridge the gap between the past and the future."

The team had a full-scale model of the structure built on top of the building. When university President Joseph M. McShane, who made all decisions impacting the exterior architecture of the school, returned from the 2011 Saint Patrick's Day Parade, where he had been "seeing green all day long," the team showed him the 20-foot-high glass mock up. "Within two minutes, he said 'do it,'" Gering says.

But the real challenge the design team faced was how to fit the school's extensive program within the confines of a five-story building with a 125-by-50-foot footprint. The original structure—cast iron columns in a central corridor with steel girders and wood joists spanning to the granite exterior bearing walls—took up too much floor area.

"We went against conventional wisdom and got rid of all the interior columns to create an open span of space," says Jennifer Brayer, HLW's partner in charge. The decision allowed for a very effective interior plan that accommodated classrooms, offices, a trading floor, common areas, and

more. "There was a lot to cram in," she says.

This meant removing the original structure while keeping the exterior walls intact. Everything inside the four walls of Hughes Hall—the mechanical systems, the roof, the wood-joint framing, cast iron columns, structural steel beams, and footings—had to be removed. "We called it melon-ballining," Gering says. "We took a melon-baller and scooped everything on the inside and took it out."

The university did not allow external temporary bracing for aesthetic reasons, so the team had to develop a creative interior plan for bracing the building's perimeter walls while the demolition of the interior took place. HLW's structural engineers developed a sequencing plan that would transfer the lateral support from the original timber framing, which was pocketed into the bearing walls, to twelve perimeter columns just inside the walls.

First, the team had to dig down 3 feet so that the basement space was usable for classrooms and to ensure the floor-to-floor heights were properly aligned. This entailed underpinning the basement. "The profile of the borings under our building showed



that the bedrock ranged from 5 feet down to 20 feet down," says Frank Polemeni, project executive and vice president for construction manager Tishman Construction.

The exterior bearing walls at the base are 3 feet wide. "The underpins had to go to firm soil, and span the depth of the walls," Polemeni says.

When the underpinning was in, new footings for the twelve perimeter columns were formed. The footings would bear the entire weight of the new interior structure, explains Tom Gasbarro, HLW partner and director of structural engineering. "It was like building a new building inside an old one," he adds.

The original timber framing was pocketed into the bearing walls and provided the lateral support for the walls. "One of the first things we thought about was, if we take the framing out, will the walls be stable?" Gasbarro says. "We didn't want

to take any chances. We designed a sequence of installation so that we would maintain lateral support through all phases of construction."

The construction teams opened up each floor in 5-foot sections from top to bottom and threaded the W10x100 steel columns from the roof down through the entire building; W18x76 beams were installed below the original floor slab and attached to a temporary whaler system (W18x45) installed around each floor.

Once the metal deck and slab were in place and doweled into the original granite walls for stability, "it was a conventional job," Polemeni says. "But the challenge was getting to that point."

Polemeni jokes that the temporary bracing plan seemed like "overkill" at first. "I swear, we had this conversation, and the next week, I was in my office and I heard this rumbling sound. I thought 'No, way,' and I ran all the way to the building. An earthquake had hit farther south and we felt it all the way up here. The building was fine. Then the conversation was, 'Thank goodness we had it!'"

This spread and opening spread: HLW

**Above** Architects replaced the building's original structure—consisting of cast iron columns, steel girders, and wood joists—with steel columns and beams to create room for the business school's many functions.

**Facing** A circulating staircase encourages interaction between students and lends to the school's collaborative atmosphere.



The project team also faced the challenge of widening the north and south entryways to 20 feet. "At those large openings, we had to have new lintels for the stone and those members were 27x129 and 21x93 side by side. Each opening had both because the opening was 3 feet thick," Gasbarro says. Because of the size of the opening, the load from the stone above the doorway had to be supported temporarily until the load could be transferred to the steel members.

"We used the new footings to support the shoring as we put the new beams in," Polemeni adds.

At the entrances and for the temporary and permanent

structural needs of the building, "there wasn't any thought to using any other material other than steel," Gasbarro says. While the design team explored different sequencing schemes and temporary bracing alternatives, he says that steel was always the choice for bringing the building from the 19th century into the 21st century.

When the lights glow from Hughes Hall at night, the bright future of Fordham's business school clearly shines from the windows, roof, and entryway. In Brayer's words: "The building is the connector bridge between the old and the new and now provides a sense of community on campus."

#### FORDHAM UNIVERSITY GABELLI SCHOOL OF BUSINESS

Location: 441 East Fordham Road, Bronx, NY

Owner: Fordham University, Bronx, NY

Architect: HLW, New York, NY

Structural Engineer: HLW, New York, NY

Mechanical Engineer: Jaros Baum & Bolles, New York, NY

Construction Manager: Tishman Construction Corporation, New York, NY

Structural Steel Erector: Burgess Steel, Englewood, NJ

Miscellaneous Iron Erector: GC Ironworks, Elmsford, NY

Architectural and Ornamental Metal Fabricator and Erector: Coordinated Metals, Inc., Carlstadt, NJ

Metal Deck Erector: Burgess Steel, Englewood, NJ



Iwan Baan

Facing Terraces and external stairs emphasize the structure's "lines in space" concept, inspired by field-play diagrams used in sports.

# Campbell Sports Center at Columbia University

**Resting on steel point foundations, a new athletic facility is inspired by the crisscrossing lines of field-play diagrams and creates a gateway to the university's Inwood sports complex.**

LOCATED IN THE INWOOD NEIGHBORHOOD at the northernmost tip of Manhattan, the Baker Athletics Complex has been the home of the outdoor sports programs at Columbia University for decades. The complex seemingly had it all: a football stadium, soccer fields, tennis courts, two baseball fields, even a physical fitness center built in the mid-1970s. What was lacking, up until recently, were offices for the varsity sports athletic staff as well as meeting rooms for larger gatherings. Since the complex is a few miles distant from the main campus, there was also a need for study rooms and strength building facilities for the student athletes plus a hospitality suite to support event activities.

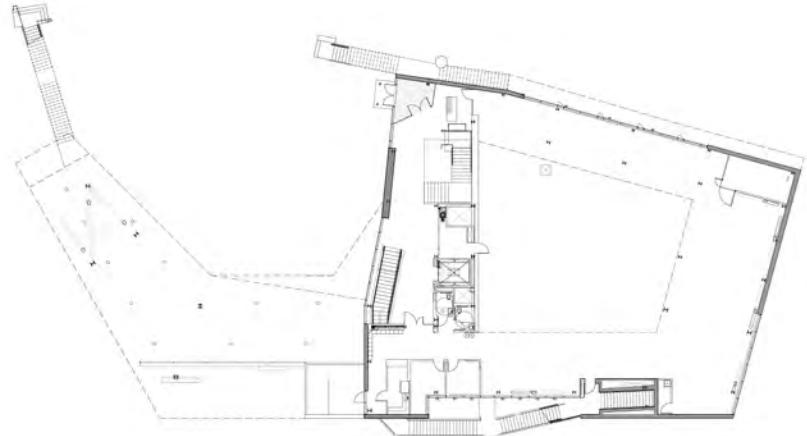
Recognizing these needs, the university commissioned Steven Holl Architects of New York to develop a building that could fit into the overall complex and become a focal point for the facilities already there. Together, they determined that the corner of West 218th Street and Broadway—where Broadway crosses with Tenth Avenue and the elevated tracks of the 1 subway line—was an ideal opportunity to both shape an otherwise obscure urban corner and to create a new anchor for the overall sports complex.

Steven Holl, well known for insightful designs, saw the building as serving the needs of the whole athlete. He states that the 48,000-square-foot Campbell Sports Center "aims at serving the mind, the body, and the mind-body for aspiring scholar-

athletes." Inspired by the diagrams used in field sports that define "points on the ground, lines in space," his building design developed from "point" foundations on the sloping ground and exposed terraces and external stairs that serve as the "lines in space." By extending five stories upward from Broadway it connects the elevated playing fields with the lower streetscape while giving views from the upper levels over the fields and Manhattan. One of the main design features is the creation of an elevated narrow extension of the building that is described as an "arm" that reaches around from the third level and down an exterior stairway to the athletic fields. In the process it creates open space below that serves as a covered portal or gateway to the athletic fields for spectators.

Olaf Schmidt, associate in charge of the project for Steven Holl Architects, saw the need to combine this intricate design intent with the practical construction requirements right from the beginning. "Up-front coordination was very important as the way to bring all ideas and all parties to the table." This began with the decision to use all-steel structural framing for the project in order to provide the flexibility and versatility needed to meet the design intent and the sloping site. The elevated "arm" of the building was a particular feature that grew from strong collaboration between all of the parties involved. The original structural design had more columns exposed under the arm to support it but the architect asked if that could be modified to use fewer columns. Pat Arnett of structural engineer Robert Silman Associates led his engineering team to experiment with designs that removed more and more of these columns across six different designs. In the end, he points out that, "Everyone agreed on a design that includes more trusses and fewer columns. This whole elevated section of the building functions more like a bridge. The design achieved lateral stability by using moment connections and some angled columns that all worked together to transfer the loads." To help minimize columns in this area, one portion is supported in tension from the upper structure using a solid round 4-inch steel bar with custom connections at the top and bottom. "This was an unusual and unique solution that worked quite well in this case," says Arnett.

The rest of the building relied on some innovative steel structural design as well. In essence, the engineers established a few lines of structure that ran through the building and determined where they could put lateral bracing in between. The structure was held back from the exterior, meaning that the floors were cantilevered out 2 or 3 three feet depending on the location. It was these floors that required considerable attention to detail and coordination since they were framed with steel beams that supported pre-cast concrete plank. The design intent was to have the concrete plank sit flush with the top of the steel beams and then pour over it a 3-inch concrete topping that would remain exposed as the finished floor of the building. These A992 steel beams ranged in size from W12 to W24. Then, A36 plates and angles were connected to the web or the bottom flange to secure the 12-inch-thick concrete plank in place at the proper elevation. The varying geometry of the building was the reason for the variations in the steel sizes, but it



**Left** A plan of the center's fifth floor.  
**Center** The building shapes an urban corner on Broadway and 218th street.  
**Bottom** Extending over a stepped landscape, blue soffits heighten the openness of the urban-scale portico to the Baker Athletics Complex.  
**Facing** The 48,000-square-foot facility houses strength and conditioning spaces, offices for varsity sports, theater-style meeting rooms, a hospitality suite, and student-athlete study rooms.



meant that every concrete plank and connection to the steel were drawn and heavily coordinated and reviewed by the designers, the steel fabricators and the concrete plank supplier all under the oversight of the construction manager and engineers.

The main weight room on the second floor of the building also posed a structural challenge that was readily met. The weight room is a two-story atrium space ringed by views from the upper level. The loads from the floors above it needed to be transferred around this open space, so a massive 54-inch deep plate girder with 18-by-4-inch flanges was used to meet the need. The structure is exposed and expressed in this space, so it seems only fitting to everyone that this plate girder resembles a giant barbell in appearance and is quite consistent with the weight room use.

The metal building facade is an elegantly designed arrangement of open joint aluminum rain screen panels accentuated with metal covered exterior stairs. The panels were installed with narrow 1/4-inch gaps and secured to conventional construction behind. The architect and curtain wall consultant W.J. Higgins worked directly with the fabricator to create these custom panels from 1/4-inch raw aluminum flat plate. Each panel was sanded to create the desired appearance and then received a clear anodized finish. Panels that cover over the exterior stairs were finished in the same manner but perforated to create a lighter appearance in contrast with the solid rain screen panels. The exposed exterior structural columns were painted to carefully match the coloring and sheen of the sanded aluminum such that the total building presented a unified appearance. Olaf Schmidt says he was particularly pleased with the overall end result finding that, "The aluminum rain screen panels and stair panels accommodated the design very well. These different pieces ended up matching in appearance quite well due to the careful work of the fabricators."

The large aluminum soffit areas under the upper sections of the building are finished in Columbia blue. While this gives an appropriate nod to team spirit and loyalty, it also provides a design feature that works particularly well at night when the building lights are on to showcase the color. Extending

Top: Steven Holl Architects; center and left: Iwan Baan



#### CAMPBELL SPORTS CENTER AT COLUMBIA UNIVERSITY

**Location:** W. 218th Street at Broadway, New York, NY  
**Owner:** Columbia University, New York, NY  
**Architect:** Steven Holl Architects, New York, NY  
**Structural Engineer:** Robert Silman Associates, New York, NY  
**Mechanical Engineer:** ICOR Associates, Iselin, NJ  
**Construction Manager:** Structure Tone Inc./Pavarini McGovern, New York, NY  
**Curtain Wall Consultant:** W.J. Higgins, Wasau, WI  
**Structural Steel Fabricator:** Weir Welding, Carlstadt, NJ  
**Structural Steel Erector:** North American Iron Works Inc., Ridgewood, NY  
**Miscellaneous Iron Fabricator and Erector:** Post Road Iron Works, Greenwich, CT  
**Architectural Metal Fabricator and Erector:** City Glass Co., Bayonne, NJ  
**Ornamental Metal Fabricators and Erectors:** City Glass Co., Bayonne, NJ; Post Road Iron Works, Greenwich, CT  
**Metal Deck Erectors:** North American Iron Works Inc., Ridgewood, NY;  
**Weir Welding,** Carlstadt, NJ  
**Curtain Wall Erector:** City Glass Co., Bayonne, NJ

## INSTITUTE NEWS AND EVENTS

### Designing Structural Stainless Steel Conference



On September 18, 2013, the Steel and Ornamental Metal institutes of New York hosted the Designing Structural Stainless Steel conference at McGraw-Hill Auditorium. Architects, engineers, and

building industry members attended the day-long event, which began with a keynote address by distinguished professor and researcher Dr. Theodore (Ted) V. Galambos, Ph.D., P.E., emeritus professor of structural engineering at the University of Minnesota in Minneapolis.

Although stainless steel has been used for structural applications in the United States since the early 1900s, only with the recent publication of the AISC Structural Stainless Steel design guide does this versatile metal have a U.S. resource for architects and engineers to use in designing

### Fall Lectures: Jon Magnusson and Willem Jan Neutelings:



Magnusson's firm has engineered some of the most innovative structures in the world including

Structural Engineer Jon Magnusson, founding partner of Magnusson Klemencic Associates, gave a lecture entitled *Structure Becoming Architecture: Case studies of aesthetics, form and efficiency* on October 21, 2013, at Cooper Union. Magnusson's firm has engineered some of the most innovative structures in the world including

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Institute ads appear regularly in New York-area industry publications to let readers know that we can help turn their design aspirations into realities.

**UN  
VEILED**

When erected in 1952, the United Nations Secretariat symbolized the latest advances in curtain wall construction. But rapid deterioration by the elements soon masked the transparency envisioned in the original design. Only after HLW International and R.A. Heintges & Associates undertook its replacement as part of a 21st-century update has the facade's intended splendor been revealed. Now, along with added energy efficiency and blast-resistance required by its prominence, it gives the city a long-desired glimpse of the grandeur that helped shape global architecture in its day.

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**UP  
STAGED**

Larry Silverstein's 9/11 Memorial Museum Pavilion must echo the somber dignity of its WTC environs while admitting thousands of visitors to its exhibits each day. To achieve these diverse goals, Snøhetta teamed with consultant Frei Inc. to design an enclosure that both maximizes the building's security and mirrors its plaid surroundings. Through the changing days and seasons, it offers visitors a unique space designed for theatrical productions while giving them a vantage point from which to view from among the surrounding trees.

**Structural Steel Right for any application**

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**REFLECTING  
PRESENCE**

As the only building officially on memorial grounds, the National September 11 Memorial Museum Pavilion must reflect the somber dignity of its WTC environs while admitting thousands of visitors to its exhibits each day. To achieve these diverse goals, Snøhetta teamed with consultant Frei Inc. to design an enclosure that both maximizes the building's security and mirrors its plaid surroundings. Through the changing days and seasons, it offers visitors a unique space designed for theatrical productions while giving them a vantage point from which to view from among the surrounding trees.

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**COURT  
ROOM**

A state-of-the-art arena with unparalleled sightlines and an interior environment as dynamic as its sculptural exterior, Barclays Center is New York's first major new entertainment venue in nearly a half century. To achieve these diverse goals, Snøhetta teamed with consultant Frei Inc. to design an enclosure that both maximizes the building's security and reflects its plaid surroundings. Through the changing days and seasons, it offers visitors a unique space designed for theatrical productions while giving them a vantage point from which to view from among the surrounding trees.

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the Seattle Public Library and the Wyly Theater with Rem Koolhaas as well as the Experience Music Project with Frank Gehry. Mr. Magnusson discussed these and other projects from his firm's portfolio of work. With offices in Seattle, Chicago, Shanghai, and Riyadh, the 175-person firm has provided engineering services for projects in 47 states and 51 countries.

On November 6, Willem Jan Neutelings, founder of Neutelings Riedijk Architects, lectured on his firm's current work to an audience of students and professionals in Columbia University's Wood Auditorium. Both lectures were sponsored by the Steel Institute of New York.

### Continuing Education With Architectural Record

This year, the Steel and Ornamental Metal institutes of New York launched a series of AIA Continuing Education articles with *Architectural Record*. The first two topics are available online at [continuingeducation.construction.com](http://continuingeducation.construction.com): *Design Flexibility Using Structural Steel* outlines how architects can address challenging urban site conditions through innovative structural design;

*More Than One Way to Skin a Building*, winner of a readers' choice award, presents four curtain wall-design case studies illustrating different ways to address daylight while achieving superior aesthetics and performance in new and renovated buildings.

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The Steel and Ornamental Metal institutes of New York are not-for-profit associations created in 1972 to advance the interests of the structural steel and the architectural, ornamental, and miscellaneous metal construction industries. They serve a geographical area encompassing New York City and the adjacent counties of Nassau, Suffolk, and Westchester. Each sponsors programs to aid architects, engineers, construction managers, and developers in selecting structural systems and architectural metals for optimum building performance. Programs in which the institute is engaged include:

- Seminars covering structural systems, economy of steel design, curtain wall systems, design, and use of alloys and surface treatments for miscellaneous iron work, and issues important to the construction industry addressed to developers, architects, engineers, construction managers, detailers, and fabricators
- Representation before government bodies and agencies in matters of laws, codes, and regulations affecting the industry and the support of programs that will expand the volume of building construction in the area
- Consultations extending to the preparation of preliminary design and construction cost analyses for alternative structural systems
- Granting of subsidies to architecture and engineering schools and funding of research programs related to the advancement and growth of the industry
- Consultations on design and finishes for bronze, stainless steel, and aluminum for architectural and ornamental ironwork, curtain wall systems, window walls, and metal windows and panels
- Publication of Metals in Construction, a magazine dedicated to showcasing building projects in the New York area that feature innovative use of steel

Institute staff are available with information regarding the use of structural steel and architectural metals for your project by contacting institute offices at

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