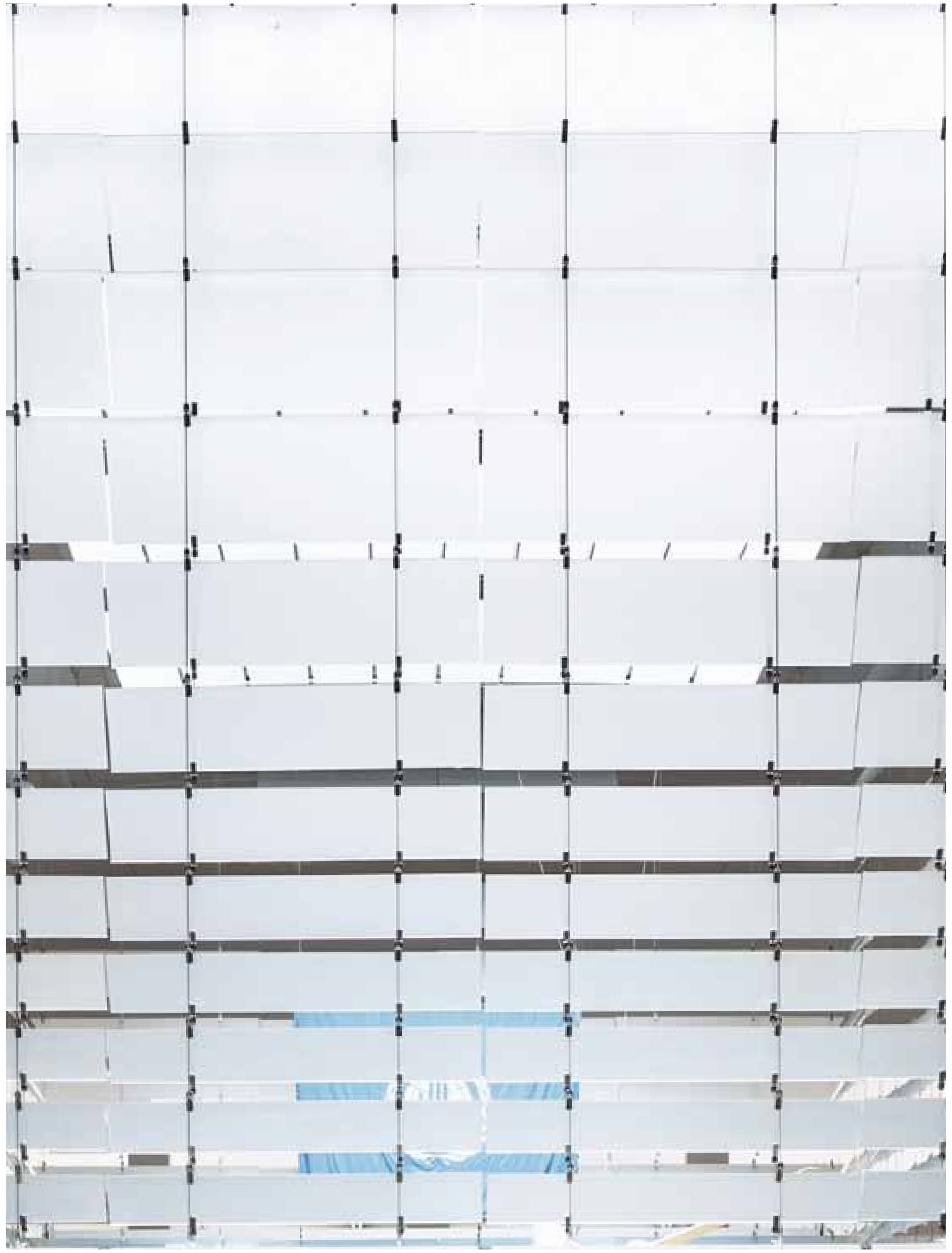
METALS IN CONSTRUCTION

PUBLISHED BY THE STEEL INSTITUTE OF NEW YORK AND THE ORNAMENTAL METAL INSTITUTE OF NEW YORK
SPRING 14

THE PAVILION AT BROOKFIELD PLACE / NEW SCHOOL UNIVERSITY CENTER / HUNTER'S POINT CAMPUS / QUEENS MUSEUM / POLONSKY SHAKESPEARE CENTER / BELFER RESEARCH BUILDING / MADISON SQUARE GARDEN / LEHMAN COLLEGE SCIENCE FACILITY

CONTENTS
SPRING 14



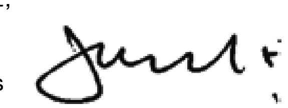
Published by The Steel Institute of New York and The Ornamental Metal Institute of New York

Above The interior lantern of Queens Museum, designed by Grimshaw Architects.
Cover The Weill Cornell Medical College Belfer Research Building, designed by Ennead Architects.

This page: © David Sundberg/Esto; cover: Tex Jernigan

EDITOR'S NOTE
Architectural evolution

I RECENTLY HAD REASON TO browse through several decades worth of *Metals in Construction* and came away awed by the advances in curtain wall technology as chronicled in past articles. When—and why—did designers begin thinking of a building's exterior wall as more than just a static enclosure, one that modulates the elements instead of bowing to them? Was it in response to the energy crisis of the seventies? Did the introduction of digital design tools mark the beginning? Were advances in the development of new materials the instigator? In fact, one learns, it began much earlier with these influences only a few among many that have played pivotal roles in curtain wall development over the past century. As a result, today's building enclosure is the element most influential in delivering the desired energy performance. In achieving this prominence, its potential as a catalyst for building-wide change has inspired some of the most stimulating architecture of any era, much of it and the history behind it illustrated in the recently released *KINECTIC ARCHITECTURE*, a new book by Charles D. Linn, FAIA, and Russell Fortmeyer, writers well-known to New York's design community. Today, with rising greenhouse gas emissions and resource depletion evergrowing concerns, any serious book on architecture examines a building's environmental performance if it is to be influential. This book is no exception. Although its pages are filled with detailed case studies and striking photography, Linn and Fortmeyer profess their book to be about energy rather than buildings. In focusing on facades with dynamic components that help conserve energy, they provide a valuable resource for architects, engineers, builders, and others interested in this architectural evolution. More information about it can be found on our websites, www.siny.org and www.ominy.org. And of course, the reader will continue to find articles on innovative curtain wall projects printed in this magazine.



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The design of 54-foot-tall expressive columns at the center of the pavilion began as a solution mandated by structural conditions created by transit tunnels below.

The Pavilion at Brookfield Place

A pair of 54-foot-tall expressive columns supports the roof of a new front door to Lower Manhattan's transit hubs, bearing the structure's loads with a woven basket of lightweight twisting steel tubing that spirals down to plaza level.

REBUILDING LOWER MANHATTAN IN THE decade since 9/11 has resulted in one of the densest constellations of new architectural ideas—and challenges—in the city's history. These have created a stronger infrastructure, and the opportunity to meet the needs of a changing city, which is seeing the influx of a diverse workforce beyond financial services, including media, technology, and other fields that will allow New York to compete in the rapidly changing global economy.

A key piece of the undertaking is the Pelli Clarke Pelli Architects-designed Pavilion at Brookfield Place, formerly known as the World Financial Center, a public space that serves as a front door to the Fulton Street and World Trade Center transit hubs used by more than 100,000 commuters and visitors daily. The pavilion will be the western terminus of the highly anticipated east–west underground pedestrian passageway, a half-mile corridor that allows workers and tourists to access subways, office buildings, and the World Trade Center complex without having to contend with inclement weather. Visitors enter from ground level entries or from six high-speed escalators that travel 50 feet below grade to the World Trade Center Concourse, Port Authority Transportation Hub, and September 11 Memorial sites.

Softly curving glass curtain walls define the pavilion's exterior, allowing its 8,000-square-foot volume to glow like a lantern at night. But the transparency of this enclosure was paramount. "Our goal was to build upon our 2002 renovation by extending a glassy pavilion outward from the existing Winter Garden, a contrast to the more massive existing stone base frontage on West Street," says Craig Copeland, associate partner and Design Team Leader of the project for Pelli Clarke Pelli Architects (PCPA). Inspired by the way that the glassy Winter Garden faces the Hudson River, PCPA wanted to give an optimistic, transparent face to the center of Lower Manhattan. "The design intent was to create a secured entrance that would still be open and inviting, as opposed to closed and fortress-like," says Copeland.

To achieve the striking transparency of the glass-and-steel pavilion, PCPA worked with structural engineer Thornton Tomasetti (TT) to examine how the structure could be built. (TT and PCPA were part of the team that designed the original, 1980s Winter Garden, from which the new pavilion extends. TT also performed repairs to significant portions of the structure after the 9/11 attacks.) Because of the underground passageway and transit system beneath, the team discovered the

Clockwise from top The columns' first two tiers were fabricated and assembled at Walters's Canadian facility, while the larger third, fourth, and fifth tiers arrived at the site in sections. Metropolitan Walters devised a temporary mechanical connection to ensure precise alignment of the steel tubes before erection in the field. A built-up grillage at the base of the columns consists of an upper and lower plate with cross- and circumferential-stiffener plates. Once column sections were erected on site, the temporary connections were removed to give the basketlike form its continuous appearance.

Above The twin columns mirror each other, with outer tubes spiraling in opposite directions. At each of five vertical tiers, a continuous elliptical steel ring plate holds tubes together.

soaring roof and hanging glass curtain wall could only be supported at two points of contact at the center of the space.

"What emerged was the concept to treat the structure like a pair of trees joining to support a singular canopy," says Copeland. PCPA did not want the columns to feel solid, so working with TT they developed a diagrid steel structure that allowed an expressive, basket-like form to emerge. This design for the 54-foot-high sculptural columns could support the entire pavilion, providing its main lateral resistance system while amplifying the openness of the space.

The contract for fabrication and installation of the column superstructures was awarded to Metropolitan Walters, a Canada-based firm with an installation and erection arm in New York City. Seamless in appearance, the twin columns required meticulous machining, erection, and finishing because each is composed of five separate steel sections with exposed connections that had to be welded in the field. After developing an initial Rhino model of the columns and testing it through 3-D printing and simple physical models, PCPA shared the design files with TT, who translated them to a Tekla model to study and tune to meet critical structural dynamics, and further to enable sharing the model with Metropolitan Walters.

"As Metropolitan Walters was figuring out not only the final structure but the process of how to build it, they proposed an innovative approach to phasing the fabrication and installation," remembers Copeland. "We conceived each of the columns in five tiers, and our impression was those would be the fabrication demising lines. Metropolitan Walters cleverly reconceived the connection points." In typical diagrid structures, members are in a common plane and intersect at joints. But Metropolitan Walters realized a problem—because tubes for the sculptural columns were arranged in two separate layers, locating connections at each seam would make intersections that were too tight for installation by hand in the field. To solve the challenge, they moved connection points slightly above the columns' tension/compression rings. This allowed them to avoid any complicated welds at intersection points. At each of the five vertical tiers, the tubes are held together by a continuous elliptical steel ring plate, and at intersections between

This page: Pelli Clarke Pelli Architects; opening page and facing page: © Jeff Goldberg/Esto

Above Each one unique, the columns' 6-inch curving steel tubes are arranged in two separate layers, creating an intricate basketlike form.
Facing top At 55 feet high and 113 feet wide, the pavilion's curving curtain wall is designed for maximum transparency, allowing the basket superstructures within to be the emphasis.
Facing bottom A half-mile corridor connects pedestrians to subways, office buildings, and the World Trade Center complex.

each tier a hidden solid steel pin connects the 8-inch O.D., 6-inch I.D. tubes.

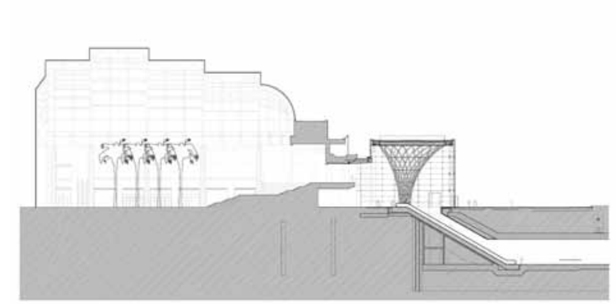
With the limiting factor the size of a flatbed truck, the columns' first two tiers were fabricated in Hamilton; the third, fourth, and fifth tiers arrived at the site in two, three, and four sections, respectively. The seams between these joints had to align precisely—any irregularity would show up in high relief in the sunlit pavilion space. Metropolitan-Walters set up a system allowing their installation team to mechanically fasten bolts on temporary plates installed to make sure the tubes would align. Once alignment was confirmed in the shop, the temporary bolts were removed. The erection team then reassembled these mechanical connections, performed field welds, and then ground them off for a perfectly smooth finish.

"Like any great solution, once the fabrication phasing was revealed it seemed very simple and obvious, but we really struggled as a team to figure it out," says Copeland. He likens the solution to the story of Brunelleschi, who—according to the Renaissance biographer, Vasari—proposed and then achieved the seemingly impossible challenge of balancing an egg upright on a piece of marble. "As Vasari recollects, maybe with extra poetry, once somebody sees the trick—which is simply cracking the egg—they understand it, and anybody could do it. This is not completely true in the case of the pavilion baskets—because their fabrication and installation still required extreme care and coordination in carrying it out—but of course conceiving of the process was the big step forward."

The structural system for the pavilion is independent from the adjacent steel and concrete superstructure of the main building. The two sculptural columns work together with deep beams concealed within the roof to support the weight of the hung glass facade, while also providing the entire lateral resistance for wind and seismic loads. In one direction, the deep beams tie the two sculptural columns together to act as a moment frame, while in the other direction the columns act as cantilevers to resist overturning.

For Copeland, who joined PCPA in 1988, the opportunity to work on updating a project that was so often discussed year after year by the more senior staff around the office was an unforgettable one. "I'd always heard about the World Financial Center and there was this mystery and allure to it," he says. For the firm, designing the new pavilion has been an opportunity to appreciate designs from more than 30 years ago, when the first phases of the World Financial Center were finished. "What I'm very excited about is we've taken the existing building and helped bring it up to date, functionally and aesthetically, working off of the substance of so much that was already there to begin with." □

This spread photographs: © Jeff Goldberg/Esto; drawing: Pelli Clarke Pelli Architects



THE PAVILION AT BROOKFIELD PLACE

Location: **100 West Street, New York, NY**
Owner and Developer: **Brookfield Office Properties Inc.**, *New York, NY*
Architect: **Pelli Clarke Pelli Architects**, *New York, NY*
Architect of Record: **Spector Group**, *New York, NY*
Structural Engineer: **Thornton Tomasetti**, *New York, NY*
Mechanical Engineer: **Flack + Kurtz**, *New York, NY*
Construction Manager: **Plaza Construction**, *New York, NY*
Structural Steel Fabricator and Erector: **Metropolitan Walters, LLC**, *Hamilton, ON*
Curtain Wall Fabricator: **Permasteelisa North America Corp.**, *New York, NY*
Curtain Wall Erector: **Tower Installation**, *Windsor, CT*
Miscellaneous Iron Erector: **Hallen Welding Service Inc.**, *Long Island City, NY*
Ornamental Metal Fabricator and Erector: **A-Val Architectural Metal**, *Mount Vernon, NY*

The New School University Center

The hand-finished brass shingle facade of The New School's University Center takes cues from the Greenwich Village architecture to the south and the strong cast iron buildings of Ladies' Mile to the north.

Courtesy SOM / © James Ewing

A brass and glass facade reveals a lively interior circulation system, reflecting The New School's progressive approach to education and linking the institution to its roots in the surrounding New York neighborhoods.

THE 16-STORY, 375,000-SQUARE-foot New School University Center on Manhattan's Fifth Avenue and 14th Street is a mixed-use LEED Gold facility that includes seven stories of academic space for an 800-seat auditorium, library, classrooms, labs, nine stories above for a 600-bed dormitory, and most important, spaces throughout for students to interact spontaneously. One of the primary programmatic requirements was to create opportunities for students to socialize, says Lia Gartner, vice president for design, construction, and facilities management for The New School. Before the University Center was built, The New School had neither a student union, nor a college green or quad, for chance encounters. "The streets of New York were our campus," says Gartner.

In fulfilling this complex program that emphasizes interdisciplinary collaboration, architects Skidmore, Owings & Merrill (SOM) relied on a series of innovative architectural forms to both meet circulation goals and express the building to the surrounding neighborhood. Internally, the University Center's spatial organization is articulated dramatically through a skin of hand-finished brass shingles that contrast with the open connective tissue of the stairs and "sky quads," social spaces that are visible through a glazed skin.

"The stairs give students a privileged view of the city, and from the street, pedestrians see that the building is alive, buzzing, and well-used," says Jon Cicconi, SOM's senior design architect. To achieve this effect, SOM reinvented the traditional fire stair to supplement vertical transportation and activate social spaces in the building. They uncoiled the stair from its traditional tower formation and stretched it out along the facade of the academic building, creating 18 unique gathering spaces at landing areas in the process.

This configuration also enabled The New School to provide easy access for students to get to classes without relying on elevators. "The entire classroom population changes on a bell schedule," Gartner says. "In any given ten-minute interval, everybody

Left At the fourth floor, three 10-to-12 foot deep transfer trusses were installed to make the clear-span space for an 800-seat auditorium.
Below Tube steel is used to create the perimeter trusses for the stair.

This page: Daniel Faraone of DeSimone Consulting Engineers

gets up and leaves and an equal number come back in. It was critical not to have students rely on the elevators to get to class."

Fire stairs are usually hidden in ugly, dark interior caverns, Gartner says. "We wanted something visible and inviting. The architect came up with an ingenious solution that married the fire stairs with open stairs."

The system that SOM created for the academic portion of the building stacks two stairs: the egress fire stair, fully enclosed and fire-rated, is topped by an inter-communicating stair. There are three stairways in all, and each consists of a steel truss on the perimeter which is used for lateral load resistance to wind and seismic activity, according to Michael Beals, senior project manager for DeSimone Consulting Engineers, the project's structural engineer. "We were able to economize on the shear walls in the core by moving the lateral bracing to the perimeter and making the stairs perform double duty," says Beals.

Each Grade 65 perimeter truss is built up of 12-by-8-by-⅝-inch horizontal HSS steel tubing for the top and bottom chord and 8-by-8-by-⅝-inch vertical HSS steel tubing for the interstitial members. The steel trusses are welded to steel couplers up to 3 feet high at the concrete columns to integrate the two structural systems. The stairs, made up of embedded steel Vierendeel panels, either cantilever from the perimeter steel tube truss 8 feet to 10 feet or frame across to steel posts or hangers supported by the concrete structure beyond.

"Surprisingly, it is a code-mandated fire stair that ends up defining the geometry of the entire building," says Adam Letcher, senior architect responsible for technical coordination and construction administration for SOM. "The stair gives the impression of weightlessness, but in reality it is either hung from the floor above, or posted from the floor below, depending on its position."

Right At each stairway landing social spaces allow for spontaneous meetings.
Center The stairway gives students a privileged view of the city.
Bottom The auditorium is flexible in order to accommodate different types of performances.

This page: Courtesy SOM / © James Ewing

Because the fire stairs are uncoiled, the standpipe and air pressurization ducts for the fire stair zigzag rather than proceed straight up the building. This afforded artist Rita McBride the perfect canvas for her art—she encased the protruding ducts in pentagonal-shaped brass throughout the building.

The stairs' angled profile visually protrudes through the horizontal bands of the facade and brings a three-dimensional composition to the building. The Toronto-based design/build curtain wall contractor, Gamma North America, designed custom unitized curtain wall panels with vision glass.

Gamma's anchoring system was designed with custom aluminum outriggers. These outriggers, coupled with the units' aluminum hooks, carried the load of the units onto the concrete slabs and/or structural truss members of the building. Because of the complexity of the lower seven floors of the building, especially at the staircase area, the outriggers had to be customized according to the various in and out and up and down conditions in order to successfully engage with the units' hooks. The customization was achieved by designing custom steel extensions at several locations along the truss structure.

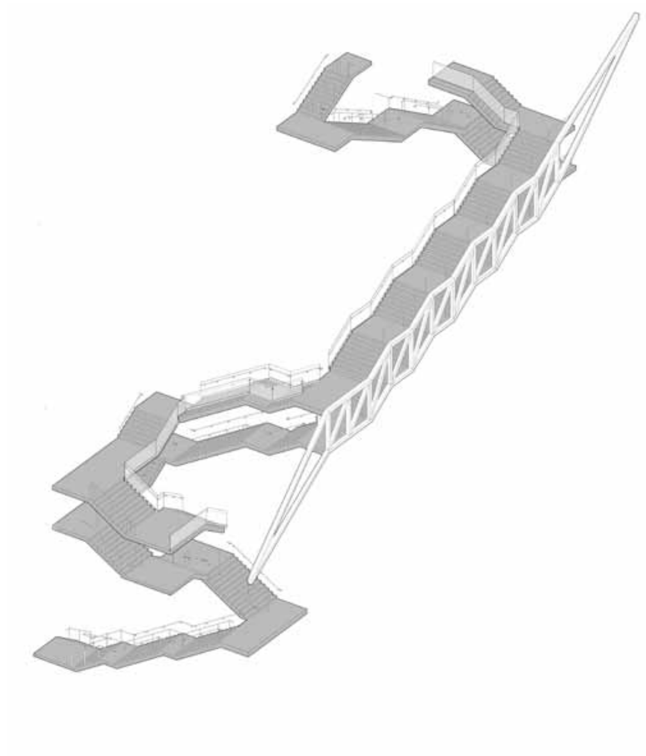
To make material selection for the building's horizontal banding, SOM took cues from the architecture of Greenwich Village to the south and of the strong cast-iron buildings of the Ladies' Mile historic district to the north. "We used metal in a creative and contemporary way that is unique and yet harmonizes with the other architecture in the area," Gartner says. "This is not a precast facade that repeats. It is very handmade and expresses the handmade sense of neighborhood."

Skidmore, Owings & Merrill selected Muntz metal, CDA Alloy 203, a non-corrosive alloy of brass typically used in shipbuilding, for the curtain wall system. "Brass mediates the two building scales in the area and relates

Courtesy SOM / © James Ewing

Left The spatial organization of the center is articulated dramatically through the brass curtain wall, which frames the open connective tissue of the stair that is visible through a glazed skin.

Right The uncoiled fire stair defines the geometry for the entire building.



to the natural materials used in Greenwich Village," says Cicconi. "We decided to go with brass because the colors age in a graceful way and it is slightly less price-volatile than copper."

The 131,000 square feet of custom brass curtain wall entailed the creation of 149 dies. A total of 5,277 brass panels were fabricated for the project, says Jim Mitchell, president of Gamma North America. The brass alloy had quite a journey before arriving at the site in New York City. First, Gamma's engineers designed the system in Miami and the 1,815 unitized aluminum panels that would hold the brass panels were produced there. The panel design was then transferred to Gamma's Quebec City operation for production. "This facility has the expertise to make and bend panels such as this," Mitchell says. "Each panel was a custom fold."

After producing the 2 mm-thick panels, Gamma shipped the panels for finishing in Toronto, where craftsmen gave the panels their patina using acid and oil rubs. Because of the number of variables involved in the process, patinas are prone to color variances over large surfaces. SOM performed quality control, inspecting 30 percent of all panels to ensure the finish would provide the intended look. From the Toronto shop, the panels were shipped back to Miami to be installed in the unitized panels before being sent to New York.

The custom vertical and horizontal aluminum extrusions for Gamma's pressure-equalized system were designed to carry the glass and brass panels and to meet the stringent structural and thermal requirements of the building. The units were individual unitized panels that varied in height and width. Each unit had an anchoring component attached to each vertical mullion used to hang the unit from the outrigger located on the building structure. Each unit was carefully installed in a well-defined sequence around the perimeter of the building.

While the school's aesthetic presence and connection with the surrounding community are crucial, it also has to engage the thousands of university students who use it each day. As with the staircase design, structural steel performed an important function in the building's auditorium, creating a clear span space to accommodate 800 seats. At the fourth floor, three 10-to-12-foot-deep, 65-to-80-foot-long steel transfer trusses were installed over the auditorium space. "The steel transfers accommodated the transition between the column module above to the column-free space below," explains Beals.

Because the trusses were designed in Grade 65 steel with heavy W14x700 shapes for top and bottom cords, construction manager Tishman Construction, an AECOM Company, was able to bring each truss in fully assembled. "The use of the lighter steel allowed us to bring them on the road in one shot," says Thomas Hoban, senior vice president of Tishman Construction. "We had a low-snow winter last year; the day the trucks came in with the trusses, it started to snow." Nonetheless, the trusses were dropped into place and "fit like a glove. We were done by the afternoon," Hoban adds.

Tishman required each subcontractor to utilize BIM on the project—the building's intricate details and construction coordination demanded three-dimensional modeling from the top down. "This was really a 3-D building," Hoban says, an observation clear to both students the enjoying lively spaces within and to passersby on the street who observe the unique tableau through the glazed skin. "Drawings in 2-D couldn't convey the true nature of the building, especially how the interactive spaces at each stair lobby were connected. The model allowed us to ferret out the information each trade needed to perform its job. If ever there was a building that needed BIM, this was it." ◻

THE NEW SCHOOL UNIVERSITY CENTER

Location: **65 5th Ave, New York, NY**
Owner: **The New School**, *New York, NY*
Developer: **The Durst Organization**, *New York, NY*
Architect: **Skidmore, Owings & Merrill**, *New York, NY*
Structural Engineer: **DeSimone Consulting Engineers**, *New York, NY*
Mechanical Engineer: **Cosentini Associates**, *New York, NY*
Construction Manager: **Tishman Construction, an AECOM Company**, *New York, NY*
Curtain Wall Consultant: **Gamma USA**, *New Rochelle, NY*
Structural Steel Fabricator and Erector: **Metropolitan Walters LLC**, *New York, NY*
Miscellaneous Iron Erector: **FMB, Inc.**, *Harrison, NY*
Curtain Wall Erector: **Gamma USA**, *New Rochelle, NY*
Metal Deck Erector: **Metropolitan Walters LLC**, *New York, NY*

Hunter's Point Campus anchors Hunter's Point South, the Long Island City neighborhood master-planned by FXFOWLE; it marks the eastern edge of the Hunter's Point South Waterfront Park designed by Weiss/Manfredi and Thomas Balsley Associates.

Hunter's Point Campus

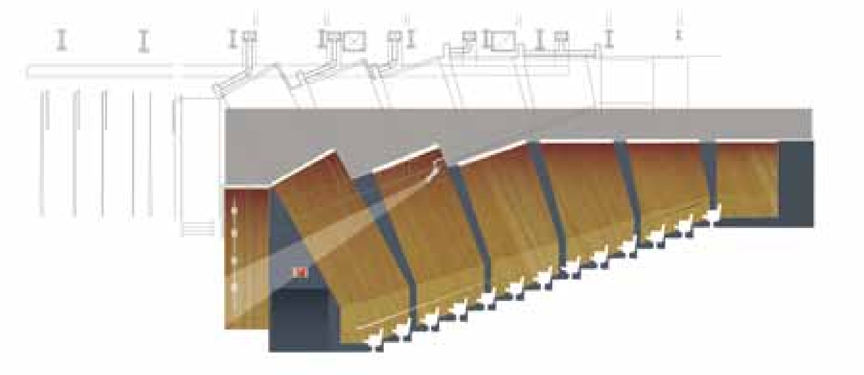
Structural steel allows a school to maximize its efficiency with a centrally located auditorium amid long-span spaces for varied student activities.

A FACETED FORM WHOSE IRON-SPOT brick exterior is slashed in orange Alucobond panels, the recently opened Hunter's Point Campus appears like an outcropping that fierily erupted on the East River shoreline—or at least a cool incubator of up-and-coming Queens creatives. The five-story, 145,000-square-foot building by FXFOWLE is actually home to 1,071 combined students of the Academy for Careers in Television & Film high school, Hunter's Point Community Middle School, and the Riverview School for special education.

An unexpected appearance was exactly the point of the design, according to FXFOWLE principal Nicholas Garrison, who also is design director of the firm's cultural/education practice. "So many schools are very playful, like an adult's idea of what a kid would like," says Garrison. Instead, the architects "thought of it as this eroded form that could have been sculpted by the river or wind, and as a backdrop to the new Hunter's Point South Waterfront Park."

Before it could arrive at its geological metaphor, the design team first had to decipher a site it likened

This page, clockwise from left The library serving the entire Hunter's Point Campus is co-located with the Riverview School on the second floor. Sunlight pours through the gymnasium's Kalwall skin to illuminate W14x190 steel columns and W14x132 steel beams. The building's wedge-shaped glazing permits daylighting of circulation spaces.
Facing, top The auditorium fills the third and fourth floors of the campus, so that students from the Academy for Careers in Television & Film and Hunter's Point Community Middle School may access the space separately.
Right This sectional drawing of the auditorium shows the W30- and W27-section transfer beams that span the room, as well as the relationship between structure, systems, and acoustical finishes.



Previous page left: © David Sundberg/Esto; previous page right: FXFOWLE

Facing page and top: © David Sundberg/Esto; bottom: FXFOWLE

to a pork chop. It wraps the north and west sides of a multifamily plot in Long Island City's 30-acre Hunter's Point South neighborhood, whose mixed-use master plan FXFOWLE completed for the City of New York in 2008. An easement for the Queens Midtown Tunnel takes a nibble from the southwest part of the L shape.

"After deciding to make a school that doesn't pander to kids, our next decision was how to fit the building on this odd footprint," Garrison says. Of half a dozen schemes, one that inserted an auditorium into the building core proved so efficient that it saved constructing an extra floor. Placing this double-height space within the third and fourth floors also entailed single-loading classrooms along the perimeter, mostly along elevations facing away from the future apartment tower—maximizing daylight and easing traffic in stairs and corridors, as well. The school's other long-span interiors were positioned to similar multitasking effect. A ground-floor gymnasium allows students to move seamlessly between indoor sports and activities held in the adjacent park, and the cafeteria's top-floor perch makes certain that the best Manhattan views belong to the whole school community.

What is unusual is that the three major column-free spaces are not aligned vertically. With the largest of them located on the ground floor, transfers on the fifth and third floors accommodate the column-free planning requirements. FXFOWLE not only took these and other engineering solutions into consideration, but also celebrated them in the building's form.

The first facet in the outcropping-like design motif was generated as a response to the easement, for example: The gymnasium volume, which meets the zoning setback requirements, pulls back at its southwest corner to circumvent the easement, while the third floor of the building cantilevers over it. "Because we couldn't have any load bearing on the Midtown tunnel zone, the building's steel structure was designed to transfer loads accordingly away from the easement," points out Damian Monteiro, associate principal of structural engineer Ysrael A. Seinuk. "It's easier to bring the load inboard at the third floor to a column than to have a heavy strap beam picking up the corner of the building at the foundation level." In the resulting structure W14x190 steel columns load directly onto 50 isolated, reinforced-concrete caissons, which were specified for the foundation in the influence area (adjacent to the easement) to prevent vibration; W14x132 steel beams laterally brace the vertical members, and all steel in this configuration is ASTM A992.

The gym's diagonal braces are wide-flange, because FXFOWLE decided to expose them behind a Kalwall curtain-wall system. Lateral framing elsewhere in the building perimeter is typically constructed of HSS 6x6 ASTM A500 grade B diagonal members, W18 or W24 ASTM A992 beams and W12 ASTM A992 columns, which were strategically placed according to their architectural effect. Where interior spaces are not long-span, typical column bays measure 30 feet with infill beams spaced between 10 and 12 feet apart, again using ASTM A992. Beyond the influence area, the foundation comprises 80 steel H-piles driven to a maximum of 40 feet below grade. The ground floor is a 12-inch concrete framed slab.

Because the third floor must cross 80-foot spans in the gymnasium and support the double-height auditorium above, the structural design took deflection into account. "The School Construction Authority wants 24 feet of clearance in the gymnasium below," Monteiro explains, "By the time you subtract the auditorium floor thickness, you're left with a member 40 inches deep. Regular W40 rolled shapes did not meet our serviceability criteria, and W44s would not have met minimum clearance requirements." Consequently, ASTM A572 grade 50 plates were welded into plate girders that support the loads on the third floor, as well as plate girders that also support columns and loads from above. The two types of girders are 40 inches deep and vary in width, from 16 to 36 inches, to handle the anticipated deflection. The floor beneath the fifth-floor cafeteria represents a similar approach: W30s and W27 sections were employed for the transfer beams, since the overall load is less and the auditorium spans reach no more than 56 feet.

Chiseling out the southwest corner of the gymnasium "started the whole indentation on the south elevation of the building," Garrison says. Treating the condition as an opportunity for expression, FXFOWLE continued making non-orthogonal gestures, especially with slices into the iron-spot brick that allowed insertion of curtain wall to illuminate corridors.

The building's most dramatic departure from schools' typical box-like form is an open-air indentation on the top floor. Conceived as a penthouse terrace, the recessed area invites students to spend their cafeteria time out of doors, and a wedge-like canopy whose underside also is clad in Alucobond reflects the shapes outlined in orange that punctuate the envelope. The canopy also invokes FXFOWLE's neighborhood master plan from 2008, which made a special point of minimizing the visibility of air handlers and other rooftop mechanicals from the street. "That led us to looking at alternatives for raising the parapet," Garrison says. "It's angled up in such a way not only because it was interesting, but also to eliminate views of the equipment from ground level."

The canopy's asymmetric silhouette meant creating a parapet that reaches as much as 27 feet beyond the cafeteria for shading and rain shielding; the bottom of canopy is 17 feet above the cafeteria terrace. "Your standard School Construction Authority detail would be 3 ½ feet high, which we could easily achieve by cantilevering a parapet wall above the roof. But because the parapet walls around the perimeter of the building are so high along the north, south, and a portion of the east elevations, we decided to extend the building's steel columns as much as 8 feet, 10 inches above roof level and cantilever the parapet wall from that," Monteiro says.

This spread *Afterview* is a Percent for Art commission by Natasha Johns-Messenger that enlivens the cafeteria terrace's safety partition and echoes the orange Alucobond cladding the underside of the canopy 17 feet above.

© David Sundberg/Esto

Instead of creating a moment connection at the top of the roof-level steel column to restrain that cantilever, "we decided to create a frame with the column and canopy beam, and brace the frame on the roof level and the floor below, to resist the loads," Monteiro adds. The engineering team executed this shear connection with an eye to construction ease—fabricating the 27-foot-long projection, for example, on its sister column and shipping the hybrid to the site as a single member. The column splice is located approximately 10 feet below roof level, which corresponds to the typical splice location for the balance of the columns between the fifth floor and roof. The canopy's frames vary from W33x291 to W18x76 at its shorter end. The overall result not only shelters students as they watch the famous skyline across the water, but also crowns a local landmark for Long Island City residents to call their own. ◻

HUNTER'S POINT CAMPUS

Location: **1-50 51st Avenue, Long Island City, Queens, NY**
Owner: **New York Department of Education**, *New York, NY*
Architect: **FXFOWLE**, *New York, NY*
Structural Engineer: **Ysrael A. Seinuk, PC**, *New York, NY*
Mechanical Engineer: **Kallen & Lemelson, LLP**, *New York, NY*
Construction Manager: **Skanska USA**, *New York, NY*
Structural Steel Erector: **Weir Welding**, *Carlstadt, NJ*
Miscellaneous Iron Fabricator and Erector: **Transcontinental Steel, Inc.**, *Newark, NJ*
Ornamental Metal Fabricator and Erector: **Transcontinental Steel, Inc.**, *Newark, NJ*
Curtain Wall Erector: **Utopia Construction LLC**, *Farmingdale, NY*
Metal Deck Erector: **Canam Steel**, *South Plainfield, NJ*; **Weir Welding**, *Carlstadt, NJ*

Grimshaw Architects inserted five new skylights 15 feet wide by 60 feet in length. Tensile fabric along the curved roof and baffling prevents direct light from creating hot spots in the gallery below.

© David Sundberg/Esto

Queens Museum

A renovation transforms the Flushing museum's facade, bringing it to life for those passing on Grand Central Parkway; a new vision of its modern mission awaits inside, where a glass lantern suspended from a skylight and a new circulating stair enliven the decades-old space.

QUEENS MUSEUM IN FLUSHING, NEW York has undergone more renovations than most buildings in New York—and certainly more than any structure intended for show at most World's Fairs. Originally designed by Aymar Embury III to house the New York Pavilion in the 1939 fair, it has subsequently functioned as the initial home of the fledgling United Nations General Assembly, and as exhibition space for the 9,335-square-foot architectural model depicting Robert Moses's Panorama of the City of New York featured at the 1964 World's Fair, among other things. Despite this storied past, few knew of its existence. The building's blank, unarticulated facade—which countless commuters pass each day—was an opportunity to alert vehicular passersby of the museum's presence.

Despite four sizable rehabilitations, the building's core characteristics have remained intact for more than 75 years. The most recent of these—completed in November of 2013 after Grimshaw Architects won the 2005 Design and Construction Excellence program from the New York City Department of Design and Construction—aims to increase visibility, bring in abundance of natural light to a dark interior, and direct visitors to one of the museum's most celebrated collection items: the Panorama of the City of New York. Following a 1994 update by Rafael Viñoly Architects, the existing site presented some unique challenges for Grimshaw. The east side of the museum, which is open to Corona Flushing-Meadows Park, features views over a broad pond, but the western side of the museum is flanked by the Grand Central Parkway, which runs almost parallel to the building.

"Hundreds of thousands of cars that pass the museum every day probably didn't know it existed, so opening the landscape design and adding a new entry with signage considerations, and an interactive dynamic LED wall, creates visibility that otherwise didn't exist," says Casimir Zdan, head of industrial design at Grimshaw Architects. "This new design helps puts the museum on the map."

The building's nearly perfect symmetry is expressed through a glass-brick fascia fronted by a colonnade of limestone pilasters embellished with dark granite. To avoid breaking moisture barriers and thermal seals, a custom decorative solution called for a 200- by 27-foot cantilevered glass rain screen on the western elevation. Ten 10-inch, Architecturally Exposed Structural Steel (AESS) carbon steel columns support a network of 2-inch, tubular carbon steel outriggers that cantilever 3 feet and align with panel points on the glass. Welded hatch fittings attach to 4½-by-4½-foot panels of ⅜-inch tempered glass, which form a geometric series of light boxes. The glass sports acid etching and a ceramic frit to reflect color tones of the original structure and diffuse artificial light. At night, the glass is illuminated by vertically integrated, programma-

ble color LEDs that transform the building into a glowing billboard to relay current events and various programming to Grand Central Parkway passengers.

Within the glass, a new 56-by 13-foot-3-inch piece of Type 316 stainless steel sheet metal forms a canopy over the western entrance. While the length is a continuous sheet of 3/16-inch stainless steel, the width was harder to achieve, so two 56-foot sheets at 8 feet and 5 feet, 3 inches in width were spliced together to achieve the desired depth. “The west canopy is designed to be a pure sculptural object rather than an assembly of materials executed through typical panelized construction techniques,” says Richard Yoo, project architect with Grimshaw. The length of the canopy was fabricated by forming it over the carbon steel that floats 1 inch above the finished floor. A similar reveal along the remaining three sides produces a ribbon of light that adds drama to the entrance. To account for the material’s significant expansion due to direct sunlight exposure, a custom Teflon-coated sliding bearing system is welded to the frame and rotates slightly for a subtle hinging effect when a minimal rotation of the walls pushes against the roof during expansion.

The visitor entrance from both East and West are identical, and open to an expansive hall, in which a large, four-sided glass chandelier hangs over a main gallery space. What was once a dark, shadowy skating rink is now a space full of natural light thanks to a series of five new skylights with a suspended, 80-by-40-by-30-foot glass volume that hangs approximately 30 feet from the ceiling. Because the architects had envisioned a modern aesthetic, the team designed 9-foot segments of solid carbon steel ring beam at the base of the structure, which was carbon-steel bolted on site and coated with chromium electroplating. Acid-etched glass panels handle partial structural loads, in addition to stainless steel springs every 4½ feet that support 8mm (exterior) and 6mm (interior) tensioned cables. The springs also help maintain the weighted curvature, which measures 35 degrees from the top horizontal louver and 51 degrees at the bottom.

All hardware connections—an approximate total of 300—function as hinges to support a flexible engineering plan, horizontally stabilized at the base by the 6-inch solid steel ring beam that also helps maintain tension. “In the case of any seismic movement or natural disasters, the lantern was designed to actually move within a 5-foot range,” says Michael Ludvik, glass and special structures engineer of his own eponymous firm. “Theoretically, you could actually swing from it.”

Another unique feature of the museum is a triple-tiered glass and metal staircase that carries visitors to what is arguably the museum’s best known exhibition; the Panorama of the City of New York. The free-form shape was modeled extensively in STAAD, and then again in RISA-3D, says Joel Stahmer, vice president at Ammann & Whitney, whose firm served as engineer of record. “What’s unique about the stair-

Above A 53-by-13-foot sheet of 3/16-inch stainless steel metal is affixed to a frame via a Teflon-coated sliding bearing system that accommodates material expansion and contraction.

M. Ludvik Engineering

This page, except where noted: M. Ludvik Engineering; lantern hardware details: George Valkai

Clockwise from top left Two-inch annealed glass treads support vertical loads from foot traffic. A tri-tiered staircase carries visitors to a landing that overlooks Robert Moses’ Panorama of the City of New York, which has been a feature of the museum since the 1964 World’s Fair. Acid-etched, canted glass panels are strung between tensioned cables and stainless steel springs that handle partial structural loads and maintain the lantern’s weighted curvature. Details of the lantern’s 3/16-inch stainless steel hardware and cable system. The central gallery’s 80-by-40-by-30-foot glass volume of acid-etched glass panels is stabilized with a carbon steel ring beam that serves as a counter weight and maintains tension.

case is that it uses no off-the-shelf, rolled shapes; every section is custom built."

The base sports a configuration to echo the shape of the Unisphere in the distance, set within a new pile foundation that supports the stairs. Three, three-sided masts fabricated from ⅝-inch A36 steel plate fan upward to support three landings at shorter intervals. These are more like a terraced descent than an abrupt experience, explained Zdan. The first landing is approximately 8½ feet above the ground floor, the second landing is at approximately 12½ feet, and the top landing reaches a height of 14½ feet. The delicate apex at the base also keeps the ground level uncluttered, accounting for three existing columns that support the Panorama.

Horizontal steel beams connect to the curved steel plates via welded built-up construction around a 5-inch solid round. The outer steel ribbon is made up of three 1-foot-and-1-inch plates, while the interior plate's height of 7 inches forms a shoe to pick up the balustrade. Two-inch annealed glass treads from AGNORA fabricators, measured by a laser on-site and CNC-milled in Canada, support vertical loads.

Since the building was established as a museum post–World's Fair in 1974, Grimshaw Architect's renovation has nearly doubled the institution's square footage to 105,000 square feet. Newly defined entrance points that now direct visitors through the large central gallery to various specialty and temporary exhibitions are equipped to meet the Museum's charge: to attract approximately 200,000 members of the Queens borough community through engaging art, history, and educational programming. □

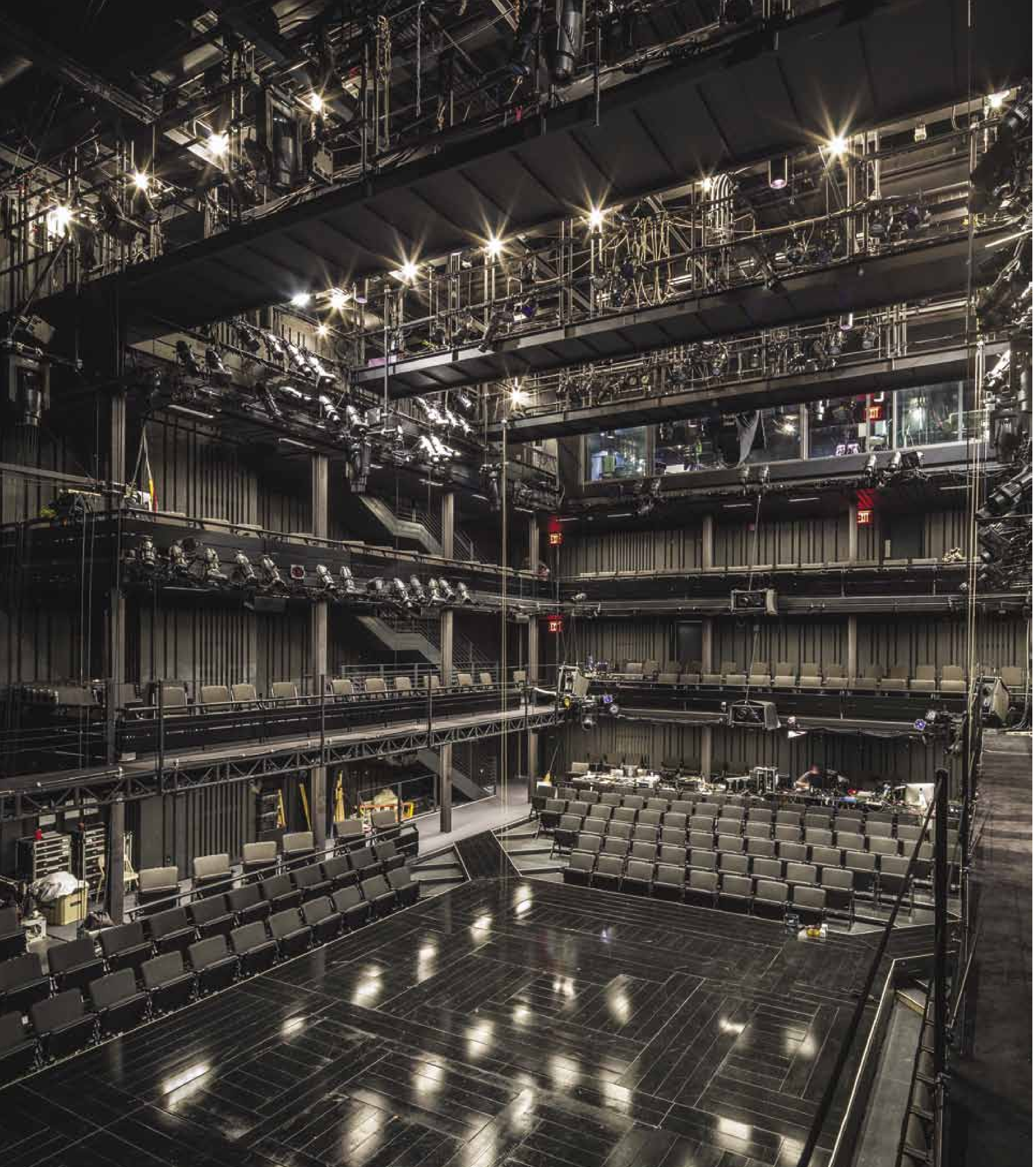
Above left The west elevation of the Queens Museum fronts a major vehicular parkway, and is now articulated with an LED-illuminated decorative glass facade to alert passengers of its existence.

Above The base of the staircase, which was designed to echo the shape of the nearby Unisphere, supports three, three-sided steel masts that fan upward to support three gently terraced landings.

This spread: © David Sundberg/Esto

QUEENS MUSEUM

Location: **New York City Building, Queens, NY**
Owners: **Queens Museum**, *Queens, NY*; **New York City Department of Design & Construction**, *New York, NY*
Architect: **Grimshaw Architects**, *New York, NY*
Executive Architect: **Ammann & Whitney**, *New York, NY*
Lead Structural Engineer: **Ammann & Whitney**, *New York, NY*
Mechanical Engineer: **Buro Happold**, *New York, NY*
Specialty Structures Engineer (interior lantern): **M. Ludvik Engineering**, *Brooklyn, NY*
General Contractor: **Volmar Construction Inc.**, *Brooklyn, NY*
Construction Manager: **URS Corporation**, *New York, NY*
Architectural Metal Erector: **CAPCO Steel**, *Providence, RI*
Curtain Wall Erector: **Action Storefronts**, *West Islip, NY*



Polonsky Shakespeare Center

In Brooklyn's burgeoning cultural district, the Theatre for a New Audience's new headquarters relies on structural sophistication to present an open, welcoming face to the neighborhood and a flexible space to the performers.

ALL THE WORLD MAY IN fact be a stage, as one of Shakespeare's best-known lines suggests; the jury will be out indefinitely on that. All the city, however, is definitely a stage—the Downtown Brooklyn Cultural District (formerly the BAM Cultural District) in particular. The eyes of Fort Greene's residents and businesspeople, the arts community, developers, and others are sharply focused on this experiment in neighborhood revitalization through investment in cultural institutions. No less than the artists within, the facades and profiles of these buildings perform for and communicate to the public.

The area's newest component, the Polonsky Shakespeare Center, gives the Theatre for a New Audience (TFANA) its first permanent home and extends its community-outreach policy into a visual metaphor: a boldly cantilevered front curtain wall, framed like a proscenium, highly transparent, and vibrant as a high-resolution monitor. Passersby get a full view of activities and displays in the lobby, including its main staircase and second- and third-story landings. The column-free lobby and exterior plaza blend together across the facade, with serpentine stainless steel inlays running beneath the glass and connecting with aluminum divider strips set in the lobby's terrazzo floor, emphasizing continuity rather than borders. A pointillist depiction of Shakespeare by Milton Glaser, TFANA's regular graphics collaborator, shifts between abstraction and portraiture depending on one's perspective relative to the lobby wall, reinforcing the impression of the playwright's complexity and universality. Classical theater, this building says to passersby, is inclusive and open; it addresses everyone, not just cultural insiders or economic elites. Have a look inside, and feel free to wander in.

With a mission "to develop and vitalize the performance and the study of Shakespeare and classical drama," says founding artistic director Jeffrey Horowitz, TFANA defines new audiences not only in demographic or economic terms but by their openness to ideas and discovery. This policy calls for a highly adaptable building that lets directors vary its structures and perspectives, Horowitz adds. "When it comes to production of Shakespeare and classical drama, there's no one way of doing these

Above left Construction photos reveal the structural steel beams that support the Polonsky's cantilevered front curtain wall, with ample diagonal members.
Above right, top and bottom The tight site in the Downtown Brooklyn Cultural District posed challenges during construction of the hybrid structural system, a steel frame in front and CMU in back.

plays.... We built into the theater's design the concept of change."

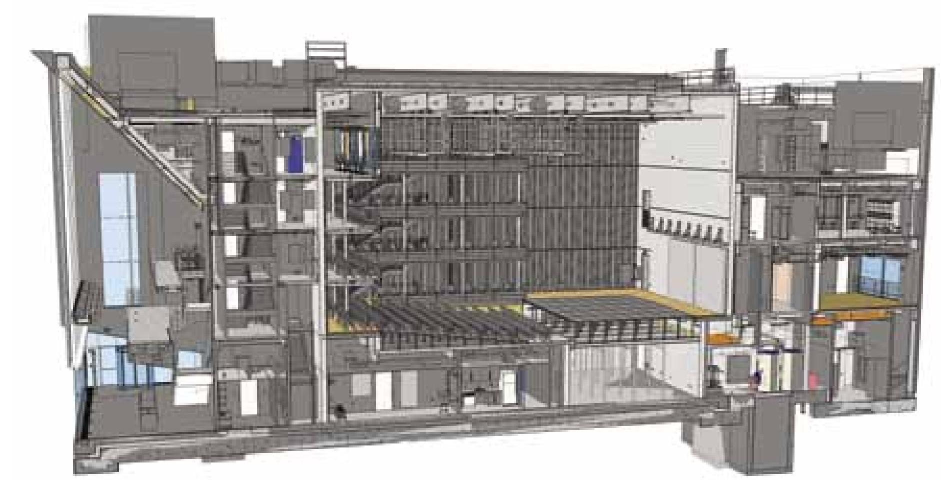
With a 299-seat capacity, nine available configurations (variations on either a thrust-stage or proscenium form, with trap space available below about half the stage), and a three-level seating plan, the Polonsky's Samuel H. Scripps Main Stage is proportioned to allow both the intimacy of a downtown black-box theater and the epic scale that Shakespeare and other dramatists require. Scenes like King Lear's mad raving on the stormy heath, Horowitz comments, "feel squashed" when performed in rooms without adequate height; more subdued moments, on the other hand, call for acoustics that do not force actors to bellow to be audible. The distance from center stage to the back of the orchestra roughly equals the distance to the top balcony (slightly over 100 feet), and the height from the stage to the rigging beams attached to the roof steel is a generous 34 feet 9 inches; the Polonsky thus places the whole audience in a unified space and supports performers' articulation at any volume. Floor-to-floor levels measure just 8 feet 6 inches in the balconies, ensuring that no one in the audience is far from the action.

Optimizing sonic clarity was not easy at this site: the Polonsky sits on top of multiple subway lines. To control vibrations from both the subway and basement equipment, says Lynch, the building is "actually structurally two buildings made to look like one ... [it] feels like one building, but it's structurally separate." A 2-inch gap separates the backstage from the thrust area, orchestra, and lobby, helping to isolate mechanical rumbles. The entire front half of the Polonsky floats on 8-inch-thick steel-reinforced rubber pads, interspersed in the void space between a 12-inch structural slab and a 30-inch mat slab on piles at foundation level. Coordination among structural engineering by Robert Silman Associates, acoustical design by Akustiks, the MEP work by Flack + Kurtz, and principal design work by H3 was enhanced by 3D modeling in Revit throughout the process.

The structural system is a hybrid design using steel in the lobby to support the cantilever, mixed steel and CMU infill for the outer 20 feet of the auditorium, and all CMU enclosing the remainder of the auditorium, stage, and backstage area to provide optimal acoustic insulation. All-steel acoustic "guillotine" doors, 6 inches thick and 10 feet by 10

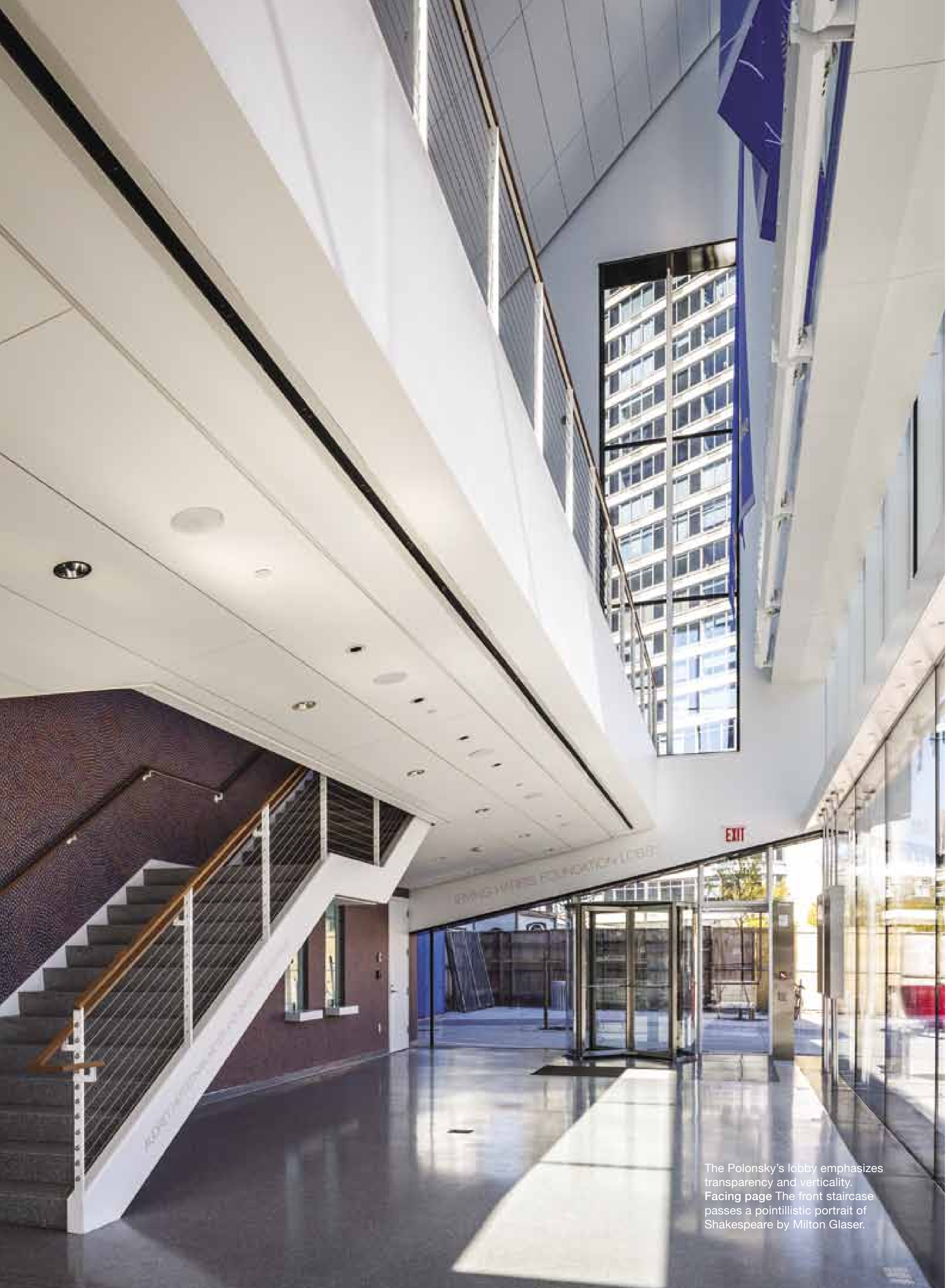
This page and facing page top: H3 Hardy Collaboration Architecture; facing page bottom: © Francis Dzikowski/Esto; opening page: © Francis Dzikowski/Esto opening page: © Francis Dzikowski/Esto

Right A Revit structural image of the Polonsky Shakespeare Center.
Below The Polonsky's front curtain wall and entrance open onto a public plaza with serpentine stainless steel inlays.



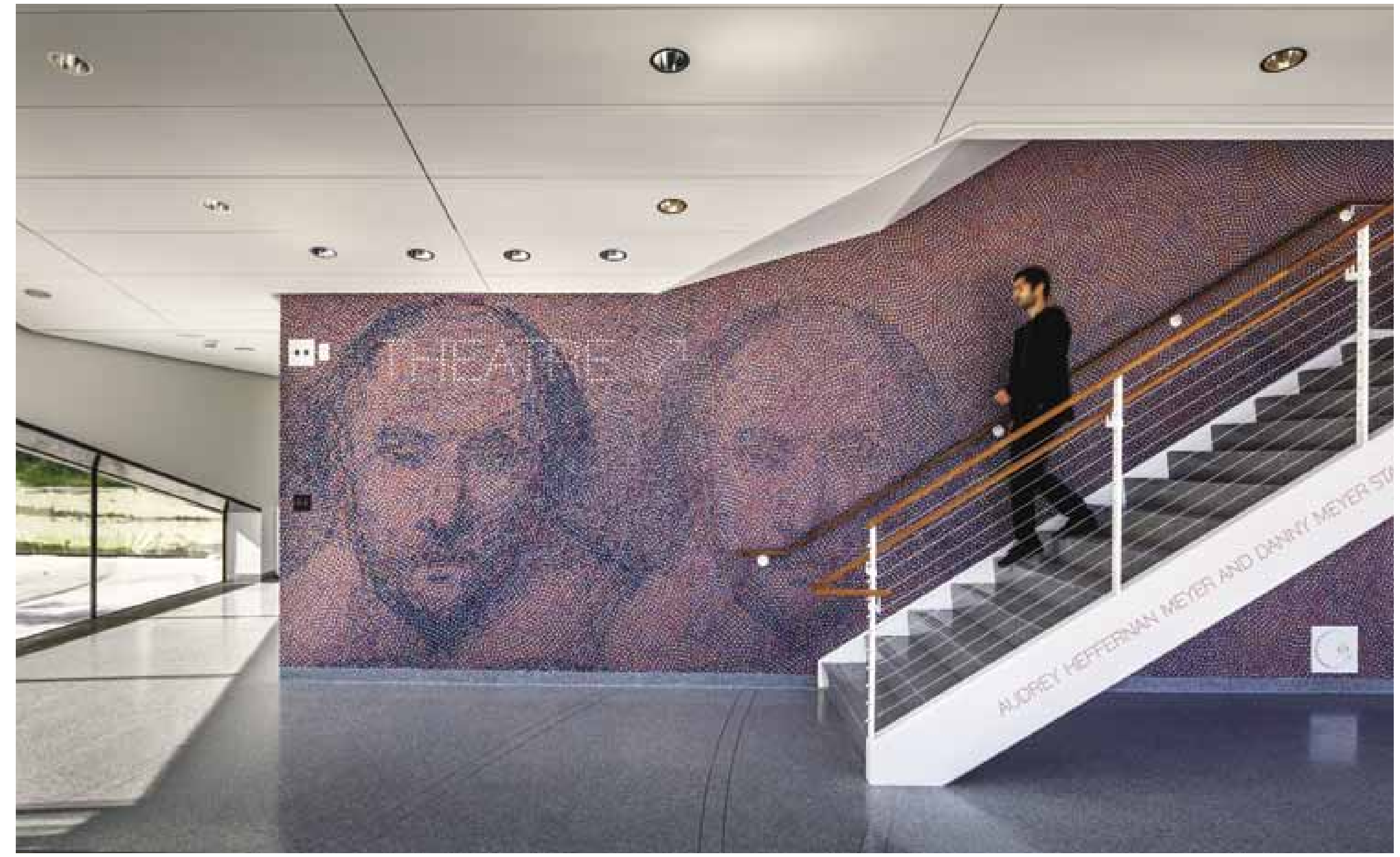
feet, appear on the wings, sliding on a 40-foot track bolted into the concrete blocks (itself so large that the construction crew had to load it into the building through a backstage rear window). These doors can be closed for maximum acoustic protection or opened, either to allow natural light and air in from backstage during rehearsals and other non-performance times or to deepen the stage for certain performance effects. An army, notes project architect David Haakenson, could march in from backstage through these doors for a battle scene in a production of Macbeth.

The theater's internal features, H3 partner Geoffrey Lynch notes, are sturdy and minimalist: W10 columns with intumescent paint; exposed steel fascias; steel stairs, stringers, handrails, visible roof beams, and catwalks; and all-black detailing in both the auditorium and back-of-house spaces (not just the floors and walls but the baseboards, corner guards, signage, outlet covers, acoustic doors, and even pantry appliances). He describes the atmosphere is "raw, but kind of a refined raw ... a very, very complex black box [and] a very intimate one" whose surfaces are "not to be treated delicately [but] to be whacked pretty hard." The front curtain wall, like many features of the building, presents a simple appearance supported internally by complex design and engineering. To create the elegant screen-like facade and minimize structural interruption, the architects specified a expansive curtain walls: four rows of triple-glazed panels for the top three floors, 5 feet, 1 inch by 11 feet, 1 inch each, atop a ground level of 7-foot-8-inch by 11-foot-3-inch double-glazed panels. The upper assembly is held by slim steel T mullions suspended from what Haakenson, calls "the mother of all beams," a 30-inch by 30-inch horizontal tube beam at roof level. That beam is in turn supported by diagonal cross-bracing within a complex structural system calling for a total of 84 columns and 686 other structural members. Columns include hollow structural section members HSS 6x6x½, HSS 6x6x⅝, HSS 9x5x⅝, and 11 different dimensions of wide-flange members ranging from W6x25 (15 in total) to W18x71



The Polonsky's lobby emphasizes transparency and verticality. **Facing page** The front staircase passes a pointillistic portrait of Shakespeare by Milton Glaser.

This spread: © Francis Dzikowski/Esto



(18); framing members, respectively, include HSS 6x6x½ through HSS 24x22x10 and W8x18 through W33x118, with the most common being HSS6x6x⅝ (178 in total) and W18x71 (64). The side walls of the lobby, stabilized by another horizontal beam, do not meet the ground, so that the building appears to tilt up and back to let the plaza slide in beneath angled wraparound extensions of the ground-floor glass. "To spend our facade money wisely, we knew that this end was our big move," says H3 partner Geoffrey Lynch, AIA, LEED AP, since the other sides would lack windows. "Theaters often aren't inviting, and here we wanted to make sure it's as open and as inviting as possible."

Inside, the theater draws from world-class precedents to maximize dramatic impact within a relatively small space. Horowitz worked actively with architect Hugh Hardy, FAIA, throughout the planning and design phases, investigating comparable-sized theaters from Minneapolis to Paris and modeling the new facility on the smallest of the British National Theatre's three chambers, the Cottesloe. That London theater, he notes, has appropriated a line from Christopher Marlowe's Jew of Malta as an informal slogan ("infinite riches in a little room"), a phrase he finds appropriate to TFANA's new theater as well. ☐

Optimizing sonic clarity was not easy at this site. To control vibrations from the subway and basement equipment, the theater "feels like one building, but it's structurally separate."

**Geoffrey Lynch,
H3 Hardy Collaboration Architecture**

POLONSKY SHAKESPEARE CENTER

Location: **262 Ashland Place, Brooklyn, NY**
Developer: **New York City Economic Development Corporation**, *New York, NY*
Architect: **H3 Hardy Collaboration Architecture**, *New York, NY*
Construction Manager: **F.J. Sciame Construction Company**, *New York, NY*
Structural Engineer: **Robert Silman Associates**, *New York, NY*
Structural Steel Erector: **Atlantic Detail & Erection**, *Far Rockaway, NY*
Ornamental Metal Erector: **David Shuldiner Inc.**, *Brooklyn, NY*
Curtain Wall Fabricator: **Gartner Steel and Glass (Josef Gartner, USA, a division of Permasteelisa North America Corp.)**, *New York, NY*
Curtain Wall Erector: **Tower Installation LLC**, *Windsor, CT*

This spread: © Jeff Goldberg/Esto

Belfer Research Building

A new research tower on the Upper East Side medical campus of Weill Cornell Medical College reflects a rethinking of academic science, fostering new ideas in interdisciplinary research behind an advanced, high-functioning facade

Facing The Belfer Building's undulating south facade references the folded cladding of another Ennead building on the same campus (the Weill-Greenberg Center) and controls solar thermal gain passively with a double curtain wall whose perforations let warm convection currents escape the cavity between its inner and outer surfaces.
Above right The curtain wall viewed from the sidewalk near the building's entrance.

WHILE THE SCIENTIFIC, ACADEMIC, and architectural media have been focusing considerable attention on the Roosevelt Island partnership between Cornell University and Israel's Technion, another intriguing new research facility has quietly arisen among the Art Deco Gothic clinical buildings of the university's uptown campus. The Belfer Research Building opened last January; though it is flying somewhat under the media's radar so far, it is a significant achievement for the university, architects, and consultants. With a lounge floor and two stories of conference space on the first three floors, 13 floors of laboratories, and two more research floors below grade, the 500,000-gross-square-foot building nearly doubles Weill Cornell Medical College's available research space. It reflects a sophisticated rethinking of the organization of an academic research enterprise, with an emphasis on collaborative work and translations from bench science to clinical applications; it presents a striking face to the neighborhood through its complex, gemlike, energy-efficient double curtain wall. It is one of the powerful factors, says campus architect William H. Cunningham, behind Weill Cornell's successful recent recruitment of several prestigious scientists, including Dean Laurie H. Glimcher, MD.

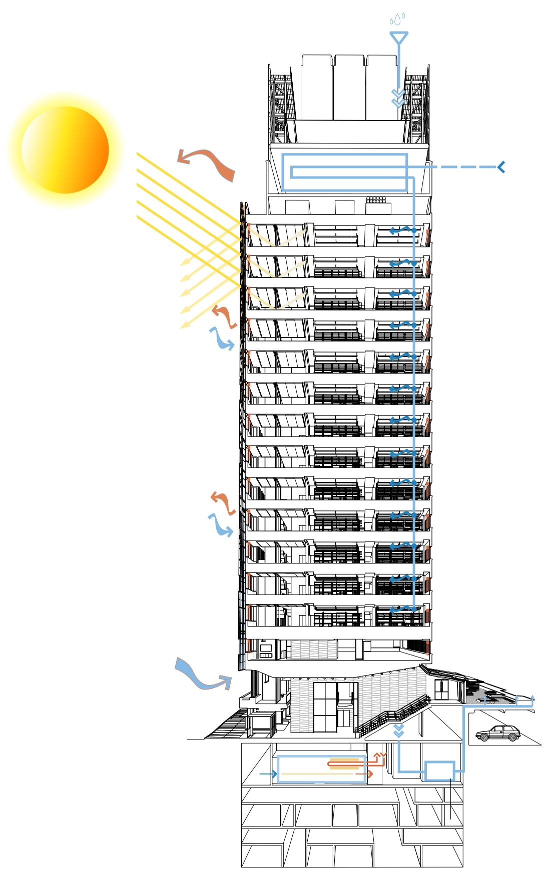
The architectural talent behind the Belfer is substantially homegrown: Cunningham and two of the key figures at Ennead Architects (design partner Todd Schliemann and project architect Craig McIlhenny) are all graduates of Cornell's architecture school. The same firm designed the university's National Healthcare Design Award-winning Weill-Greenberg Center (2007), a nearby clinical building with a similar folded glass facade. If universities with strong architecture programs have high design standards to meet in their own buildings, the tightness of academic budgets adds to the challenge. The team of Cornell, Ennead, curtain-wall consultants Heintges, fabricators Permasteelisa, and Tishman Construction, an AECOM Company, met that challenge through a patient planning process and a long timetable. The building has been in the works since 2007, with site activity (demolition of existing buildings and utility relocation) beginning in the fall of 2008; excavation to a depth of 65 feet (through bedrock only about 10 feet below ground) began in summer 2009, foundations were placed in November 2010, and foundations and basements were built back to ground level in May 2011, leading to aboveground work until the opening in January 2014.

"We are a very conservative client, all of this innovation and

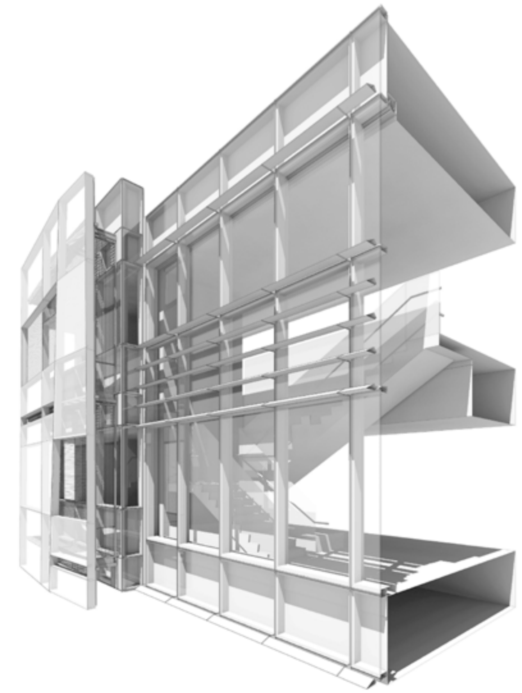
testing aside," says Cunningham. "We're going to own our own buildings, and we intend to keep them for 100 years, so we are very careful to do something that we think is going to have longevity."

"While the components are standard," notes McIlhenny, "the way we put them together, I think, was rather unique," particularly in the signature south facade. "There's a certain efficiency that went into selecting the die shapes, so that when the unitized pieces were set together in the field, even if the angle was 10 degrees off from another angle, those shapes were able to accommodate that through the gasketing and still keep it air- and watertight. So while it looks like there may be a lot of complicated dies involved in this, there actually was a lot of repetition and parts that were reused for different geometries." Unitized components in both the inner and outer curtain walls allowed elegant solutions to a set of interdependent problems without breaking the bank. The undulating facade with punched openings and ventilation slits offers unusual visual complexity. Reading variously from street level as a theatrical curtain, a chessboard, rows of balconies (referencing those of the residential Upper East Side, McIlhenny notes), or an irregular geometrical pattern of rectangles and trapezoids (echoed by detailing throughout the interior, with a nod to the Weill-Greenberg's folded planes as well) it is an arresting exercise for the eye.

Beyond its striking aesthetics, the double curtain wall functions as an energy-sparing *brise-soleil*. It is one of several areas where creative metalworking is essential to the Belfer's high performance, both in environmental terms—the building will achieve at least LEED Silver, the architects note, and at the current commissioning stage is within a few points of Gold—and in creating welcoming, flexible working spaces for researchers in multiple fields. "There's every type of curtain wall or enclosure known to mankind on this building," comments Richard Mazzella, senior vice president at Tishman: "There are ribbon windows, there are decorative metal panels, there's the sunshade curtain wall with the catwalks in it, a regular storefront, the skylight in the back ... a lot of different types of facade systems that played into the structure."



This spread: diagrams: Ennead; photos: © Jeff Goldberg/Esto



This page Communicating staircases link pairs of floors and increase interactions between different teams of researchers.
Facing top Laboratories include ample interior glazing to admit natural light.
Facing left Ennead and sustainability consultants Atelier Ten incorporated advanced sustainability features in the Belfer, including stormwater retention, sensor-controlled air-handling systems, high-efficiency chillers, and other means of optimizing energy performance.

The United States does not have Germany's code requirement that every worker be located near natural light, but if it did, says McIlhenny, Belfer would easily pass. With floor-plate dimensions of 85 by 260 feet, it is a long, slim building whose ample interior glazing ensures that daylight from its southern facade penetrates deeply into not only the offices and lounges along that south wall but the laboratory areas reaching the north. Even with low-emissivity glass, controlling solar gain here is a challenge; the solution is the passive double-skin curtain wall, which serves multiple purposes along with defining the building's visual profile.

The outer skin, Cunningham reports, is composed of aluminum and laminated low-iron glass, ¾-inch thick, with a double-pass ceramic frit pattern of two different densities, 75 percent on spandrel glass and 50 percent on vision glass, and two different colors, white for high reflectance on the exterior and black inside. The weather-tight inner curtain wall, tied back to the structural concrete slabs, supports brackets at the lower edge of each panel; these support catwalks (some open and grated, some solid), which in turn support the outer wall. Computational fluid dynamics (CFD) studies, McIlhenny notes, found that the cavity between the outer and inner layers (varying from a foot to 30 inches deep with the panels' undulations) acts a chimney, carrying heat upward by convection. To reduce heat buildup, the designers introduced ventilated openings, both large rectangles and horizontal slots at levels where the catwalks are solid.

The openings, the architects realized, might invite pigeons. Rather than just deter them with unsightly conventional bird wire, says McIlhenny, "we came up with this idea of tube-steel frames with these tension rods, absolutely straight, [with] over 1,000 deflection criteria, so we had to keep it very, very taut... almost like bicycle spokes." The aggregate tension requires a stiff frame of tubular steel around the perim-

eter. Set screws in the side panels allow the rods to be tightened in unison if they ever slacken over time, he adds; no problems with uneven tension have arisen to date, so the frequency of such maintenance is impossible to project, but the capability is there. Daylight dimming systems on the perimeter optimize lighting control depending on how much sun enters the working spaces.

Belfer's second and third floors answer a longstanding need on this campus, a shortage of space for conferences and informal meetings. The labs themselves, composing the bulk of the building above the fourth floor (which is owned by neighboring Hunter College in a condominium arrangement for its own research), are designed on a modular, repeating floor plan, since at the design stage no one, including the faculty panel directing programming for the Belfer, knew who would be occupying it. The different floors have now been assigned not according to conventional academic departments, Cunningham reports, but by disease entities and major body systems: one floor is dedicated to brain and mind diseases, for example, mixing psychologists, neurologists, neuroscientists, surgeons, and medical personnel all working together, breaking down the siloing that so often hinders interdisciplinary communication. The ample lounge areas, visible from the labs through interior glazing, increase the awareness of colleagues' work and the opportunities for casual conversations that lead to intellectual cross-pollination.

Commissioning to date, Cunningham reports, is ongoing and complicated but has proceeded smoothly. "I have to really hand it to Tishman: the project's come in on budget, it's come in on schedule, it looks fantastic, and the level of workmanship is high." Belfer has already won a 2014 Diamond Award from the American Council of Engineering Companies to MEP consultants Jaros, Baum & Bolles for engineering excellence in the Building/Technology Systems category. One suspects that this is only the first of many formal recognitions for a building whose design/construction team's thorough efforts offer immense opportunities for teamwork in tomorrow's sciences. ☐

Above left The Belfer's second and third floors address Weill Cornell's need for conference and event spaces.
Above The south curtain wall's open ventilation segments exclude birds with tension rods spaced approximately ¾ inch apart. Grated and open catwalks support the outer skin and allow access for maintenance.

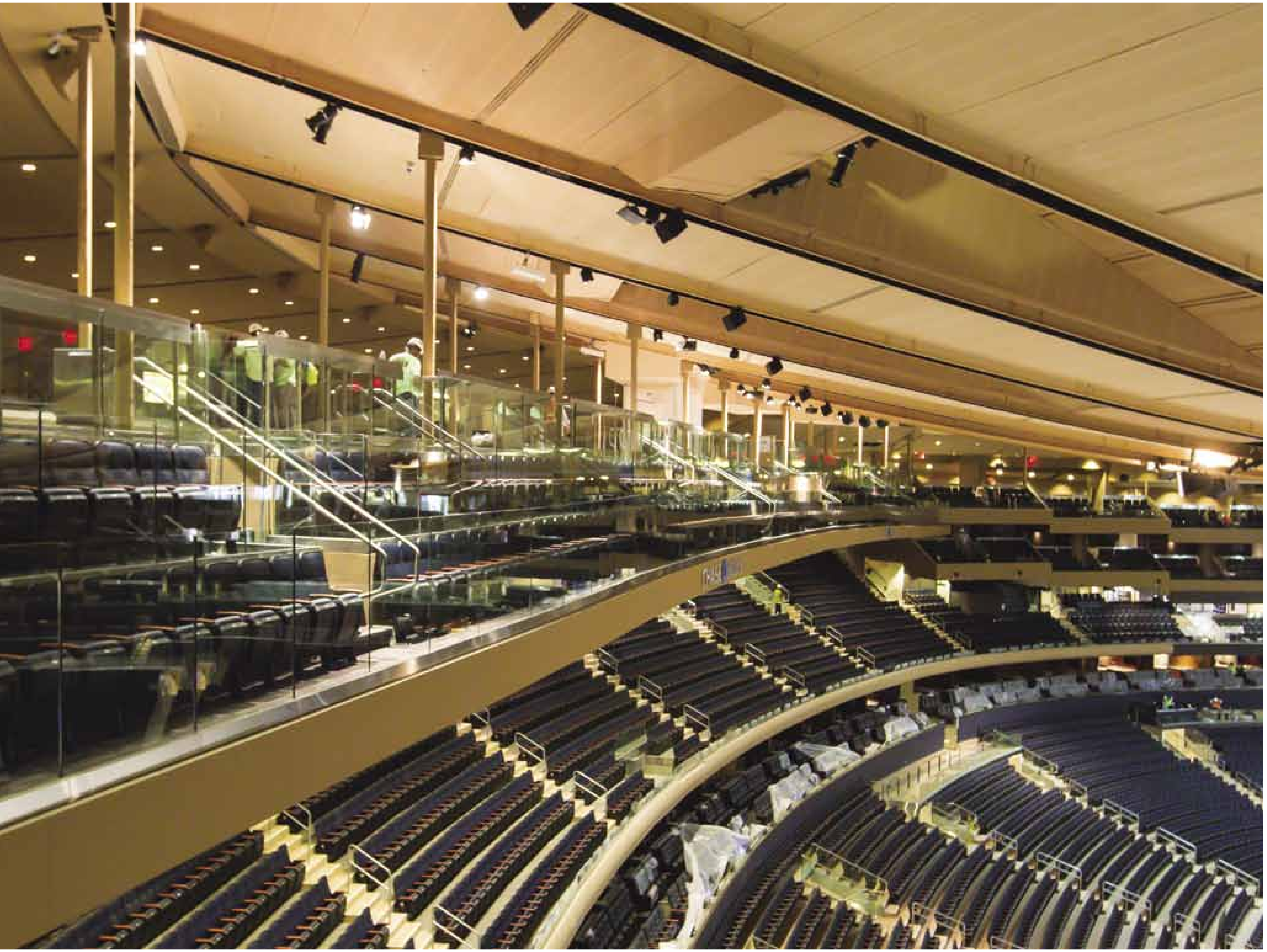
This page: © Jeff Goldberg/Esto; facing page: Ennead

"We're going to own our own buildings, and we intend to keep them for 100 years, so we are very careful to do something that we think is going to have longevity."

William H. Cunningham,
Weill Cornell Campus Architect

BELFER RESEARCH BUILDING

Location: **413 East 69th Street, New York, NY**
Owner: **Weill Cornell Medical College**, *New York, NY*
Architect: **Ennead Architects**, *New York, NY*
Structural Engineer: **Severud Associates**, *New York, NY*
Mechanical Engineer: **Jaros Baum & Bolles**, *New York, NY*
Construction Manager: **Tishman Construction, an AECOM Company**, *New York, NY*
Architectural Metal Fabricator and Erector: **Coordinated Metals, Inc.**, *Carlstadt, NJ*
Ornamental Metal Fabricator and Erector: **Coordinated Metals, Inc.**, *Carlstadt, NJ*
Curtain Wall Fabricator: **Permasteelisa North America Corp.**, *New York, NY*
Curtain Wall Erector: **Tower Installation**, *Windsor, CT*



The need to re-work the seating areas of Madison Square Garden was one of the main reasons for the renovation. New suites were placed between the lower and upper levels and a new "bridge" that provided upper level seating was hung from the roof structure.

Madison Square Garden

Renovating and expanding "the world's most famous arena" while it was still open and operating required close collaboration between everyone involved—and some creative engineering to add a new interior level for fans.

FOR ANYONE AWARE OF ITS legendary history, Madison Square Garden exudes images of activity and excitement. It is home to the New York Knicks, New York Rangers, New York Liberty, and is a setting for the most sought-after rock concerts and family shows held in the Tri-State area. Located on Seventh Avenue between 31st and 33rd streets in Manhattan, it sits directly over Pennsylvania Station, providing easy access to several modes of public rail transportation. These virtues notwithstanding, it is a forty-year-old venue that needs to compete with today's newer arenas. So in 2003 its owners, The Madison Square Garden Company, challenged Toronto architects Brisbin, Brook, Beynon (BBB) to update it, beginning a decade-long renovation and expansion project that transformed the building into a state-of-the art arena.

The original 1968 building is the third bearing the Madison Square Garden name. Constructed as a cylindrical building whose roof is suspended by steel cables from a perimeter compression ring, it allows a wide-open stadium floor elevated five stories above street level. Above that, three tiers of seating accommodate up to 20,000 people depending on the event.

In 1991, a $200 million renovation project changed some of the upper level seating into enclosed luxury suites for corporate and sponsor purchase. Less than a decade later it was clear that another upgrade was needed to locate the pricey suites closer to the arena sports floor. By including upgrades to the broadcasting and electronic systems, "hardening" the building for post 9/11 security measures, improving the lobby and flow of people, and enhancing the general interior character, the owners were committing to a nearly $1 billion project that would take seven years to design and three years to construct—all while keeping the arena operational during the hockey and basketball seasons.

After several years of analyzing options, the design team led by BBB began work in earnest with the engineering firm who designed the original structure, Severud Associates. It became quickly apparent that some of the most attractive features of the building would become some of the biggest challenges of the renovation. Its location above four levels of underground rail lines meant that the existing columns and footings supporting the building were fixed in strategic locations between train tracks, eliminating any opportunity to strengthen or add columns.

The rework of the seating areas needed to address the existing structural constraints but still achieve the desired outcome of an improved seating experience. The existing seating was defined by an upper and lower bowl section and it was determined that the best place for the new suites was in between these two sections at the seventh level of the building, two levels above the arena floor. The lower seating section was essentially re-used, but the existing upper section was removed and the new suites built above the lower level seating. New, steeper upper-level seating was then built above the new suites that sloped up to be 13 feet higher than the previous top of the upper seating area. This put it at nearly the same level of the existing roof, so the perimeter of the roof was literally removed and raised to be less steep but still supported by the existing cables. This created the needed clearances and sight lines, but new column locations required by this rearrangement had to be supported on transfer girders to spread the load to the existing structure below in the rail transit areas.

Perhaps the biggest single challenge, yet the most defining change to the arena is the addition of two new promenade and seating bridges located

Below The short time intervals available to perform construction work meant that multiple subcontractors and multiple pieces of equipment were used simultaneously while the arena floor served as the staging area for the transformation of seating zones.
Facing, clockwise from top The new "bridge" areas at the upper level give spectators a view directly onto the arena and are stabilized against movement using Tuned Mass Dampening (TMD) devices. The installation of a new, larger scoreboard and LED video monitors meant that additional weight needed to be accounted for and transferred to the steel cable roof system and supported by steel trusses along the perimeter. Upper-level seating behind the new bridges still provides a full view to the arena floor due to the raised roof along the exterior. Large LED monitors provide information from the scoreboard that is screened from view in some locations.

at the tenth level—one on the north and one on the south side above the playing surface. Their purpose is twofold: create more seating to make up for what was lost in the suite construction, and include a dramatic walkway where fans can look down at the events below. The problem was how to support the bridges without adding new columns that would interfere with sight lines for seats on the lower levels. The answer: suspend them from the roof. If this were a new building, the structure would be designed to accommodate the weight of the bridges plus the live load of the spectators. As an existing building with limited ability for structural changes, adding the new bridges required creative problem solving and detailed engineering.

Cawsie Jijina, the Severud principal overseeing the structural work at Madison Square Garden, led his team to first look at the space above where the bridges would reside. They saw that all of the arena's air, water, and electrical systems convened there as well. That precluded the use of solid members, so twenty pairs of 4-foot-6-inch-tall steel trusses were designed that pick up the weight of both bridge decks, while allowing the various MEP systems to thread through them. Ultimately, the trusses deliver their load to the existing suspension cables supporting the roof. Each truss is fabricated from approximately 6 tons of grade 50 (A992) steel using double L4x4x½ chords and 2 L3x3x⅜ diagonals. The trusses are positioned directly under the existing roof beams (situated on top of the roof support cables) and support W14 and W16 members plus cables that hang intermittently to support the 230-foot spans of the two new bridges. Each massive bridge is constructed of approximately 76 tons of structural steel covered with 134 tons of 4,000-psi lightweight concrete; they comprise an area of approximately 6,700 square feet each. In addition to its self-weight, each bridge is capable of supporting an additional 600,000 pounds of occupants, evenly distributed.

In their static condition, the design of the bridges is quite adequate with the appropriate safety factors worked in. But one of the more critical aspects of the structural design is the dynamic behavior of the bridges. Because the bridge is ultimately supported by the existing cable roof system, rhythmic movements, such as those generated by an excited crowd during a rock concert or sports event, can potentially cause motions strong enough to make spectators uncomfortable. Rather than adding brute force stiffness (and additional weight) to the roof, truss, and bridge decks, the project's engineers sought a more elegant and cutting-edge design solution. RWDI Motioneering, based in Ontario, Canada, worked with the design team to devise a "tuned mass damper" (TMD) to dissipate the dynamic energy. Each of the two bridges received five TMDs, three on the front (arena side) to combat vertical motion and two on the back (street side) to combat horizontal motion, with all five working simultaneously to control roll.

Each TMD comprises 9,000 pounds of stacked lead plate, a crank-shaft and two hydraulic pistons (weighing approximately 1,000 pounds) that translate rotational motion into vertical motion (similar to the engine of a car). The lead plates are put into motion by the motion of the spectators during an event. The entire TMD system is calibrated to oscillate (move) in the opposite direction as the loading frequency caused by the spectators. Thus, this opposing motion caused by the TMD will weaken the loading frequency, dissipating the energy and dampening the perceivable motion throughout the entire structural system. Monitoring the TMDs during events has verified their satisfactory performance.

Turner Construction served as the project's overall construction manager and began during the design phase to review constructability issues. Because of the extent of the work and the limited construction time of only 20 weeks between sports seasons per year, three separate and distinct phases each were planned as a stand-alone project that left the building fully functional until the next one started. Hence, the driving force for the renovation wasn't budget as much as a critical time schedule. Major-league sports team schedules were pre-determined so the building absolutely needed to be open in time for the games to take place and the public to attend. Consequently, in each of the three phases construction crews worked 24 hours a day, six days a week to maintain the schedule.

In order to further avoid any chance of delays the steel work was separated out into five different subcontracts that required additional coordination, particularly for the new tenth-level bridges. For each bridge, the steel structure was fabricated by one steel company, the cables to hang it from above by a second, and the trusses that it all hung from by a third. This divided production up to increase capacity, but added to the effort needed by the engineers, contractors, and construction manager to carefully check and coordinate everyone's drawings, not to mention coordinating them with mechanical and electrical equipment that was already in place.

In the end, it the project's prolonged effort and extra coordination work was well worth the wait. The design team, construction team, and owners have created what is truly one of the most exciting sports and entertainment venues anywhere—one that wouldn't be enjoying the popularity it sees today without the finely engineered structural steel trusses, members, and cables that gave it new life. ☐

This page and opening spread: Rebecca Taylor/MSG Photos; facing page: The Madison Square Garden Company

MADISON SQUARE GARDEN

Location: **4 Pennsylvania Plaza, New York, NY**
Owner: **The Madison Square Garden Company**, *New York, NY*
Architect: **Brisbin Brook Beynon**, *Ottawa, ON*
Structural Engineer: **Severud Associates**, *New York, NY*
Mechanical Engineer: **M-E Engineers**, *New York, NY*
Construction Manager: **Turner Construction**, *New York, NY*
Curtain Wall Consultant: **Israel Berger & Assoc. Inc.**, *New York, NY*
Structural Steel Fabricator: **Helmark Structural Steel Inc.**, *Wilmington, DE*
Structural Steel Erectors: **W&W Steel, LLC**, *Camden, NJ*; **Stonebridge Steel Erection Co., Inc.**, *South Plainfield, NJ*; **Titan Erectors, Inc.**, *Woodcliff Lake, NJ*
Miscellaneous Iron Fabricators and Erectors: **Empire City Iron Works**, *Long Island City, NY*; **FMB Inc.**, *Harrison, NJ*
Curtain Wall Erector: **W&W Glass LLC**, *Nanuet, NY*
Metal Deck Erectors: **W&W Steel, LLC**, *Camden, NJ*; **Stonebridge Steel Erection Co., Inc.**, *South Plainfield, NJ*; **Titan Erectors, Inc.**, *Woodcliff Lake, NJ*

The four-story atrium is capped with a one-story clerestory and contains an Architecturally Exposed Structural Steel stair. The atrium separates the teaching and research wings.

Lehman College Science Facility

A new teaching and research building creates a gateway to the school's science campus with a flexible structural steel design that will accommodate future changes and a four-story atrium that creates informal gathering spaces for students.

LEHMAN COLLEGE IN THE BRONX has a richly textured, 37-acre campus. Founded in 1931 as part of Hunter College, the stone and brick structures of its four original Tudor-Gothic buildings have held up well—and are a refreshing contrast—next to modern and contemporary additions to the school, which include Rafael Viñoly's 1994 Athletics and Physical Education Facility (APEX). It was against this motley but cohesive background that the New York office of Perkins+Will conceived a new 69,000-square-foot science laboratory for Lehman, with classrooms, offices, seminar rooms, labs for different disciplines, and gathering spaces. After deciding on its location in 2002 as part of a facilities master plan, the college completed the new Science Hall and opened it for classes in the Spring of 2013, making it a centerpiece project of CUNY's "Decade of Science." That initiative has seen the University focusing on modernizing or building new facilities to support the latest advances in undergraduate and graduate research, making it easier for students to enter science, math, engineering, and technology fields. It is the first CUNY building to be designed to meet LEED certification, and has achieved a Platinum rating.

Literally creating a link to the old campus, the new L-shaped, four-story science building connects by a third-floor bridge structure to Gillet Hall, one of the original buildings housing Lehman's science programs. The wings of the "L" are actually two independent steel structures above the first floor. Because the majority of the corner slab diaphragms (typically used to brace against wind and seismic forces) at each level were removed to create a soaring glass atrium in the center, structural engineers at Leslie E. Robertson Associates (LERA) introduced a

Left, from top Perkins+Will modified prefabricated greenhouses that perch on the roof of the facility. The long span capability of the steel accommodated the high live load and stringent vibration requirements of a teaching lab. Each atrium level doubles as common space.

Opening spread and facing page: Perkins+Will; this page, top: Phyllis Yip, Lehman College; center and bottom: Perkins+Will

Above A glass-enclosed bridge connects Gillet and the Science Hall, creating a visible link between new and old structures.

seismic joint along one side of the atrium to isolate the two wings.

A final wing of the new science building may yet be constructed as part of a later phase, and Gillet will be renovated. The possibility of future expansion or changes in the program will be made easier because of the steel frame construction. "If you build in concrete and you need to make penetrations through the slab for unplanned things, it's hard," says Robert Goodwin, the architectural design director of Perkins+Will's New York office. "But when you use steel, you have more flexibility for adapting the building for future changes."

In the meantime, the Science Hall is complementary to its older counterparts. "If you walk around the campus, you can see how well the architecture works together; it doesn't fight itself," says Rene Rotolo, assistant vice president for campus planning and facilities. "And that's also what we wanted to achieve with the science facility."

It accomplishes that balance, in part, with a quiet palette and narrow massing. The glass atrium—really, a glorified egress—serves as the hinge between the two wings of the "L" and contains an elegant Architecturally Exposed Structural Steel (AESS) stair, which connects all four floors (stair stringers are comprised of built-up box members that are 18 inches tall by 5 inches wide).

The main AESS column in the atrium is an HSS 12x12x½. The atrium is then capped with a one-story clerestory, where the AESS columns are HSS 8x8x⅜. AESS horizontal beams at the glass perimeter are HSS 12x12x½. AESS members are coated with an intumescent paint for fire protection and then finish-painted. "The stair is probably one of the more expressive parts of the metal construction in the building," says Goodwin. "We exposed things that would ordinarily be concealed. We used it as part of the design intent."

At each main stair level, the architects created informal gathering spaces with seating and whiteboards. These areas take advantage of the daylight streaming through the fritted glass curtain wall and on a recent tour they had even lured students from another department (something that a facility manager says is the norm). "We took something we had to have anyway and turned it into more than what it was," says Goodwin.

Left and facing The curtain wall is a stick built, field glazed system with mostly vertical mullions spanning at least two floors, supported at the edge of slabs. Vented shadow boxes were part of the spandrel conditions of the curtain wall. Extensive decorative metal was used at the exposed areas of the curtain wall, to accentuate its distinction from the masonry plane.

Perkins+Will chose W12 Firetrol columns wrapped in a circular steel tube for use along the main corridors adjacent to the glass curtain wall. Not only did this proprietary fireproofing system provide a pre-fireproofed and pre-enclosed structural column, but also "if we didn't do that, the columns would be fatter," says Goodwin. "Making this frame look as lightweight as possible was really important to us."

The flat, textured surfaces of the rest of the building's facades are calm counterpoints to the Viñoly complex, but also share architectural details with Gillet. Clad in panels of ochre-colored norman brick (hand-laid in a stack bond pattern), with flashing that intentionally aligns them with the window mullions, planar walls jut out subtly from alternating bands of glass and aluminum. The A-frames of off-the-shelf rooftop greenhouses are barely visible from the ground, peeking above the Science Hall's roofline. "Let's keep making it calmer and calmer, and simpler and simpler," says Goodwin of his goal for the design of the building.

The delicate-looking bridge that serves as the visible connection between Gillet and the Science Hall has a 34-foot span, accomplished by its two W24x76 roof beams. Its W10x33 floor beams are suspended from the roof by HSS 3x3 hangers. A slide bearing connection from the bridge to the existing building allows for movement of both along the axis of the bridge, but not parallel to the wall plane of the existing building. Connections from the bridge to the new building restrain relative movement of the bridge and the new building, both in the direction along the bridge axis and parallel to the wall plane of the new building. However, the connections at the new building are also designed to allow for in-plan relative rotational movement of the slab diaphragm of the bridge and the new building slab diaphragm.

Inside the Science Hall, Perkins+Will split the program into teaching and research wings, placing chemistry labs and classrooms in the eastern wing, and pushing offices and more labs to the perimeters of the northern wing. Column spacing in the teaching lab wing is 33 feet. This is 50 percent higher than customary lab column spacing; the long span capability of steel accommodated the high live load and stringent vibration requirements of a teaching lab.

While it's possible to design concrete laboratory buildings, Goodwin says that the steel frame of the Science Hall helps stabilize the moment frames that are necessary to combat any vibrations that could adversely affect lab results. The lateral load resisting system of the superstructure above the first floor is a combination of ordinary moment frames and concentric braced frames. Columns in both of these frame types are W14 wide flange columns. Diagonal braces consist of HSS 8x8, HSS 7x7, and Double Angle 6x4. Moment Frame Beams are W24, W30, and W33. Connections of moment frame beams to columns are comprised of complete joint penetration welds of beam flanges to column flanges, and single plate shear bar web connections.

The Science Hall's two basement levels and the first floor are cast-in-place concrete. The superstructure above the first floor is a structural steel frame supporting composite concrete slabs on metal deck. (In the concept design phase, a structural steel superstructure was compared to cast-in-place concrete and was found to be more economical for the building above grade, says LERA's Rick Zottola. "Structural steel is also the customary superstructure material for buildings of this type in New York City," he says.)

Rotolo, from campus planning and facilities, reported that the students, faculty, and researchers are all finding spaces to collaborate in the new building. "Before, there were individual silos where they weren't interacting," she says. "We deliberately created spaces where researchers from different departments would meet and interact and work together. We created a lot of the spaces in this building that would be ideal for all of our buildings." □

This spread: Perkins+Will

LEHMAN COLLEGE SCIENCE FACILITY

Location: **250 Bedford Park Blvd. W, Bronx, NY**
Owner: **The City University of New York (CUNY)**, *New York, NY*
Developer: **Dormitory Authority of the State of New York (DASNY)**, *New York, NY*
Architect: **Perkins+Will**, *New York, NY*
Structural Engineer: **Leslie E. Robertson Associates**, *New York, NY*
Mechanical Engineer: **Syska Hennessy Group**, *New York, NY*
Construction Manager: **Gilbane**, *New York, NY*
Structural Steel Fabricator: **Metropolitan Steel Industries Inc.**, *Sinking Spring, PA*
Structural Steel Erector: **J.C. Steel Corporation**, *Bohemia, NY*
Metal Deck Erector: **J.C. Steel Corporation**, *Bohemia, NY*

INSTITUTE NEWS AND EVENTS

Kinetic Architecture: Design for Active Envelopes

In their new book, *Kinetic Architecture: Designs for Active Envelopes* (Images Publishing), authors Russell Fortmeyer and Charles D. Linn discuss the innovative ways in which building envelopes can be used to modulate energy in its primary forms.

In a recent review published in *Architects' Journal*, architect and scholar Alan Dunlop praises the authors for their success in exploring, "in a comprehensive and rigorous manner how contemporary architects have reacted to escalating international concern over the use of natural resources and climate change by modulating their designs to consume less energy, perform better and respond to site context."

A valuable resource for architects, engineers, and students, the accessible and entertaining resource is illustrated with exceptional photography and has been written to appeal to both professionals and those with a general interest in architecture and the environment.

From the Publisher: A shift in the architecture industry's focus in the last 20 years toward ecological concerns, long-term value, and user comfort has coincided with significant new developments in digital controls, actuators, shading typologies, building physics simulation capability, and material performance. This collision has afforded architects an expanded set of opportunities to create architecture that can respond directly to environmental conditions, resulting in innovative facade designs that quickly become landmarks for their cities. Fortmeyer and Linn trace the historical development of active facades in modern architecture, and reveal how contemporary architects and consultants design and test these systems.

Visit www.imagespublishing.com for more information.

Seismic Design Seminar: October 7, 2014

On Tuesday, October 7, 2014, the Steel and Ornamental Metal Institutes of New York will sponsor a Seismic Design Seminar at McGraw-Hill Auditorium, 1221 Sixth Ave., New York. Check www.siny.org and www.ominy.org for details.

The *2010 AISC Seismic Provisions* and 2nd Edition of the *Seismic Design Manual* are now available. This seminar will highlight proper application of key design and detailing requirements and introduces important technical changes in the recently updated Seismic Provisions. Design Examples from the new 2nd Edition of the *Seismic Design Manual* will be included.

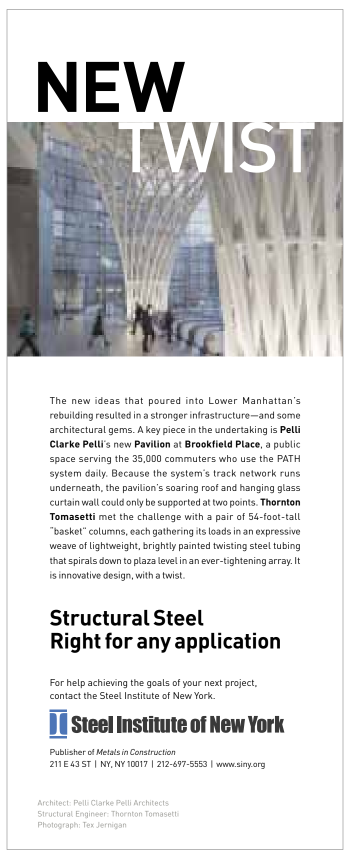
The seminar will be presented by Thomas A. Sabol, Mike Engelhardt, Clint Rex, John Rolfes, and Rafael Sabelli throughout the U.S. in April and May 2014. Attendees will receive 0.80 CEUs/8.0 PDHs for this session. This session is approved by AIA.

Continuing Education With Architectural Record and Architect

The Steel and Ornamental Metal institutes of New York will continue its series of AIA Continuing Education articles with *Architectural Record*, and has added a new series with *Architect* in 2014. Topics are available online at continuingeducation.construction.com and www.architectmagazine.com via the Continuing Ed tab.

For more information about upcoming Institute-sponsored events, visit www.siny.org and www.ominy.org.

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



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- Consultations extending to the preparation of preliminary design and construction cost analyses for alternative structural systems
- 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
- 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
- Granting of subsidies to architecture and engineering schools and funding of research programs related to the advancement and growth of the industry
- 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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211 EAST 43RD STREET, SUITE 804
NEW YORK NY 10017

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PUBLISHED BY THE STEEL INSTITUTE OF NEW YORK AND THE ORNAMENTAL METAL INSTITUTE OF NEW YORK