METALS IN CONSTRUCTION

PUBLISHED BY THE STEEL INSTITUTE OF NEW YORK AND THE ORNAMENTAL METAL INSTITUTE OF NEW YORK
WINTER 18

USTA ARTHUR ASHE STADIUM ROOF / USTA GRANDSTAND /
THE BRIDGE AT CORNELL TECH / JEROME L. GREENE SCIENCE CENTER /
LENFEST CENTER FOR THE ARTS / EAST SIDE ACCESS: MANHATTAN CAVERNS /
FLUSHING COMMONS / ELMHURST COMMUNITY LIBRARY

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Above Detail of double-pane glass walls in Jerome L. Greene Science Center by Renzo Piano Building Workshop (design architect) and Davis Brody Bond (executive architect).
Cover A Teflon-coated fiberglass membrane fastened to a cable structure with parametric geometry at the USTA Grandstand designed by Rossetti.

Nic Lehoux; cover: Rafael Gamo

EDITOR'S NOTE

Building WELL

Early in August, *Metals in Construction* launched its 2018 Design Challenge. Entitled **Design the Next-Generation Facade** and sponsored by the Ornamental Metal Institute of New York, it is the third in the magazine's increasingly successful challenge series. Unlike most architectural competitions, which usually solicit concepts for a building and then award a commission to develop it, the magazine's challenge is used to generate ideas. It seeks innovative approaches to building systems that can help achieve social objectives. By way of example, last year's challenge—which named ODA New York the $15,000 grand prizewinner—called for participants to reduce a project's embodied energy by integrating the facade within the structure. This year, participants are asked to submit their vision for ways in which the facade can be used to enhance employee health and well-being. Long acknowledged as driving building energy performance, the facade is now recognized as also influencing human performance. Researchers looking beyond workplace aesthetics and evaluating WELL Building factors such as air/water quality and thermal controls have learned that visual access to outdoor environments offers one of the most positive and direct effects on employee well-being. This is significant not only for those in the workforce, but also for the organizations that employ them. The reason: increased well-being has been shown to boost productivity and shrink recovery time from stress and mental fatigue. This link between productivity and well-being has even more significance when considering that 75 percent of our working population will be millennials by 2025. And unlike previous generations, millennials expect a healthy, engaging work environment. Organizations must be poised to offer WELL Building design features such as visual access to outdoor environments or they may not be able to attract and retain the most ambitious, tech-savvy workers. The issue is that providing these amenities isn't cheap, especially with facades accounting for up to 35 percent of the overall building cost. Fortunately, enlightened organizations understand that increasing worker productivity by just 1 percent will pay for many of these amenities. So, just as cost should not constrain the creativity of those planning these features, it should not be inhibiting the vision of those who register to enter the 2018 Design Challenge. Information on registration can be found at www.metalsinconstruction.org. Entries are due by February 1, 2018, and the grand prize winner named during a half-day conference at The Times Center in New York City on February 23, 2018. Along with selecting the winner, the jury of highly regarded practitioners will choose up to ten honorable mentions for presentation and discussion at the conference. Finally, the winner and the top five finalists will be published in *Metals in Construction* and its digital platforms. We hope this competition, as in years past, will result in the generation of many new and innovative ideas for the building community.

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USTA Arthur Ashe Stadium Roof

The more than 23,000 seats at the largest tennis stadium in the world were not originally designed to have a roof overhead, but after rain hindered the US Open for five consecutive years, the United States Tennis Association sought a solution.

CROWDS ROARED WITH APPROVAL when the United States Tennis Association (USTA) realized Arthur Ashe Stadium in Flushing Meadows-Corona Park in 1997. “New York has not produced as energized a public space since Lincoln Center,” wrote *New York Times* architecture critic Herbert Muschamp of the campus, which since 2006 has been known as the Billie Jean King National Tennis Center. Of the 23,771-seat structure by Detroit-based architect Rossetti and engineering consultant Cantor Seinuk, Muschamp cheered, “There is excellent architectural action … where steel framing, the saw-toothed underside of the concrete bleachers and the movement of people up and down stairs and escalators create a vibrant intermediary experience.”

Yet every winning streak must come to an end, and in Arthur Ashe Stadium’s case, a roofless design was its shortcoming. Because bad weather could disrupt the US Open and its Nielsen ratings, in 2004 USTA began reaching out to architect-engineers to develop a retractable roof whose weight would not overwhelm Flushing Meadows’ marshy soil, which subsides half

an inch per year. Several years later, as solutions failed to materialize and rain delays befell the US Open annually, the All England Club addressed similar problems by constructing a folding fabric-and-concertina-truss roof over Wimbledon's Centre Court.

USTA had not asked Arthur Ashe Stadium's creators to devise a solution for the delicate situation, even though in 2010 it retained Rossetti to master-plan the wider Billie Jean site. As the design studio watched its client reject others' proposals, it decided to partner with WSP Cantor Seinuk and submit an unsolicited roof concept. "We had initially devised a way to unload capacity on the existing foundations by replacing the precast concrete stadia with lightweight composite stadia," recalls Rossetti principal Jon Disbrow, who led the charge. The substitution would allow the foundations to support a lightweight roof structure, which would then connect to the existing structure via giant ring beam. The scheme ultimately did not meet USTA's criteria for speed and durability—"the solution fulfilled the structural need, if not the operational demand," says Ahmad Rahimian, director of building structures at WSP USA—but it did persuade the organization to reunite the original Arthur Ashe team and contract it to work on a second serve.

In order to achieve a seven-minute opening time and withstand hurricane-level winds, Rossetti and WSP developed a bi-parting fixed fabric shell concept that minimizes bearing points. The scheme is supported on eight tripod assemblies that surround the stadium's octagonal perimeter: Each tripod comprises a pair of HSS 38-inch-diameter steel braces connected to a vertical HSS 44-inch-diameter column, atop a concrete base supported by 20 piles driven 175 to 200 feet below grade. Disbrow likens the superstructure to an umbrella. "A much more sophisticated, $100 million umbrella," jokes Rahimian, who notes the parallels between the roof scheme and the branching structural vocabulary of the stadium's upper seating. "They both start from our principle of finding the most economical means of transferring load."

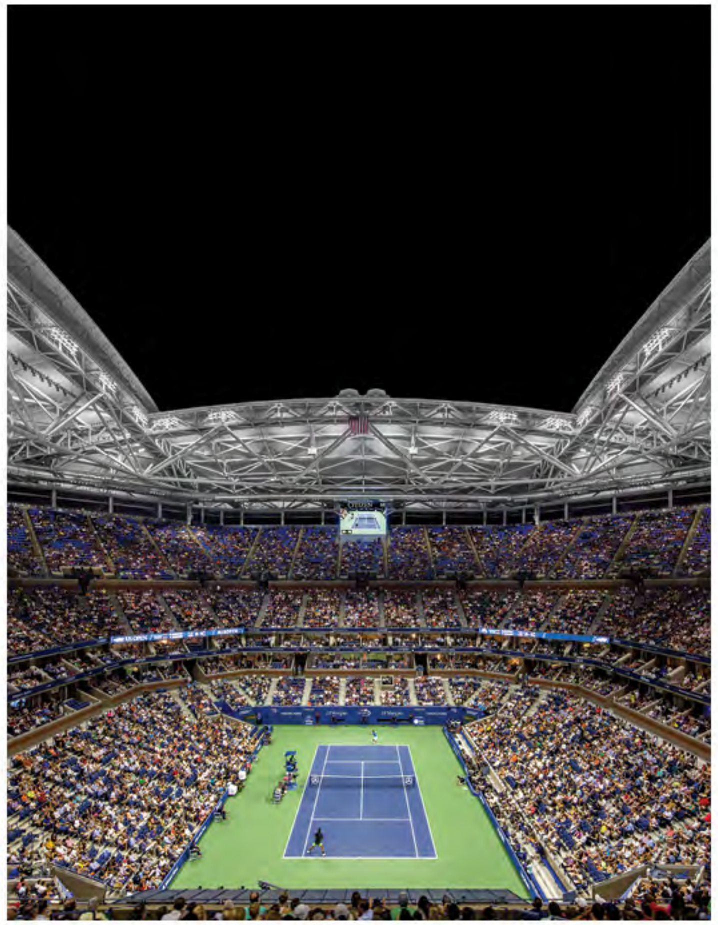
The assemblies transmit lateral and gravity loads from the roof, whose structural shell includes four catenary trusses that each span 460 feet to frame the opening of the retractable surface. The catenaries, which employ a lenticular truss configuration, are enveloped by a perimeter truss and connected by secondary one-way trusses configured in a radial direction to support the fabric roof. Tertiary X braces coupled with circumferentially running beams frame the gutter around the perimeter of the roof.

The umbrella is completely independent of the stadium, which comprises a concrete-topped composite steel structure combined with precast hollow core slabs at the superstructure level, a cast-in-place slab at court level, and steel frames spaced radially around the stadium. By concentrating the foundations in eight discrete locations, Rossetti and WSP also avoided much of the underground workings of the Billie Jean campus, as well as the infrastructure that dates to the World's Fairs held at Flushing Meadows. Potential interferences at each location were investigated beforehand to expedite steel erection and fabrication.

The fabric roof, installed by Birdair, today hovers 205 above the site. It measures 236,000 square feet in all, of which 191,400 square feet is polytetrafluoroethylene (PTFE). Within this area, two 38,000-square-foot PTFE panels open and close according to digital controls linked to sensors that monitor everything from wind and motor speed to torque, temperature, and humidity. "Tennis is an outdoor sport, so it needs to feel like the outdoors as much as possible," Disbrow says of the aperture, "We were able to far exceed the area of the court below, and to create the largest opening of any of the retractable roofs in tennis." Arthur Ashe is the sport's largest stadium.

This spread, clockwise from above Four catenary trusses form the framing system that supports the roof, each spanning 460 feet to form the opening of the retractable panels and weighing 1 million pounds each. The trusses use a lenticular truss configuration that spans between eight column supports. The final scheme of the stadium's bi-parting fixed fabric shell in closed and open positions.
Opening Spread The new structure of the stadium roof supports 190,000 square feet of polytetraflouroethylene (PTFE) fabric, a Teflon-coated membrane installed by Birdair that is lightweight yet effective in keeping out the elements.

This spread: Rossetti; opening spread and following pages: Rafael Gamo



The roof gives the appearance of being an integral part of the original stadium, which was built in 1997. In reality, the roof structure is completely independent of the stadium.

Left Engineered to open and close within 7 minutes, the roof's design and technological components allow Arthur Ashe Stadium to continue to feel like an outdoor venue.

USTA ARTHUR ASHE STADIUM ROOF

Location: **USTA Billie Jean King National Tennis Center in Flushing Meadow-Corona Park, Queens, NY**
Owner: **United States Tennis Association**, *White Plains, NY*
Architect: **Rossetti Architects**, *Detroit, MI*
Structural Engineer: **WSP USA**, *New York, NY*
Mechanization Engineer: **Geiger**, *Suffern, NY*
Mechanization Engineer of Record: **Hardesty & Hanover**, *New York, NY*; in partnership with **Morgan Engineering**, *Alliance, OH*
Retractable Roof Fabricator and Erector: **Birdair, Inc.**, *Amherst, NY*
Structural Steel Erector: **Derr and Isbell Construction, LLC**, *Euless, TX*
Architectural Metal Erector: **Metropolitan Walters LLC**, *New York, NY*

With its record-breaking retractable roof, the facility is dominating the tennis scene once again. Besides offering relief to US Open ticketholders and media buyers, the year-old project has earned new love from the architecture community. In revisiting the stadium, The *New York Times* exclaimed, "Now, the outward slope of the bowl is met with a graceful, ethereal lid." Disbrow says the design team indeed took great pains to "respond to the original building," noting how the retractable roof structure's gutter framing aligns with the raker beams that have supported the precast concrete stadia for two decades.

Rossetti continues to execute its master plan of the Billie Jean campus. And although its next major project, a replacement Louis Armstrong Stadium, cannot top the Arthur Ashe Stadium in scale, Disbrow says the all-new facility will exceed its larger, rejuvenated neighbor in terms of atmosphere. Whereas a tremendous air-conditioning system now must mechanically cool Arthur Ashe Stadium to prevent condensation from forming when the roof is closed, the new Armstrong venue pairs natural ventilation to a retractable roof. "We've designed it from the onset as an open-air breathing stadium," Disbrow says. Thanks to north- and south-facing rain screens that will allow breezes to filter through their terracotta louvers, "you won't even know you're in an enclosed space." That junior champion should be ready in time for the 2018 US Open.

The Grandstand's polytetrafluoroethylene (PTFE) fabric facade is composed of 486 panels over 26,000 square feet that were designed with computational solver software to streamline design and constructability.

USTA Grandstand

Part of a ten-year redesign of the entire Billie Jean King National Tennis Center campus, a new, relocated Grandstand plays with translucency with an innovative canopy of 486 PTFE-covered panels.

FLUSHING MEADOWS-CORONA PARK HAS come a long way from being the valley of smokestack deposits that F. Scott Fitzgerald described so evocatively in *The Great Gatsby*—as a "farm where ashes grow like wheat into ridges and hills and grotesque gardens." Before it became public open space in 1967, the site hosted two World's Fairs, a nascent United Nations, and highway infrastructure that remains vital to commuters today. The park itself took a big step forward in 1978, when the United States Tennis Association moved the US Open into an adapted World's Fair facility there. The transformation of Flushing Meadows from coal dust into community diamond continues to this day, with USTA's 2016 opening of a retractable roof over Arthur Ashe Stadium (see p. 2) and a new 8,125-seat Grandstand Stadium.

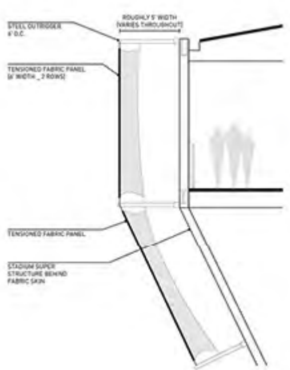
Grandstand is designed by Rossetti, and it forms the southwest anchor of the Detroit firm's own master plan for the Billie Jean King National Tennis Center. The multi-year scheme aims to remake this part of Flushing Meadows into an Olympic village–style campus, capable of accommodating an additional 10,000 visitors per day.

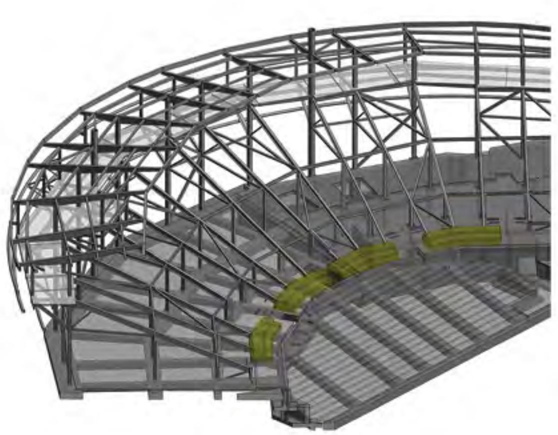
Grandstand's cornerstone location promised to unknot some existing pedestrian traffic and increase the overall capacity of the Billie Jean campus, explains Rossetti associate Matt Taylor. But Taylor, who served as design lead for Grandstand, also observes that siting placed higher aesthetic standards on the new 125,000-square-foot building. "We could have made Grandstand a much simpler design, but the site's relationship to surviving World's Fair buildings required sensitivity to that ambition," Taylor says. "We also had to take into account the orientation to campus, and make the stadium feel as open as possible to the northeast."

These considerations produced an oblong circle in plan, sectioned into 16 sides. In profile, Grandstand embodies a sloped bowl that reaches its peak in the southwest and tapers downward toward the Billie Jean campus to the northeast. Working in tandem, plan and section also maximize shade for eventgoers. A set of grand staircases spirits attendees to an upper walkway that provides vistas of the site under the cover of a cantilevered 23,000-square-foot polytetrafluoroethylene-coated (PTFE) fiberglass canopy. Inside the facility, the bowl is recessed into the earth to seat spectators closer to the play.

The Grandstand design also features a facade of 26,000 square feet of PTFE fabric divided into 486 panels fastened to an outward-facing cable structure. The design reinforces the curvilinearity of the stadium's footprint and lends a sense of movement to the volume. A sense of heritage, as well: Each panel resembles the motion of a tennis serve, or the fluttering of a park's tree canopy.

Just as local history informed Rossetti's design of Grandstand, so the site's past life as an ash dump compelled partner engineers at WSP USA to devise an innovative engineering solution for the foundation. Company vice president Craig Tracy explains, "Normally, you might break a stadium of this size into two or four pieces to allow it to expand and contract with the seasons and prevent settlement from building up stresses inside the structure. Here we just have terrible soil, and because budget eliminated pile foundations, we created a much more economical net of shallow footings." Set just below the frost line, the net's grade beams vary between 3 to 8 feet in width and measure approximately 2 feet in thickness. Even then, Tracy says, Grandstand faced significant movement due to soil settlement. "Every subsequent decision would have to make Grandstand lightweight and flexible."

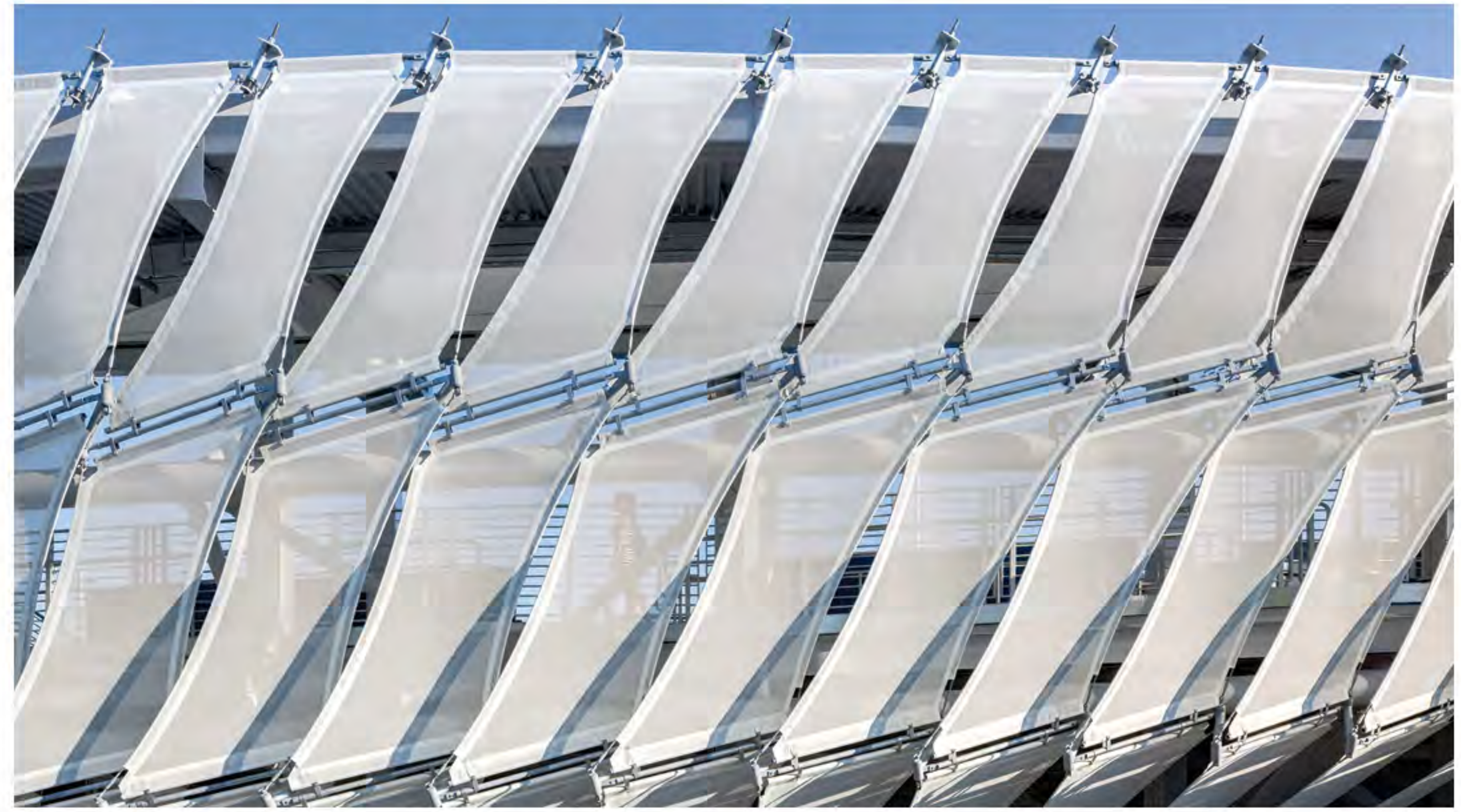




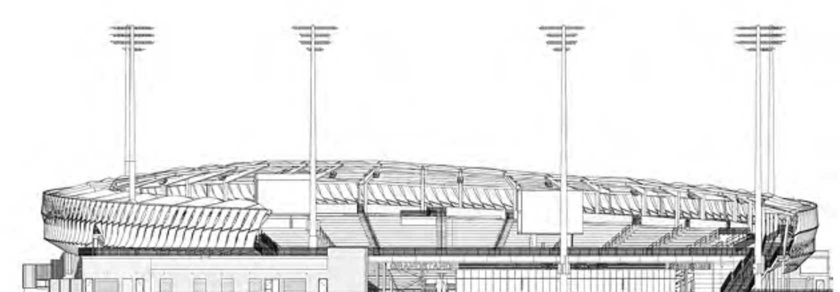
The superstructure has two parts, consequently. A lower bowl interconnected with the foundation is reinforced cast-in-place concrete that can absorb the gentle movements of settlement. The upper bowl eschews traditional precast concrete seating risers for a Sandwich Plate System divided into 14 wedge-shaped structures linked by custom expansion joints that can withstand movement. Each wedge is supported by a row of 16x16-inch HSS columns located on Grandstand's perimeter. To each column, a W21 raker beam is field welded. These raker beams support the SPS stadia and bolt to the foundations via massive concrete abutments that project above grade and form the first two rows of elevated seating. The expansion joints required precise location and fabrication of slotted holes and seated connections to accommodate the required axial releases, with some drilling performed on site.

Raker beams both carry vertical loads and act as concentric braces for lateral stability. This multitasking allowed WSP to simplify the column base supports, which did not require moment connections. Circumferential lateral stability is delivered by the concentric braced frames, with additional stability provided by framing for the pedestrian walkway and a box-girder system that forms the canopy.

All photos: Rafael Gamo; section drawings: Rossetti; raker beam diagrams: WSP



This page To the casual viewer, the building assumes a uniform single-radius arc, but its shape is a hexadecagon (16-sided form). **Facing page from top** Due to the non-linear behavior of the tensile membrane structures, Rossetti used special software to determine the forces delivered to the structure. A section detail of the grandstand canopy. Raker beams support the SPS stadia and bolt to the foundations via massive concrete abutments (highlighted) that project above grade and form the first two rows of elevated seating.



Many nodes where the bracing members meet feature exposed pin connections, which Tracy again deems out of the ordinary: "In a typical building, you can bolt everything and cover it up. But here, structure is exposed, and we need it to be flexible. Twenty bolts can be replaced by just one pin that also allows the joint to change over time."

The project team further leveraged Grandstand's HSS perimeter columns to hang the fabric facade. Three tubular ring beams support this membrane; they join to all 14 wedges via a lattice of struts and 4-inch-diameter pipes.

Curved armatures challenged the project team to modularize the PTFE panels, so that they could be fabricated efficiently while maintaining proper tension on each membrane. "When you zoom into a spline, it has an infinite number of radii," explains Rossetti technical designer Pierre Roberson, "so every instance along a spline curve has a different radius, which then had to be translated into something buildable." Rossetti divided the spline curve into 40 unique segments in Rhino, and used Grasshopper's Galapogos platform to test possible radii for the optimal radius that could be applied to all the segments.

"We used an evolutionary solver, to orient the panels and attach to the ring beams," Roberson says of the computational approach.

Taylor says that employing parametric design on Grandstand's facade initially seemed like a leap of faith, commenting that the result "offered us a lot of confidence to challenge ourselves to do things that are quite complex." Considering that Rossetti singlehandedly changed the way sports venues are designed with its introduction of luxury suites in the 1990s, Grandstand's combination of efficiency and innovation may get the industry ready for another tectonic shift.

Above The new stadium helps accommodate an increasing number of visitors to the US Open, which draws more than 700,000 fans to Flushing, Queens, each year.
Facing The Grandstand's oblong, sloping bowl gently bows to provide a vantage of the USTA campus and ensures that no two pieces of the structure are the same and no two angles are repeated.

USTA GRANDSTAND

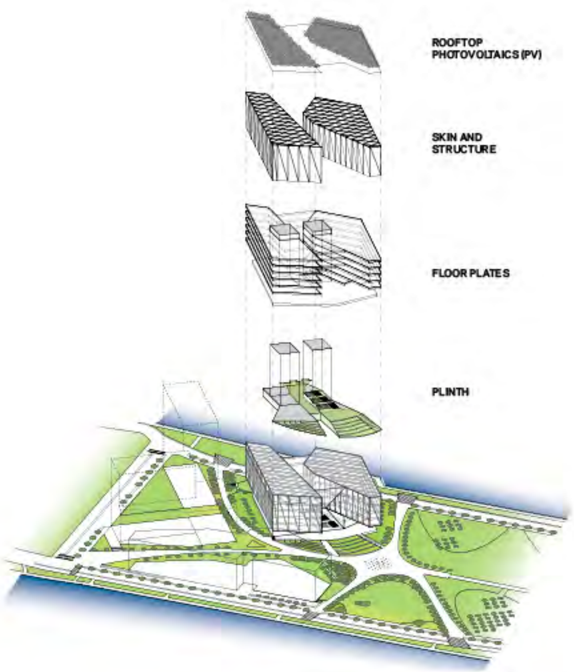
Location: **USTA Billie Jean King National Tennis Center in Flushing Meadow-Corona Park, Queens, NY**
Owner: **United States Tennis Association**, *White Plains, NY*
Architect: **Rossetti Architects**, *Detroit, MI*
Structural Engineer: **WSP USA**, *New York, NY*
Membrane and Mesh Facade Fabricator and Erector: **Birdair, Inc.**, *Amherst, NY*
Structural Steel Erector: **Northeast Structural Steel, Inc.**, *Yonkers, NY*
Architectural Metal Erector: **Metropolitan Walters LLC**, *New York, NY*

The Bridge at Cornell Tech

The Bridge (right, foreground), Cornell Tech's co-location building by Weiss/Manfredi, is one of the first three buildings to open on the new Roosevelt Island campus, along with the Bloomberg Center (Morphosis, left) and The House (Handel Architects, background).

Weiss/Manfredi Architects have reimagined an academic "co-location" building as an open connector both physically and programmatically, mixing Cornell Tech's students with entrepreneurs. With a cloven volume and an innovative facade, The Bridge is as clever a problem-solver as the tech businesses it's designed to incubate.

IF NEW YORK CITY MAYOR BILL de Blasio's intention to close the Rikers Island prison eventually comes to fruition, the planners charged with repurposing the site might take a hint from the development of Roosevelt Island. Rikers's predecessor as New York's chief penal colony—a two-mile strip of land in the East River, serially renamed from its original Lenape name Minnehanonck as Hog, Blackwell's, Welfare, and finally Roosevelt Island—hosted institutions for the incarcerated, the ill, and the downtrodden through



Top The Bridge's two conjoined volumes and central atrium offer views westward toward Manhattan (shown here) and eastward to Queens.

Above Exploded view of The Bridge's components, from the solar-panel canopies to the supporting plinth.

the 19th and 20th centuries. Its special-purpose facilities included the New York City Lunatic Asylum a.k.a. Octagon (1841-1894), Goldwater Memorial Hospital (1939-2013), and the Renwick Smallpox Hospital (1856-1875, used as a nurses' dormitory until the 1950s) as well as the penitentiary (1832-1935). It is living proof that sites reserved for deprecated uses can evolve to serve higher ones.

Today, smallpox is extinct except for a few samples in government labs, the ruins of James Renwick's hospital are a city landmark, the Octagon has been rebuilt as residences, and Goldwater has been razed to make room for an engineering and computer-science campus. The first three buildings at Cornell Tech, a partnership between Cornell University and the Technion-Israel Institute of Technology, are pioneers in forward-thinking, energy-wise architecture, designed by three top-flight firms (Weiss/Manfredi, Morphosis, and Handel Architects). The master plan by Skidmore, Owings & Merrill reimagines an urban campus as an open space engaged with its neighborhood, arranged around a public "Tech Walk" corridor that extends the spine of the island's Main Street south past its iconic tramway toward Franklin D. Roosevelt Four Freedoms Park.

The Bridge, Weiss/Manfredi's seven-story, 235,000-square-foot "co-location" building, mingles academics with entrepreneurs: Cornell Tech occupies 69,000 square feet, leaving 103,000 square feet for spec tenants in information-based industries. Its two asymmetrical masses surrounding an atrium are broken apart in a bowtie configuration to emphasize continuity and daylight, counteracting courtyard-like interiority. These prismatic volumes, set obliquely with wings pointing to the northeast and southwest, give students and workers sweeping views of Manhattan, the Queens waterfront, and the river, reinforcing the impression that the campus is simultaneously a place apart and a place connected.

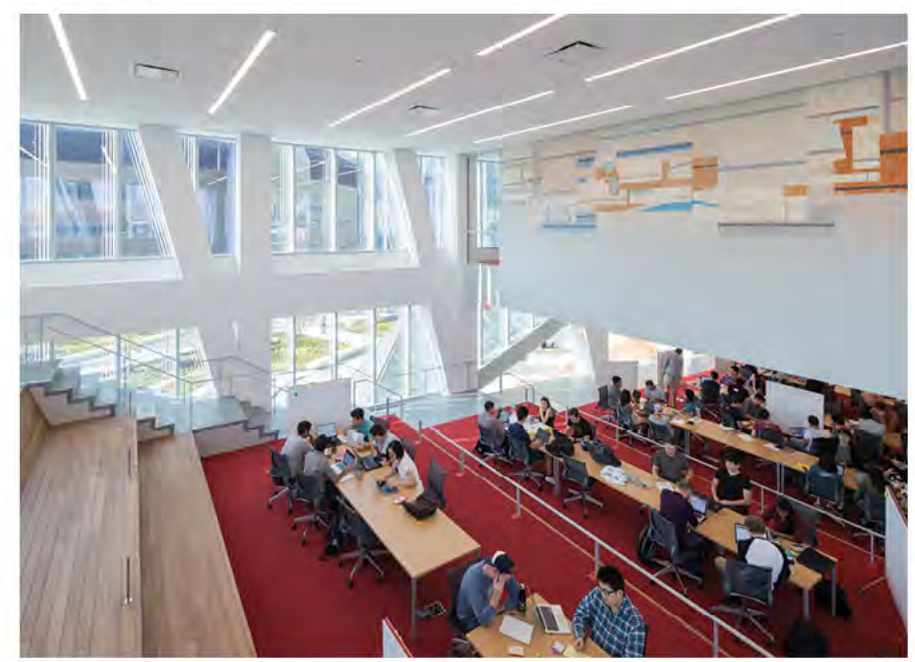
All photos: Iwan Baan; diagram: Weiss/Manfredi

From top Diagonal mullions in the facade of The Bridge's east and west volumes synchronize visually with the sharp angles of the recessed atrium glazing. The Bridge's atrium features a generously scaled staircase with multiple landings, facilitating the chance encounters and conversations that its "co-location" program encourages. Perimeter truss members in The Bridge, covered in white gypsum board, contribute to a brightly daylit interior and help reduce electric lighting.

Marion Weiss and Michael Manfredi, designing a building for a program with no exact precedents at existing institutions, took the risk of organizing the volumes around voids and views, turning "inefficiencies" into opportunities. "We've been pretty strategic about where we've located the public space," says Weiss, "by locating it at the very center and effectively creating a wedge that's more generous as it opens to the landscape, which is central to the campus, we've concentrated the most public space on the first two levels ... almost leveraging the idea of the Spanish Steps, where there's both connection and engagement in that public terrain."

The building sits on a plinth 7 feet above the 100-year flood level, with precast concrete lower-level walls and a flood wall protecting the basement from rising water. Its raised *piano nobile*, as Manfredi noted in presenting the project at last October's *Architectural Record* Innovation Conference East, brings circulation up through the building to the roof, where accessible terraces offer an "incredible panorama." The aggressively cantilevered wings keep ground-plane space clear for landscape terraces and outdoor meetings, thanks to a steel-on-concrete-base structure using hyper-efficient full-height steel trusses with an atypically low pounds-per-square-foot ratio. Maintaining column-free, light-filled work space is "why the truss is on the outside," Weiss points out: "It allows us to keep the structure concentrated on the perimeter, so that we can have open lofts for the labs, classrooms, office areas, and collaboration spaces."

The facades of the two main volumes present strikingly angled



aluminum mullions that harmonize with the interior trusses and the sharp reverse-setback segment above the atrium. "One of the engineering challenges was that the cantilevered truss areas would settle as the facade was installed," reports Chris Lalonde of curtain-wall firm W&W Glass. "Engineering had to develop the high set points for installation, so as the facade was installed, it would settle to the desired elevation points. The facade was modulated so that all the zig-zags could be done within one standard rectangular panel in our factory; the diagonal mullion was built into each unitized panel, so that we didn't have to snap diagonal units together. This was worked out with [curtain-wall consultant] Heintges during design assist. Due to the geometry, it made almost every panel on the job different."

The curtain wall includes approximately 59,000 square feet of Erie EnviroFacade™ EF 30 UW glazing with custom exterior aluminum fin-cap profiles on unitized panels. The reflective glass is Viracon's low-iron VRE 13-54 low-emission argon-filled insulated glazing units (IGUs) with custom white vertical line patterns to create the zig-zag effect; approximately 7,000 square feet of the same glass makes up the standard field-glazed system at the first floor. The water-white inverted curtain wall and sloped skylights use the Erie Custom Carrier Glazed System, approximately 12,000 square feet of low-iron IGUs with Ipasol Neutral 70/39 (also low-emission and argon-filled, with a custom-gradient white-dot frit pattern), toggled into place with carrier frames silicone-sealed to the back of the glass.

With 75% of the working and social spaces located within 30 feet of the windows, The Bridge gives occupants ample daylight, lowering electric-lighting use. Although the reflective facade appears transparent, it combines 60% opaque shadow-box units and 40% thermally efficient transparent units, considered a sweet-spot ratio for sustainable design. Solar-panel canopies 100 feet above Tech Walk combine shade for rooftop terraces with 24,000 square feet of photovoltaics, sharing the juice with Morphosis's neighboring Bloomberg Center, which aims for a net-zero energy metric. Daylight-harvesting systems and occupancy-sensor-driven dimmers enhance The Bridge's energy performance. On track for LEED Gold certification, exceeding the campus-wide goal of Silver, The Bridge observes best practices in materials and construction operations (most work for the project was completed within 500 miles of the site, and barge transportation helped minimize intrusive trucking onto an island designed chiefly for pedestrians, not vehicles).

Andrew Winters, Cornell Tech's senior director of capital projects during the building's construction, commented that for Weiss and Manfredi, "one of the genius elements ... is the ability to work landscape and architecture together; they don't really see a distinction between the two." In the Bridge, with bidirectional river views so that "no matter where you are on the campus you can orient yourself," they "took that one step further and said 'Well, why should that concept end at the front door? Why doesn't it go right through the building?'"

The wings of The Bridge are daringly cantilevered to create landscaped ground-level spaces and enhance views of the East River and Queensboro Bridge from multiple angles.

While transparency, connectivity, and sustainability are familiar principles behind many contemporary buildings' *parti*, The Bridge expresses the literal and metaphoric senses of these themes with exceptional thoroughness. The 100-person multipurpose event space includes a broad view of the Queensboro Bridge. The central atrium's social staircase and tiered lounges encourage impromptu conversations, as do diverse public zones, including a ground-level café, retail, and a terraced entryway. Plantings and rain gardens assist in stormwater management. Interior artworks include a 1942 mural by Albert Swinden, one of three Works Progress Administration-era artworks salvaged from Goldwater Hospital and restored to give the futuristic Bridge continuity with the site's past.

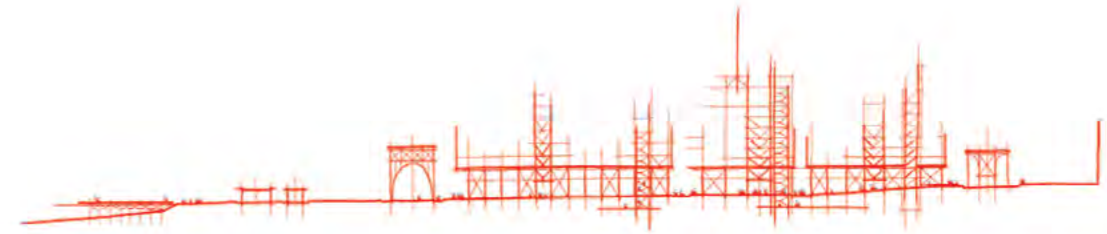
Manfredi compares Roosevelt Island in some respects to Paris's Île de la Cité, "certainly of the city, in the city, but a little different ... a bit of a heterotopia" with a distinct microclimate and a quirky history. Looking to a future where the Queens waterfront sees ample ferry traffic and other forms of revival, he observes that "after 9/11, all of a sudden there's a different perception of the water: the water is infrastructure. The water is every bit as vital a highway and a connective median as the subways are." New York is morphing from a city surrounded by water, relegating its least desirable uses to a dilapidated waterfront, into a city constructively integrated with, and respectful of, its waterways. Weiss and Manfredi and their collaborators have consequently given Cornell Tech a building that expands what it means for a school, or a city, to be a harbor.

THE BRIDGE AT CORNELL TECH

Location: **Cornell Tech Campus, Roosevelt Island, NY**
Owner/Developer: **Forest City Ratner Companies**, *New York, NY*
Architect: **Weiss/Manfredi Architecture/Landscape/Urbanism**, *New York, NY*
Structural Engineer: **Thornton Tomasetti**, *New York, NY*
Mechanical Engineer: **Jaros, Baum & Bolles**, *New York, NY*
General Contractor: **Turner Construction Company**, *New York, NY*
Curtain Wall Consultant: **Heintges**, *New York, NY*
Structural Steel Fabricator: **Beauce Atlas**, *Sainte-Marie, Québec*
Structural Steel Erector: **Stonebridge Steel**, *South Plainfield, NJ*
Miscellaneous Iron Fabricator and Erector: **Empire City Iron Works**, *Long Island City, NY*
Ornamental Metal Fabricator: **Champion Metal and Glass**, *Hauppauge, NY*
Curtain Wall Fabricator: **Erie Architectural Products**, *Novi, MI*
Curtain Wall Erector: **W&W Glass, LLC**, *Nanuet, NY*

Jerome L. Greene Science Center

Above left Floor-to-ceiling glazing maximizes sightlines and daylight for laboratories and meeting spaces. **Above right** A drawing of the Manhattanville Campus master plan by RPBW.



Clarity, openness, quiet, and energy-sparing ingenuity make the new headquarters of Columbia University's Mind Brain Behavior Institute a remarkable workplace for cutting-edge research and community health promotion. The crystalline Greene Center gives its neighborhood a view of science in vitro.

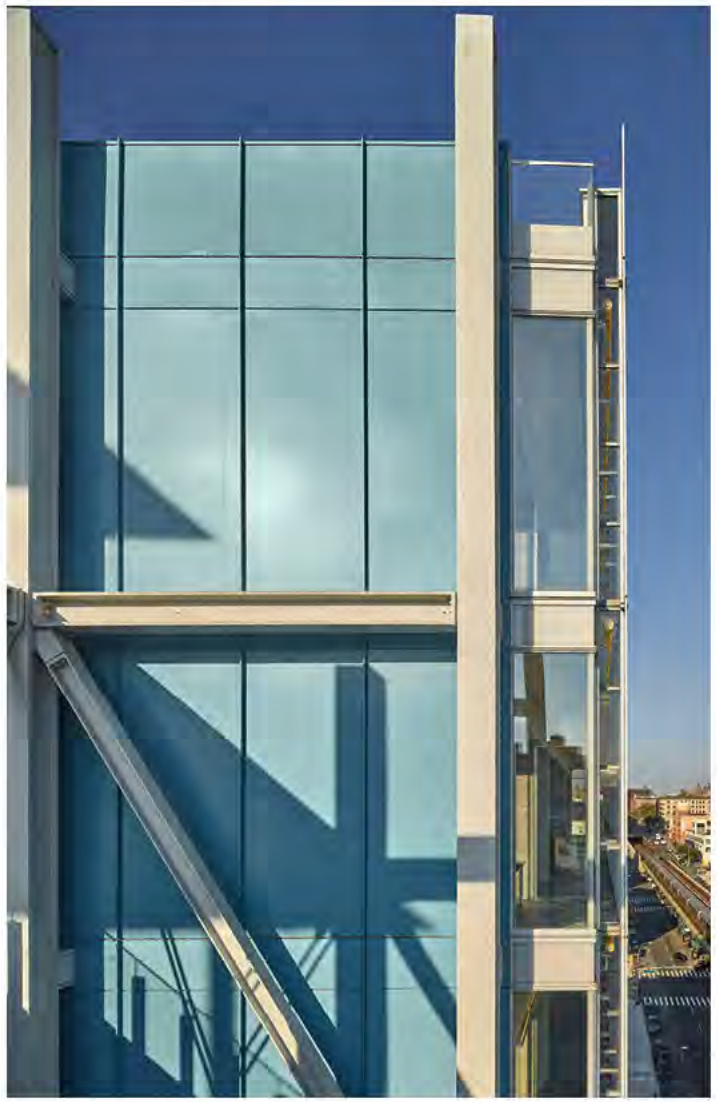
THE METROPOLITAN TRANSIT AUTHORITY'S UPTOWN 1 train roars out of its tunnel between the 116th Street/Columbia University and 125th Street stations every few minutes, demarcating districts with different sonic priorities. Near the citadel-style Morningside Heights campus, railway noise is concealed underground; just uptown at Columbia's new Manhattanville complex, elevated MTA infrastructure dominates the space and the senses. Inside the new Jerome L. Greene Science Center, however, the trains are visible but virtually inaudible, their 88-decibel outdoor thrum reduced to a 44-dB whisper. It is as if the hush of the Columbia University's Butler Library stacks were captured under glass.

Instead of clustering facilities with related programs, e.g., an all-biomedical area or an undergraduate quad, Columbia and Renzo Piano Building Workshop (RPBW) have planned the emerging Manhattanville campus to host diverse fields, banking on interdisciplinarity and connectivity both campus-wide and within single buildings. Manhattanville's Phase 1 occupants will represent the neurological and behavioral sciences (Greene), the visual and performing arts (the Lenfest Center for the Arts, featured on p. 26 of this issue), public communications (the University Forum, slated to open in 2018), and the global economy (two Columbia Business School buildings by Diller Scofidio + Renfro and FXFOWLE, projected for 2021). The new buildings will stand among several preserved buildings from Manhattanville's industrial past and a later phase of new construction over the coming decades, establishing continuity between the history and future of a distinctly productive neighborhood.

Greene will be the home of the new Mortimer B. Zuckerman Mind Brain Behavior Institute, which unites medical research into conditions such as Parkinson's and Alzheimer's diseases, biomedical engineering, data-intensive genetic analysis, community health promotion, and mental-health education on levels from K-12 to graduate and postgraduate studies. Led by a formidable trio of neuroscientists—a Kavli Prize winner, Thomas Jessell, and two Nobel laureates, Richard Axel and Eric Kandel—the researchers, physicians, and educators working at the institute will explore the complexities of neuroscience from the molecular level to the behavioral and social.

The Greene Center's atmosphere must be conducive to peace of mind for research workers and intellectual/emotional uplift for visitors; its *parti* emphasizes daylight, openness, and circulation patterns fostering the chance conversations and collaborations that can lead to discoveries. Although this is not a new philosophy in academic buildings—Frank Gehry's Stata Center at MIT (2004) takes a similar approach, with its intertwining corridors, ad-hoc meeting spaces, and internal courtyard—RPBW implements it at Greene under stringent site conditions. Sound and vibration emanate from the surrounding streets as well as the 1 train, with Manhattanville's intentionally porous master plan inviting the neighborhood in rather than walling it out. Sensitive laboratory and imaging equipment requires exceptional stability. Because the building sits on deep rock, which would make excavation for basement mechanical support prohibitively expensive, RPBW allocates the second story to the mechanical equipment. "The geotechnical conditions of the site imply that the cost of every additional basement increased exponentially and not arithmetically," says Antoine Chaaya, partner and board member at RPBW and project architect on both Greene and Lenfest.

The top priority in Greene is the working environment. "Thematically speaking, the building is telling a story," says Chaaya. "It's so transparent in order to bring daylight inside, and for this reason we put the desks and the scientists around the perimeter." Floor-to-ceiling glazing maximizes sightlines. Laboratories and meeting spaces, including dramatic double-height spaces for breaks and informal meetings and connecting levels with open stairs, are positioned where daylight is brightest, external to the central core. "The double height is really enhancing



Top Vibration support for Greene's cooling towers.
Above Several facade typologies help optimize thermal, environmental, and acoustic performance.

the team spirit and enhancing the collaboration between scientists," Chaaya says, "and deleting the horizontal segregation between levels."

The large floorplate, about 210 feet by 190 feet, is articulated into four asymmetrical quadrants by north-south and east-west axes, creating notches spanning 12 feet between columns in the north-south direction and 24 feet east-west, with an interactive space at the corner of each quad. Piano's hand sketch for the quads is preserved as a logo on elevator signage. Levels 3 through 9 harbor laboratories, offices, meeting rooms, and interactive spaces, with outdoor terraces on levels 8 and 9 and a 320-person lecture space on 9. At 450,000 total square feet (340,000 above grade and 110,000 in four below-grade levels, the steel-framed, Greene is the largest structure Columbia has ever built (just above Butler's 441,108 square feet) and the largest academic science building in New York City.

Like Lenfest and other RPBW projects, Greene wears its metals and mechanisms proudly. The steel structural frame with diagonal members is visible at the notches, and lighter external diagonal bracing reinforces the visual dialogue with the elevated viaducts for the 1 train and Henry Hudson Parkway between which it sits. Cast-iron bracing, an approach used more often in Europe than the U.S., offered "a cost-effective way to produce a quite complex piece many times," Chaaya reports. Second-story mechanical equipment dwells behind aluminum panels on the north facade, painted in Columbia's signature light blue, matching the entrance signage. "Architecturally speaking, this opaque floor, located just above the transparent urban layer," he adds, "helps in creating a mass that appears levitating above the ground." The roof sports two tall vertical smokestacks (connected to the campus's central energy plant beneath Lenfest and its small piazza) as well as smaller cooling towers and cannon fans, exposing the building's sophisticated air-handling system as another architectural feature.

"Building floor-vibration criteria used for the structural design of the above-grade levels from 3 to 9," Chaaya continues, were "about 2,000 micro-inches per second," a standard established at an early programming stage. "The structural steel frame supporting the above-grade laboratory floors was analyzed and designed to meet the baseline laboratory vibration criteria suitable for most sensitive laboratory functions, and for special equipment having more stringent criteria, it's supported with the use of local vibration isolation platforms." Below grade, reinforced concrete flooring increases local stability to 500 micro-inches per second, suitable for the most sensitive operations (e.g., electron microscopy) yet cost-effective enough to avoid "penaliz[ing] the whole project by putting too much steel everywhere."

The key to Greene's thermal, environmental, and acoustic performance is its sealed active double skin of glass and aluminum, the most complex of its six wall types. The exterior is a laminated single glazing, Chaaya notes, with insulated glass units providing a double-glazed interior and a 16-inch cavity between them. With the building's east, west, and south facades exposed to solar heat gain, sensors connected to the building management system (BMS) allow automatic deployment of motorized outer shades with 10% opacity; operable inner shades with 3% opacity give occupants the option of further glare control. (These components are deployed where needed, Chaaya adds, not overdesigned: the northwest quadrant, with lower solar heat gain because of protection by the neighboring Lenfest Center and less noise because of its orientation furthest from the subway line, dispenses with the exterior shade and the double skin.)

The double skin is integrated with the building's HVAC system to provide thermal buffering in winter and summer. Instead of being vented to the street, clean recycled air, filtered and dehumidified three times, enters the cavity at the second floor—"2 feet per second within the cavity at the bottom," Chaaya notes, slow enough "to avoid fluttering of the cavity shape, so the cavity shape will not vibrate and distract the scientists"—to wash the space as it rises to exit from the top. Chilled beams and perimeter radiant heating from concrete-embedded polypropylene tubes carrying hot water from the central energy plant also contribute to thermal stability, so that lab spaces remain comfortable with only six air changes per hour. "By using the chilled beams," Chaaya reports, "we reduced by 50% the amount of changed air." A less bulky "package of structure and MEP in the ceiling," he continues, allowed them to "reduce the height of the building by almost one floor and save cost."

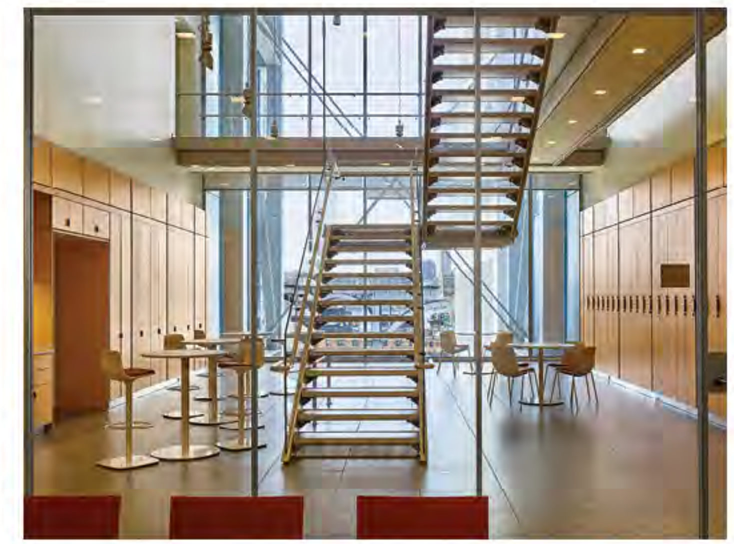
Sustainability is designed subtly into Greene's systems, Chaaya continues, "without being fashionably expressed, in the sense that we did not put [it] everywhere for the tenant to see, to say 'We are sustainable.'" Energy-conserving strategies include a high-reflectivity cool roof and terraces of light-colored composite concrete, materials with high recycled content and regional sourcing, and "clean construction" measures devised in partnership with the Environmental Defense Fund to minimize carbon-dust emissions and other disruptions to the urban neighborhood. The bottom lines Chaaya reports are impressive: annual cost savings of 32%, energy-use savings of 35%, water-use savings of 43%, and CO2 emission reduction of 33%, as compared with an ASHRAE base building. The full Manhattanville campus is expected to achieve LEED Platinum certification for Neighborhood Development.

Chaaya credits building information management (BIM), particularly Revit, as a source of significant efficiencies in this complex project. BIM made it possible to devise and combine multiple submodels

Opening spread: photo © Columbia University/Nic Lehoux; diagram: © RPBW this page from top: © Columbia University; © Columbia University/Nic Lehoux

This page and following spread: © Columbia University/Frank Oudeman

This page Collaborative meeting spaces and open-air staircases connect two floors; double-height interactive spaces are oriented to take advantage of daylight and views.



(for the central core and below-grade space, structural steel, electrical, mechanical, fire protection, slab, and plumbing), enabling trouble-sparing clash detection at the design stage. "It was really crucial for coordination with a comprehensive process of plastic action," he says, leading to tighter tolerances, more cost-effective ceiling heights, and more headroom in working space. Mockups of facade, interior, steel, and cast-iron components at a 1:1 scale also allowed the design team and university representatives control of details; Chaaya cites the architecturally exposed structural steel, intumescent paint finish and touchup, ergonomics, lighting, and laboratory materials as elements that especially benefited from extensive use of mockups.

The building that benefited from such thorough modeling can be seen as a model in its own right, an embodiment of what the "ICE economy" of ideas, culture, and education can give a city. Piano, speaking at the opening ceremony last October, described himself as "suspicious about metaphors" yet oscillated between the metaphors of a palace and a factory. "If it is a palace, it is a palace of light," he said, "and if it is a factory, it's a wise factory; it's a kind of different factory... This part of Manhattan is an industrial place; it was an industrial place. There is always... a little genius of the place. In Latin, they used to call it the *genius loci*. A little genius hiding, and you have to catch it." Contrasting with the "acropolis" of the Morningside Heights campus, he continued, Manhattanville has industrial roots, "more humble than Gothic and Greek and Roman, but more real." In giving Columbia what he calls a "factory exploring the secrets of mind," Piano and his colleagues extend their tradition of respecting the processes and components of industrial production, both by applying them and by displaying their strength and grace to the public.

Above Greene as seen from the 1 train subway platform at 125th Street. **Right** The building as seen from the southeast.

JEROME L. GREENE SCIENCE CENTER

Location: **Columbia University Manhattanville Campus, New York, NY**
Owner/Developer: **Manhattanville Development Group for Columbia University Facilities and Operations**, *New York, NY*
Design Architect: **Renzo Piano Building Workshop**, *New York, NY*
Architect of Record: **Davis Brody Bond LLP**, *New York, NY*
Associate Architect: **Body Lawson Associates**, *New York, NY*
Structural Engineer: **WSP/Parsons Brinkerhoff**, *New York, NY*
Mechanical Engineer: **Jaros Baum & Bolles**, *New York, NY*
Lighting, Acoustical and Vibration Consultant: **Arup**, *New York, NY*
Construction Manager: **Lendlease US Construction**, *New York, NY*
Structural Steel Erector: **J.F. Stearns, Co., LLC**, *Pembroke, MA*
Structural Steel Fabricator: **Cives Steel Company**, *Gouverneur, NY*
Curtain Wall Fabricator and Erector: **Enclos**, *New York, NY*

Lenfest Center for the Arts

Lenfest Center for the Arts (left) and Jerome L. Greene Science Center (right).

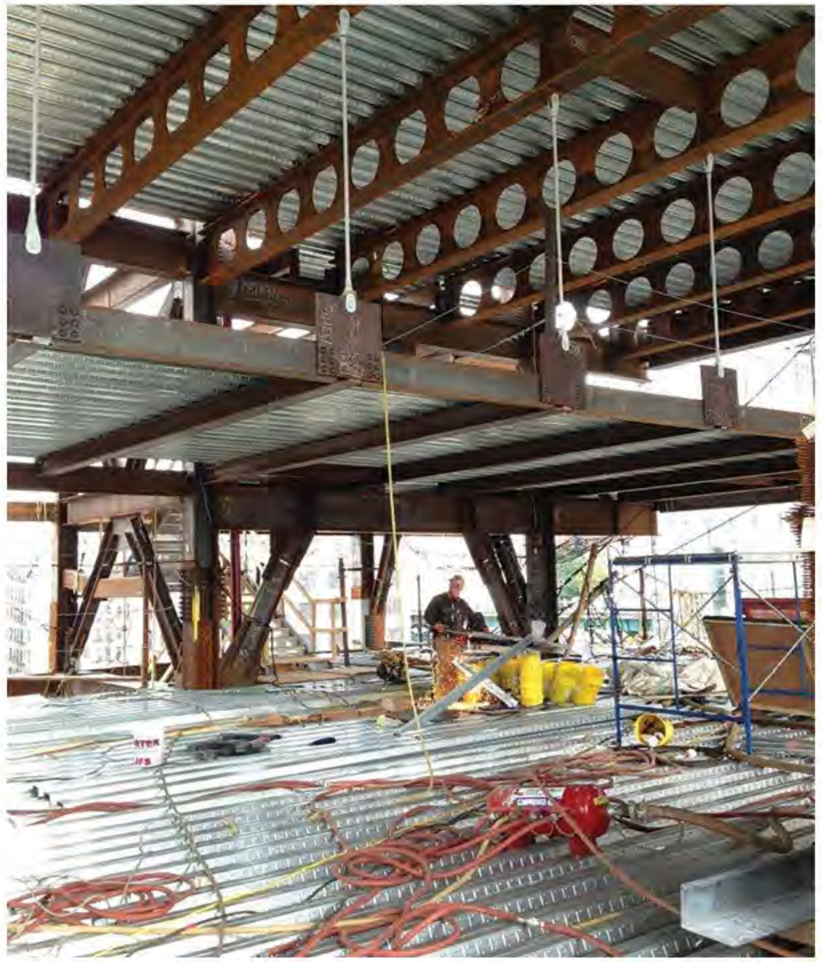
In a high-performance cultural center on Columbia University's new campus, Renzo Piano Building Workshop looks to the neighborhood's industrial tradition. Steel and aluminum make this multi-program building robust functionally and aesthetically.

COLUMBIA UNIVERSITY'S NEW CAMPUS IN Manhattanville (a.k.a. West Harlem) sits between two striking pieces of transportation infrastructure: the Henry Hudson Parkway viaduct above 12th Avenue and the Metropolitan Transit Authority's 1 line above Broadway. Their beams and arches establish a visual vocabulary for the neighborhood, both graceful and rugged. An academic complex that looks to the arts and sciences as the intellectual and economic foundation for urban reanimation, especially in this site, will naturally rely on industrial materials.

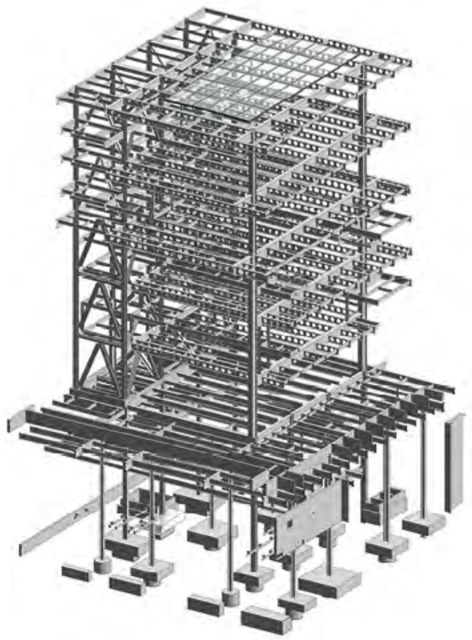
Renzo Piano Building Workshop (RPBW), long known for designs that place structural elements forthrightly in view, grounds its vision for the new Lenfest Center for the Arts in the observation, as project architect Antoine Chaaya puts it, that "steel already is part of the DNA of the site.... The soul of the place, no doubt, is industrial." Steel, proudly exposed, creates a dialogue between Lenfest and its surroundings, including the Jerome L. Greene Science Center housing the Zuckerman Mind Brain Behavior Institute (the campus's first building, opened last October) as well as the elevated structures flanking Manhattanville to the east and west. An ambitiously proportioned steel frame also helps Lenfest combine disparate activities harmoniously. Though in lesser hands a multipurpose arts complex can be a camel—a horse designed by committee, doing several things adequately-to-awkwardly and none superbly—RPBW and its collaborators (including Davis Brody Bond and Body Lawson Associates) have fine-tuned the details to make Lenfest a precision instrument for creativity, more akin to a finely crafted multifunction watch.

"The steel in this project," Chaaya says, "was really used on three different levels: first one, for the primary structure... the larger span, and then you have the secondary structure, the other beam running the smaller span, and then you have tertiary structure, where we are using this for [the] facade, for stairs, for canopies—for what we call the lace." Exterior bracing frames using cast-steel nodes and diagonal columns occupy the northwest and northeast corners, taking vertical loads transferred from the secondary members. Major members are visible both outside and inside, with architecturally exposed structural steel (AESS) protected by intumescent paint, imparting a sturdy elegance in whites and grays.

"Every member basically belongs to a surface category of steel," adds senior vice president Yoram Eilon of WSP/Parsons Brinckerhoff, "based on its location and visibility within the building," economizing on the pricey paint. "You don't treat a node that you can see from 3 feet the same way as you treat a beam that is 20 feet above you. The team categorized the steel members based on parameters such as proximity to view/touch, structural role in the primary structure, and exposure conditions in order to achieve optimum performance and economy. Selected members were categorized as AESS." The steel used on the



Clockwise from top right A model of Lenfest's structural steel framing. Large cellular beams running north-south retain strength with less mass and allow ducts, piping, and conduits to pass through the round openings. Lenfest under construction, looking northeast. **Facing from top** The Katharina Otto-Bernstein Screening Room. A north-south section depicting Lenfest's varied programming.

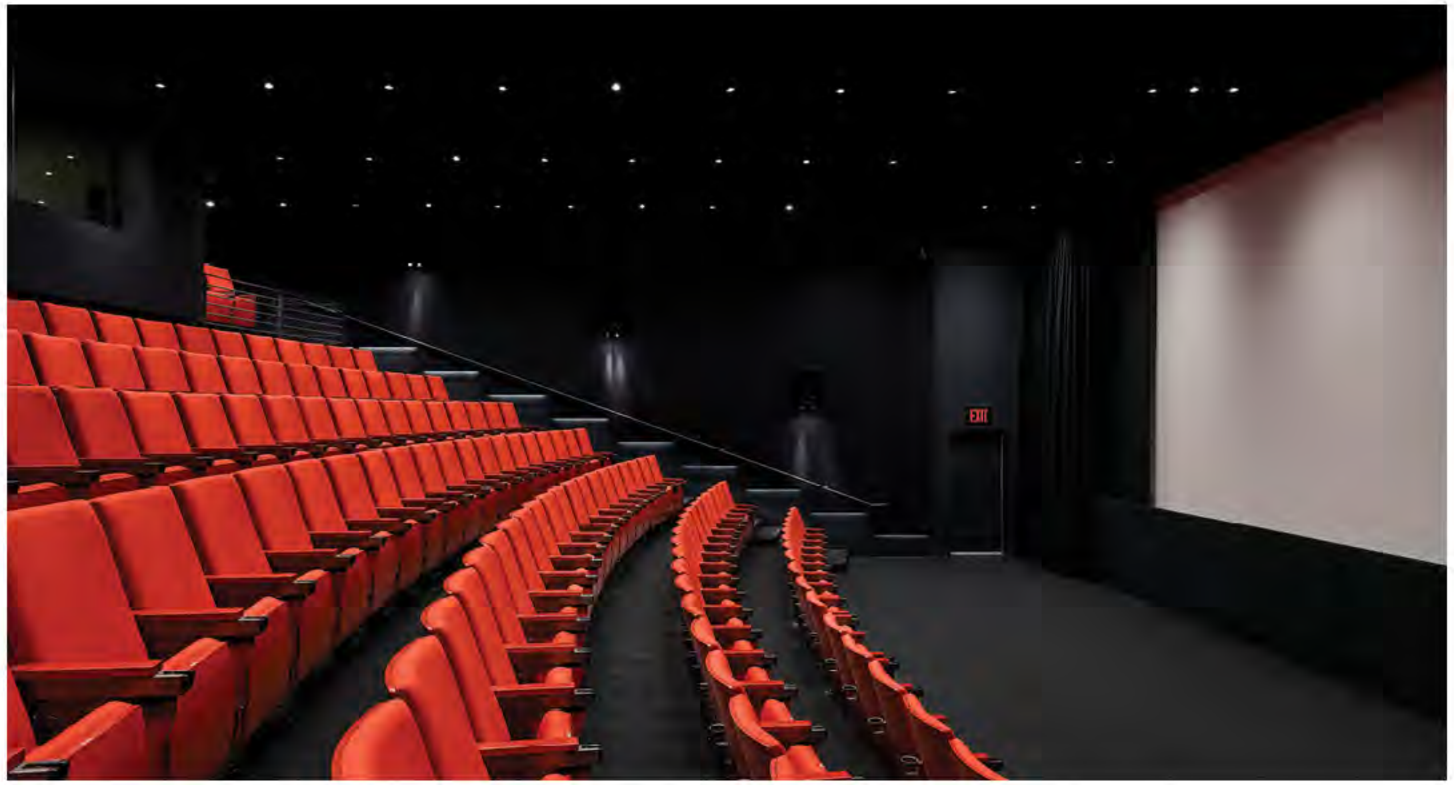


project is mostly recycled, he adds, at levels above the U.S. norm, one of many points contributing to Manhattanville's Stage 1 LEED Platinum certification under LEED for Neighborhood Development, the first LEED-ND certification in New York City.

The 60,000-square-foot building includes four distinct programs: the Katharina Otto-Bernstein Screening Room for the university's film department (seating 150, doubling the capacity of its predecessor in the Morningside campus's Dodge Hall); a black-box performance space for theater and dance; the Miriam and Ira Wallach Art Gallery; and a flexible presentation space for lectures, symposia, recitals, and other gatherings ("the Lantern"). "The structural framing concept for all the floors is similar," reports Eilon, "even though we were challenged to accommodate different performance criteria.... Meeting these criteria from a structural perspective required state-of-the-art dynamic analysis simulating the anticipated use characteristics. This was particularly important due to the framing of the long spans that made the open space possible." Each component occupies a double-height volume and requires broad column-free expanses: 72 feet of uninterrupted east-to-west space between corner columns that contribute to a moment frame stabilizing the southern portion of the building, with the elevator core offset to the north to maximize open floor areas. Floorplates vary as the building rises: the top-story Lantern measures 96 feet east to west and 54 feet north to south, Eilon continues, including nearly 12 feet of cantilever with a 72-foot girder spanning between the anchor columns. He describes the eight-story reverse-setback building as "unusual from the structural perspective... From a total area perspective, it's a compact building. At the same time, it's one of the more challenging buildings I've worked on because of [its] highly integrated systems design approach and the unique design criteria."

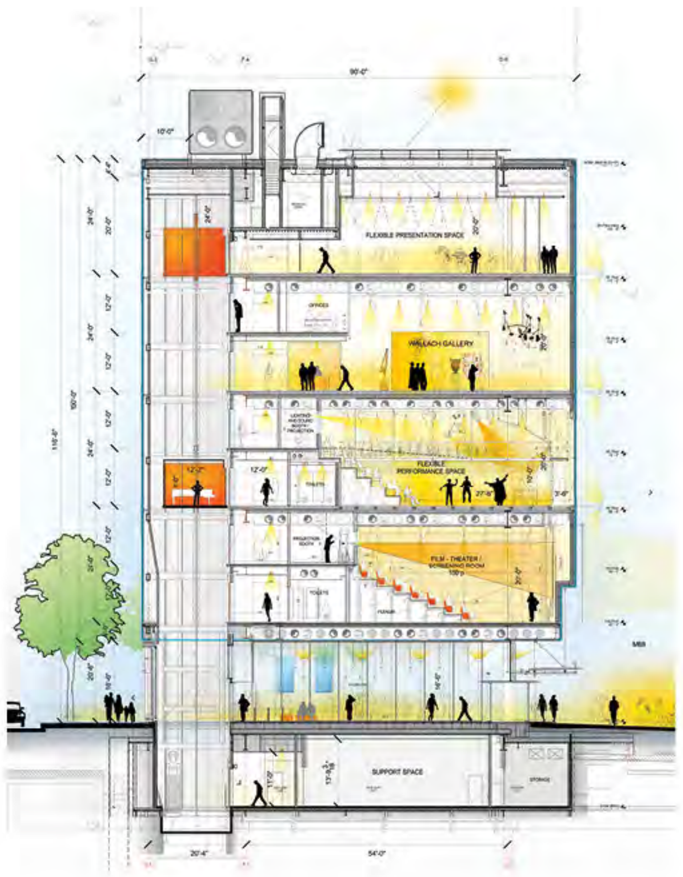
Opening spread: photo © Columbia University/Victoria Benitez; this page, clockwise from top: © RPBW; © Columbia University; © Columbia University

This page and following spread: © Columbia University/Frank Oudeman; diagram: © RPBW



The four spaces each represent a variation on the theme of large chambers served by mezzanines (providing public entry and technical booths in the cinema, balcony seating and back-of-house facilities in the black-box theater, offices for the gallery, and the mechanical floor above the Lantern). What makes the long spans possible without significant structural deflection is the secondary or north-south component: large cellular beams, a form of castellated beam with round perforations rather than hexagonal openings, retaining strength with less mass and allowing ducts, piping, and conduits to pass through the round openings. "The highest beam, which is running east-west," Chaaya notes, "is where we have the 72-foot span; it's three foot seven deep. Imagine if this needed to be in concrete.... We are giving to the beams the structural inertia that they need, but the beam does not need to be completely full in the middle." All the columns use wide-flange sections; some are also plated. Cellular beams are exposed brightly in the Lantern beneath louvered skylights and in the Wallach Gallery's uniformly white ceiling amid ducting and lighting, resembling the downtown industrial lofts where "the contemporary arts were born." In the screening room and the black-box performance space's technical-grid ceiling, the beams are darkened as the programs require, but still visible.

Sonic and vibrational isolation must meet high standards here. Chaaya describes a scenario where a meeting or musical event in the Lantern coincides with an opening in the gallery, as cocktail glasses clink and stiletto heels clack on the floor; dancers leap in the black box below, their landings cushioned by spring-loaded raised flooring, viewed by an audience in mezzanine seating suspended by steel rods from the slab above; and students in the second-floor screening room examine a film, requiring quiet acoustics and an unwobbling projector. Up to 900



people may thus be using Lenfest's facilities at the same time, each group needing different conditions. "The floor framing is composed of... cellular beams with composite galvanized metal deck on top," says project manager Frank Mannino of WSP. "The concrete topping slab is supported by the metal deck. Headed studs are welded to the steel beams and anchored to the concrete slab." An additional benefit of steel, Chaaya notes, is that it allowed top-down construction, moving down a story at a time rather than beginning with full basement excavation. "If we are not using the steel," he says, "we will not be able to use this technique, which allows us to gain more or less one year on schedule, and one year of schedule is a lot of money."

"Is this an ideal structure?" Eilon asks rhetorically. "Obviously not, but it's a very functional structure." An engineer's ideal structure, he says, is "quite boring, by the way. It wants to have a square perimeter, a core in the center as big as possible, and then... open space all around for functions. Obviously that type of structure is not applicable here, and I think that the Lenfest building responds to the architectural vision. That's the point of it. It integrates all of the building trades' efforts into a dynamic and iconic structure. You can see that this building was designed by an architect and not a structural engineer—which is actually a compliment." Although Lenfest is modest in size compared to WSP's overall work within the Manhattanville campus, adds executive vice president Jeffrey Smilow, the firm is particularly proud of its success in meeting the challenges of the jewel-like building.

Lenfest's facade is a naturally ventilated double skin of white-painted aluminum paneling (3-foot modules 6 mm thick to avoid deflection, Chaaya notes, or 4 mm in certain panels supported from behind), adding thermal efficiency in both summer and winter by serving as a rain screen and letting air circulate between the building body and the aluminum panels. The building avoids a shipping-container ambience by giving three of the four chambers large-scale fenestration and precisely controllable daylighting, the screening room being the logical exception. Broad, striking views from the Lantern, the gallery, and the black box (when its blackout shades are opened) look south across a small piazza toward Columbia's main Morningside Heights campus a few blocks away. As its ground-floor lobby is fully transparent except for the core, Lenfest appears to hover above grade, maintaining the civic permeability that defines RPBW's master plan for Manhattanville—a quality also shared with Lenfest's larger, better-known downtown counterpart, the Whitney Museum. "This is the first similarity between the projects," Chaaya says, "because we deeply believe that the building should not take possession of the ground floor. This is not only an urban attitude, it's also a human attitude and a civilized attitude... The ground floor is shared with the city; it's shared with the community. You welcome people, and you are open to the city."

Expansion into Manhattanville addresses Columbia's chronic spatial constraints (a particularly acute form of the challenge all urban universities face, finding lateral annexation impossible or prohibitively costly) while reinvigorating a district that had fallen on hard times. The university's full formal title, not always recognized outside its walls, is Columbia University in the City of New York. That relationship has always been too complex for binary terms like "town/gown" to describe. Lenfest represents a once-insular Ivy League institution's optimistic embrace of urban muscularity, a celebration of how infrastructure and expressivity are inseparable.

Above The Miriam and Ira D. Wallach Art Gallery.
Facing Flexible performance and presentation spaces will showcase thesis productions and support innovation in the performing arts while hosting a variety of public programs and events.

Installation of a groin rib in the west cavern.

East Side Access: Manhattan Caverns

One of the largest transportation infrastructure endeavors ever undertaken in the United States, the megaproject will provide new Long Island Rail Road service to Manhattan's East Side with an eight-track expansion beneath Grand Central Terminal.

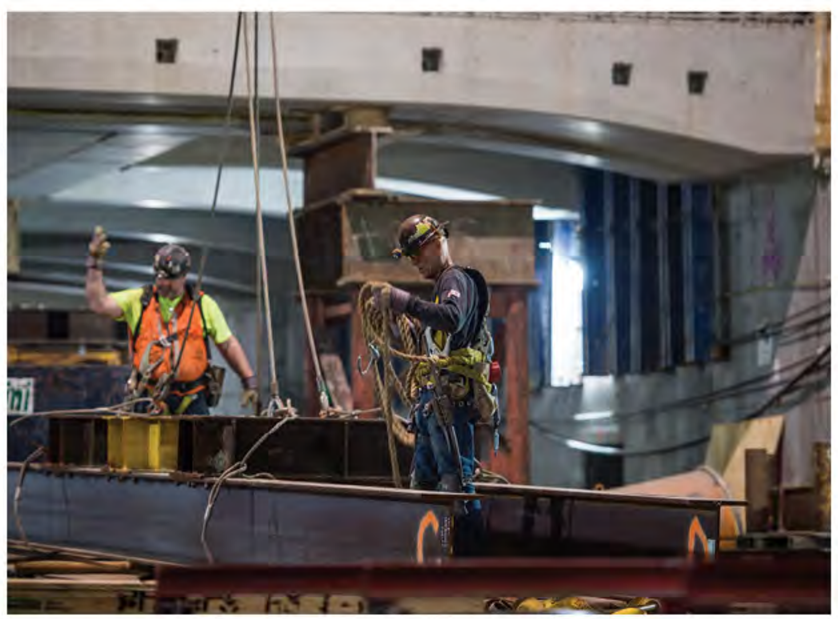
GRAND CENTRAL TERMINAL IS NOT wanting for superlatives. Host to more than 750,000 visitors and commuters each day, the station is the largest hub for train traffic in the world. Now, it can add one more accolade as the epicenter of the East Side Access (ESA) project, a more than $10 billion endeavor that is the largest project ever undertaken by the Metropolitan Transportation Authority, not to mention one of the largest transportation megaprojects in the country. With congestion on the MTA's Long Island Rail Road (LIRR) lines common, especially during morning and evening rush hours, the project will add a new LIRR terminal within Grand Central Terminal (GCT), increasing rail capacity into Manhattan by nearly 50%. The project also promises to save LIRR travelers to Manhattan's East Side up to 40 minutes of commuting time a day, touting a "one-seat ride" connection into GCT from Long Island and Queens.

Starting with new tunnel connections from the Harold Interlocking section of Sunnyside Yard, the project will connect the LIRR Main Line and Port Washington Branch to the 63rd Street Tunnel under the East River. Hard-rock tunnel boring machines have tunneled deep under Midtown Manhattan from the 63rd Street tunnel's lower level at Second Avenue to a new LIRR concourse beneath the existing lower level of GCT. Below that, two new terminal caverns each have an upper and lower level, adding eight new tracks for incoming trains. To connect with GCT's lower level, a new passenger concourse within the footprint of the existing Madison Yard will include escalator, elevator, and stair connections to GTC's dining concourse and the former arrivals waiting room, along with connections to 45th and 47th street cross-passages. When completed in 2022, the entire East Side Access project will serve an estimated 162,000 customers each day. The project's completion will also free up LIRR tracks into Penn Station, allowing trains from the MTA Metro-North Railroad's New Haven Line access to Penn Station through Queens. A Penn Station Access project will construct four new stations in the East Bronx, which will also significantly cut travel times to and from Manhattan.

With 150 prime construction contracts to date, the ESA project is a who's who of infrastructure experts. Roles traditionally held by an architect and structural and mechanical engineer are encompassed by the role of General Engineering Consultant, a tri-venture of Parsons Brinckerhoff (now named WSP USA), Parsons Corp., and STV. Overall construction management falls under the role of Program Management Consultant, held by AECOM; a Consultant Construction Management team, a joint venture of Jacobs and LiRo, provides additional construction management support.

Early in 2016, the MTA awarded the final major contract for the project's Manhattan Caverns to civil and building construction company Tutor Perini Corporation. The contract will transform two enormous 1,143-foot-long caverns carved out of solid rock into the new terminal station 100 feet beneath GCT. The work encompasses more than 12 miles of track work from Queens to Manhattan, as well as station platforms, elevators, escalators, and staircases to carry customers to and from the underground station, and all architectural finishes throughout the caverns—in renderings, these are depicted as stainless steel wall panels, modular metal ceilings, and stone flooring. When the project is complete, the caverns will hold 2,774 individual precast concrete elements including beams, deck panels, platform walls, and

The west cavern in January 2014
Below A diagram of the new LIRR terminal beneath Grand Central Terminal.



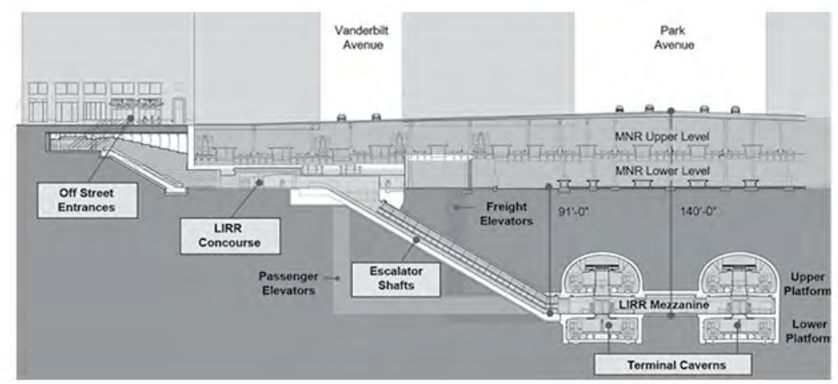
Top Groin rib installation in the west cavern.
Above Ironworkers hoist a steel truss used to support groin rib installation.

slabs installed by Tutor Perini. The new station's plenum, designed to contain and ventilate smoke if necessary, has been designed with post-tensioned precast wall panels in lieu of a traditional structural steel framing system, so the project's structural steel elements are largely used to construct elevator shafts, escalator trusses, and stairs.

"People say structural steel is good because it saves time; precast is the same way," explained Terrence Flynn, vice president of engineering for Tutor Perini's Civil Group on a tour of the site last spring. The precast concrete fabricator, Schuylerville, New York-based The Fort Miller Co., Inc., was able to homogenize the camber of many of the elements, ultimately relying on only eight molds to form the Manhattan caverns' precast members. Pieces are cast with special embeds to make crane picks safer. Fort Miller also invested a significant amount of effort to perfect the precast fiber mix, balancing a formula that would meet structural requirements while allowing for an exposed architectural finish in the completed LIRR mezzanines.

In addition to these design considerations, careful phasing was required to make work in the caverns as efficient as possible. From storage in Fort Miller's yard, precast elements were trucked and staged as needed at storage yards in Long Island City, then driven into the cavern on a designated rubber-tire route (along which train tracks will lie in the future) on the same flatbeds used for ground transportation to avoid double-handling of the ele-

All photos and diagrams: Metropolitan Transportation Authority of the State of New York



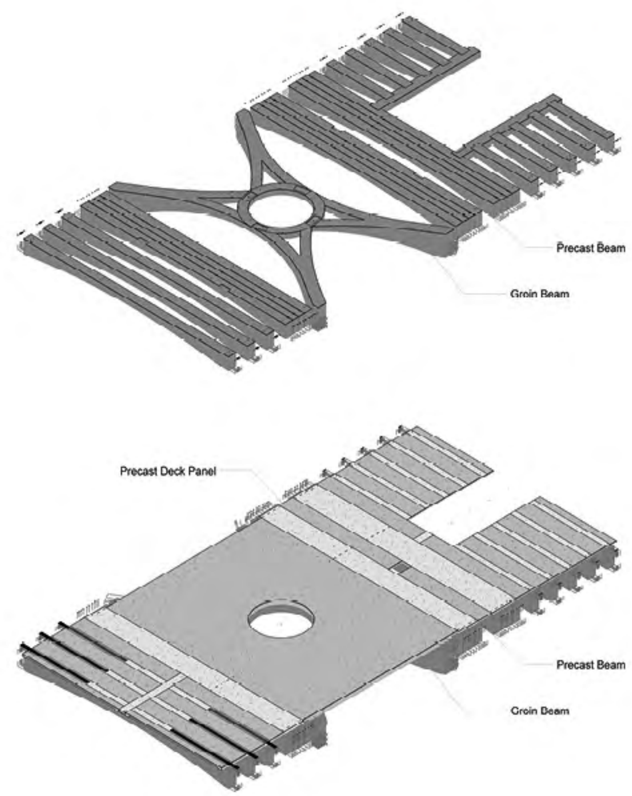
> "People say structural steel is good because it saves time; precast is the same way."
>
> Terrence Flynn, Tutor Perini

ments. Maneuvering the flatbed trucks within the tunnels and caverns posed its own challenge and had to be carefully coordinated due to constraints including duct-bench clearances, shoring, elevator pits, and overhead cantilevers.

Within each cavern, a 400,000-pound telescopic Liebherr LTR1220 crawler crane is used to pick each precast piece from the flatbed and place it in its final location. (The crane itself was brought into the cavern in pieces on 10 flatbeds and assembled in place; it will be dismantled and driven out the same way.) The project teams developed a sequencing pattern to allow the crane to complete installation of both the upper- and mezzanine-level beams and deck panels from the lower track level.

The project's most noteworthy precast elements are quarter sections of four giant groin-rib assemblies within the east and west caverns, each weighing approximately 22 tons; the exterior precast elements for the assemblies weigh approximately 24 tons each, and each completed quadruple beam assembly, post-tensioned onsite, is approximately 60 tons total and measures 52 feet long, 7 feet wide, and 2½ feet deep. Nothing was left to chance due to the tight tolerances within the existing cavern, where new installation had to contend with the existing structure and reinforcing steel elements. The project team used a full-scale mockup to test the geometry of the groin rib assembly, and its constructability from fabrication through post-tensioning.

The entire west cavern groin rib assembly takes shape.
Facing left Large precast members are trucked in on flatbeds one at a time.
Facing bottom One-quarter of the west cavern's massive groin-rib assembly waits to be hoisted into place.
Below Diagrams of the groin-rib assembly (top) and precast deck panel and beams above it (bottom).



With years of work ahead before the project alleviates Manhattan commutes for many LIRR customers, members of the public can take heart that some of the project's benefits have already been realized. The MTA has opened 50th Street Commons, a pocket park between Park and Madison Avenues, and a new entrance to Grand Central from within 245 Park Avenue, offering direct access to the terminal from points east of Lexington Avenue and north of 47th Street. And though out of sight for the hundreds of thousands of commuters, the caverns below their hurrying feet are transforming rapidly into the next chapter of Grand Central's importance to the growth and development of the city around it.

EAST SIDE ACCESS: MANHATTAN CAVERNS

Location: **Grand Central Terminal, New York, NY**
Owner: **Metropolitan Transportation Authority Long Island Railroad**, *New York, NY*
Architect, Structural Engineer and Mechanical Engineer: **General Engineering Consultant (GEC), a tri-venture of Parsons Brinckerhoff (now WSP USA), Parsons Corp.**, and **STV.**, *New York, NY*
Program Management Consultant: **AECOM**, *New York, NY*
Consultant Construction Management: **Jacobs/LiRo Joint Venture**, *New York, NY*
General Contractor: **Tutor Perini Corporation**, *New Rochelle, NY*
Structural Steel Erector: **Tutor Perini Corporation**, *New Rochelle, NY*
Terminal Structure Precast Concrete Fabricator: **The Fort Miller Co., Inc.**, *Schuylerville, NY*
Terminal Structure Precast Concrete Erector: **Tutor Perini Corporation**, *New Rochelle, NY*

A residential tower and commercial building are the first phase of the 1.8-million-square-foot Flushing Commons mixed-use complex at Union St. and 39th Ave.

Flushing Commons

New York City's Flushing Commons embraces steel framing for the differing uses and layouts of a mid-rise residential tower and commercial building.

SITUATED RIGHT IN THE HEART of the Big Apple's most populous borough, the first phase of the much anticipated 1.8-million-square-foot Flushing Commons mixed-use complex is rapidly taking shape at Union St. and 39th Ave., just a few blocks away from the USTA Billie Jean King National Tennis Center and Citi Field, home of the New York Mets.

By 2021, the five-building complex in Queens will house a residential building and office, retail, parking, and community space. For now, a steel-framed 670,000-square-foot 14-story residential tower, 11-story office building, and a 4-story 270,000-square-foot below-grade garage opened for occupancy earlier this year.

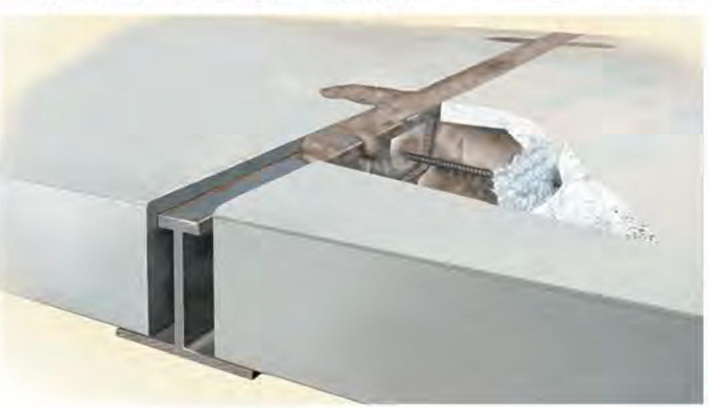
Among the challenges facing architect Perkins Eastman and structural engineer DeSimone Consulting Engineers was designing the structural steel system to optimally support both the commercial and residential towers.

While a steel framing system allowed for larger spans inside the residential tower, this created a challenging planning module for the residential space as typical parking and retail column grids often don't meld with the column spacing required for residential units.

Generally speaking, the columns for residential buildings are tucked away within the architectural elements inside the rooms. This places restrictions on the floor layout when making the columns compatible with the commercial column grids.

To solve this quandary, DeSimone went with the innovative Girder-Slab system—an assembly of asymmetrical steel beams, referred to as "D-Beams"—fabricated from a standard rolled wide-flange section and a flat bar.

"The proprietary system for gravity framing uses the D-Beam, which supports hollow-core precast plank on the bottom flange," says Amit Mavalankar, P.E., senior project manager for DeSimone. "The commercial building is designed using the composite wide-flange steel beams carrying a slab on metal deck with lightweight topping concrete."



Because a building's floor height is a function of the building's usage, the Girder-Slab system was ideal as it limited the column transfers normally required with a flat-plate concrete structure over a steel retail podium.

"The Girder-Slab system allows longer spans with smaller slab thickness than that of a conventional concrete flat plate system," explains Mavalankar. "It is good choice for a mixed-use projects where lower levels are utilized for the commercial or parking structure and residential units are situated on upper levels."

While the Girder-Slab system solves a lot of challenges, the building team still had to work with the ground-floor slab within a retail footprint and its associated level changes and slab drops.

Furthermore, the plaza slab outside the building footprint needed to support fully loaded concrete trucks, a surface detention tank, and a below-grade detention tank above the first parking level.

In order to make all of this work, "the architect, civil engineer, and our office performed extensive coordination during the design phase to ensure all conditions were thoroughly detailed and transitions between different systems were addressed," says Mavalankar.

Furthermore, the routing of mechanical systems required additional coordination due to miscellaneous steel framing for plank openings and beam lines, according to Michael Lew, a principal with Perkins Eastman.

DeSimone minimized and designed brace frames at locations near the elevator and stair core where they would most easily be concealed and not affect the layout of residential or commercial spaces.

"All braced frames needed to be within demised partition and cores with none permitted on the exterior," emphasizes Lew. "DeSimone was able to locate the brace frames within these guidelines."

The steel brace frames were also used as a lateral force-resisting system for each of the buildings and designed to react to wind loads. The concentric frames use brace and column sizes up to W14×370.

Because the system is predominantly drift-controlled, fewer braced frames were required to control both the overall and inter-story drift. Concrete shear walls were used below grade, in the parking garage. Brace frames were used for structure, above grade, and were transferred at the ground-floor level on the shear walls via strap beams.

For the gravity system, D-beams on the residential levels support 4-foot-wide, 8-inch-deep planks spanning 28 feet, and match the column spacing in the retail levels and parking garage. In the other direction, the beams span 18 feet to 20 feet between the W12x230 columns. The columns reduce in size for the higher floors to W12x87.

This page from top: Girder-Slab Technologies; DeSimone; Girder-Slab Technologies; Facing: Opening spread: Matthew Johnson

Facing from top A steel-framed 670,000-square-foot 14-story residential tower, an 11-story office building, and a four-story, below-grade garage opened for occupancy earlier this year. Concrete shear walls were used for the below-grade parking garage; above-grade brace frames are transferred at the ground-floor level on the shear walls by utilizing strap beams (pictured). A rendering of the Girder-Slab system. **This page** Construction of the office and residential buildings. To optimize the use of structural steel for both buildings, structural engineer DeSimone specified the Girder-Slab system, an assembly of asymmetrical steel beams fabricated from standard rolled wide flange section and a flat bar.

In order to meld into the surrounding neighborhood, the residential tower was designed as a window wall, blending in with a brick veneer and glass. The edge of the floor system supports the facade panels which are attached to perimeter W10x39 beams in the north-south direction. “The embed plates were cast in the slab on metal deck as well as precast hollow-core planks for the attachment of panelized brick and curtainwall system,” says Mavalankar.

To optimally locate the embed plates to support the panelized facade system with structural interfaces, and for ease of coordination between the trades, a 3D TEKLA model was created and used exclusively by the steel fabricator and erector, Berlin Steel Construction. To optimize the MEP design and coordination, the design team utilized Revit.

“The mechanical openings were coordinated early on and fabricated while casting planks, thereby minimizing the need for field cores for the openings,” says Lew.

Overall, utilizing the Revit model early on during the preliminary design phase helped resolve clashes between the structural and MEP components.

The construction manager, Tishman Construction, and design team used project-management software Constructware as a submittal tracking system, which helped expedite the construction administration process. “Use of BIM models, as well as scheduling and submittal tracking software, helped support efficiencies,” adds Lew.

Ultimately, the choice of steel framing met Flushing Commons’ unique structural requirements with its restricted overall building height and need to minimize foundation loads. The shallow foundations were used to support superstructure loads along with individual footings and mat footings supported by soil.

By specifying the Girder-Slab system for the residential tower and conventional steel for the commercial building, the project serves as a strong example of successfully coordinating both residential and commercial usages within a structural steel frame.

Above When the second design phase of this LEED-certified project is realized, a one-acre open space will serve as a welcome breather to the congested downtown Flushing area. **Facing** Phase 1 of the project used approximately 4,500 tons of steel.

This page: Perkins Eastman Architects; Facing: Girder-Slab Technologies

“The Girder-Slab system allows longer spans with smaller slab thickness than that of a conventional concrete flat plate system.”

Amit Mavalankar, DeSimone

FLUSHING COMMONS

Location: **138-35, 39th Ave., Flushing, NY**
Owners: **F&T Group**, *New York, NY*; **The Rockefeller Group**, *New York, NY*; **AECOM Capital**, *New York, NY*
Architect: **Perkins Eastman Architects**, *New York, NY*
Structural Engineer: **DeSimone Consulting Engineers**, *New York, NY*
Mechanical Engineer: **AKF Group LLC**, *New York, NY*
General Contractor: **Tishman Construction**, *New York, NY*
Structural Steel, Miscellaneous Iron, and Architectural Metal Fabricator and Erector: **Berlin Steel Construction Co.**, *Kensington, CT*
Metal Deck Erector: **Berlin Steel Construction Co.**, *Kensington, CT*

A monumental, stringerless stair connects the two main floors of the library. The extra-wide landing encourages social interaction.

Elmhurst Community Library

The borough's second-busiest library engages the community it serves with a transparent and welcoming structure that is alive with activity day and night.

IN THE DECADES FOLLOWING WORLD War II, Elmhurst, Queens, became—and continues to become—one of New York City's most ethnically diverse neighborhoods, as well as one of the most linguistically rich places in the world.

It makes sense, then, that the Elmhurst Community Library is the second busiest circulating library in the borough's network of 64 libraries, with more than 80,000 card-holding users speaking more than 57 languages. The library lends approximately 1.2 million items per year, and it often serves as a front door to this country, as well as a community center and a great equalizer.

But Elmhurst had outgrown its original 1904 Lord & Hewlett-designed Carnegie library, an imposing monolithic structure that was adapted multiple times to support increasing numbers of visitors, and in December 2016 it finally welcomed a new home built partly over the Carnegie's old foundation. The 32,000-square-foot Elmhurst Community Library, which is double the size of the Carnegie, was designed by Marpillero Pollak Architects (MPA) in collaboration with the Queens Borough Public Library and the NYC Department of Design and Construction. "Coming to library is part of the process of assimilation," says Sandro Marpillero, a founding partner of MPA. "The goal was to celebrate the diversity of this place and to try to set up the most inviting and fluid sense of spaces to respect individual patrons' differences."

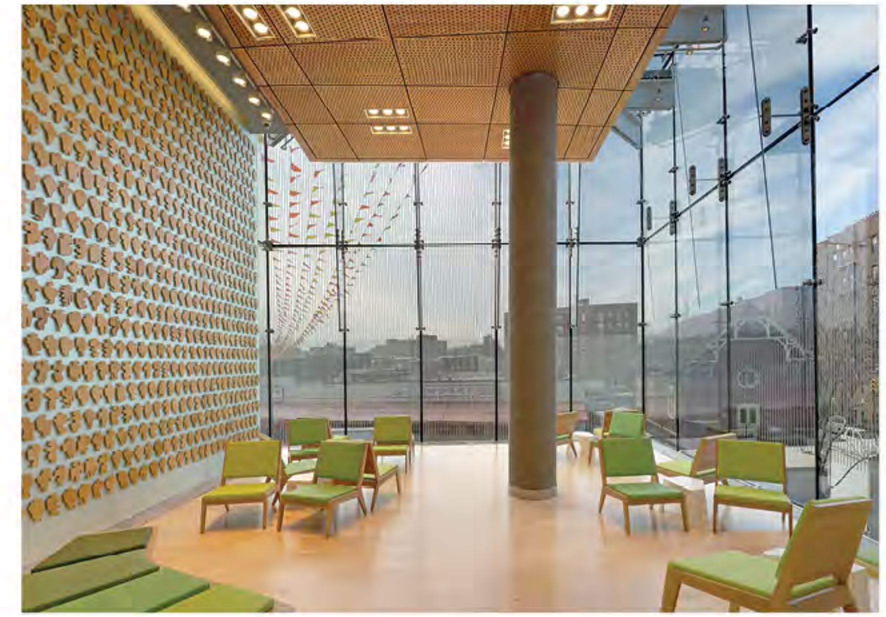
This page Construction photos show the installation of the glass curtain walls in the library's two glazed cubes. All of the steel beams and outriggers are purposefully exposed and cambered toward their apex in the most exposed corner of the cube at the center of the park. (Only the outriggers are visible, against the glass roof return, in the Broadway cube.)

The new structure is transparent and welcoming, with state-of-the-art technology and ample spaces to read, learn, and relax. It holds more than 75,000 books and multimedia for children and adults in English, and 36,000 books and multimedia in nine different languages. The design team took great care to reference historical elements of the Carnegie building, adding a "memory wall" at the entrance to the library made of bricks from the original facade and a fireplace mantel from the previous library's children's room.

Making the best use of community garden and park space that had become overshadowed by a neighboring 15-story residential tower built in the 1970s, the library now re-asserts its civic presence on the corner of Broadway and 51st Avenue. Somewhat Z-shaped in plan, it consists of two main volumes joined at the now transparent center of the site and clad in a terracotta rainscreen, with aluminum inserts marking the floors slabs and articulating bands of vertical windows. This neighborhood-appropriate treatment contrasts with two glazed cubes for reading rooms, which position patrons in the city and park. One, to the east and engaging Broadway, floats above the main entrance. The other, to the north, extends into the community park and makes a showcase of a cantilevered, monumental stair. These glowing, smaller volumes are beacons at night. In scale they reference the neighborhood's surrounding historic fabric, including the landmark 1760 St. James Episcopal Church Parish Hall across Broadway.

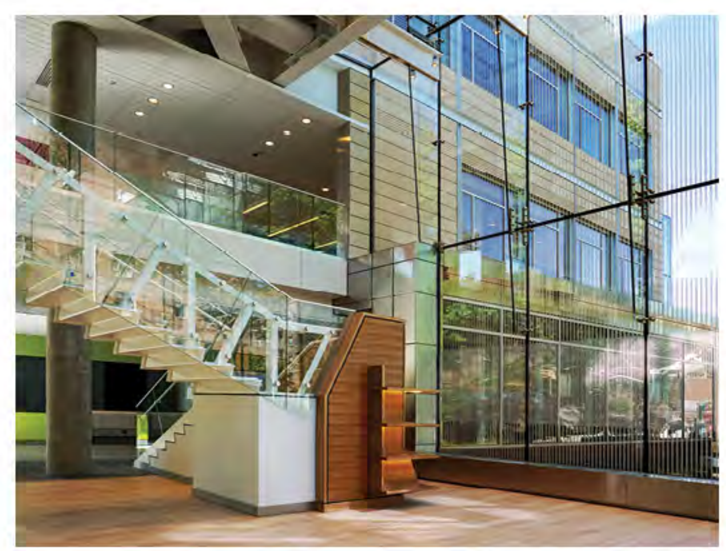
All photos: Marpillero Pollak Architects

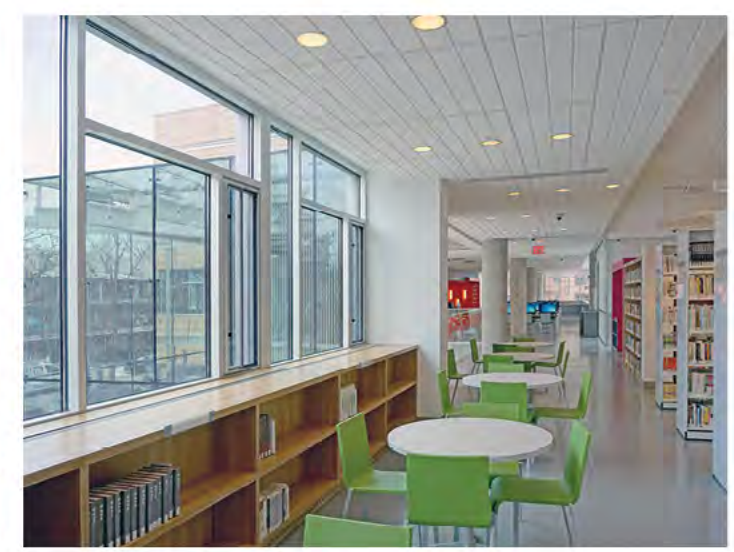
Clockwise from top The glazed Broadway Reading Room cantilevers over the street, engaging passersby with artist Allan McCollum's 20-by-20-foot "Shapes" wall installation made of elm wood. For the roof return glass in the cubes, W&W Glass selected Pilkington Optiwhite low-iron insulating PVB laminated glass with white, silk-screened vertical frit on the #3 surface. The second floor adult stacks look out over a community park. Point-supported structural glass is used in the library's two cubes, allowing natural light to flood the space. The glass walls are supported by cantilevered laminated glass fins, which lend high levels of structural support without significantly reducing the transparency of the system.



The architects and design team, including Severud Associates Principal Cawsie Jijina, established strict performance standards for the structural glass cubes, leading them to select W&W Glass. Together the team conceived of a plan to install Pilkington Planar point-supported structural glass comprised of heavy-duty Pilkington Optiwhite low-iron insulating glass units with HP 69/37 Low-e on the #2 surface and insulating units. Custom white, silk-screened frit on the #3 surface provides excellent thermal performance and glare control, with variations in pattern density on differently oriented surfaces.

For the roof return glass, the team selected Pilkington Optiwhite low-iron insulating PVB laminated glass with HP 69/37 Low-e on the #2 surface and white, silk-screened frit on the #3 surface. The facade glass is supported by steel outriggers that extend from the roof's structure and hold hanging Pilkington Optiwhite low-iron SentryGlas laminated glass fins. As Jijina explains, the weight of the glass—held more than 20 feet above the floor—puts it in tension, making it rigid enough to withstand wind loads. A 1-inch





Above The two glass cubes connect the library to newly designed side and rear parks. Windows facing the southern park feature terracotta baguettes attached to vertical metal fins anchored to the curtain wall. These louvers help to filter light daylight. **Facing** The library's glass volumes act as lanterns at night and remind passersby that the building is often open after lending hours for events and classes.

air gap at the base allows the glass to expand in the heat without touching the base of the shoe.

In the reading room that overlooks Broadway there is no dead load on the slab because there is no weight from the three-dimensional structural glass enclosure hanging from the roof's outriggers. This allows for the dramatic cantilever, which acts as a thin canopy above the main entrance. HVAC ducts are carefully sculpted between the exposed steel beams in both glass cubes. The openings in the beams are shaped to conform to the grand architectural plan. Every structural steel connection is formed so that bolt heads across a central spine are symmetric on either side. Within the glass cubes' structural framing, even the hex-head bolts are torqued to a position such that the top edge of the hexagon is always parallel to the beam flange.

For the whimsical monumental stringerless glass and steel stair, Jijina engineered a one-sided exposed truss railing from which a single steel folded plate stair is hung, adding floating glass plates to the sides of this long-span structure.

Six-inch-diameter columns, acting as supports for roof and wind load, modulate the interior of the library's two stainless steel-clad volumes that emerge from the terracotta enclosure (one story in front and two stories towards the back). "They allowed us to have the same section of aluminum curtain wall on the horizontal and the vertical members in the two-story high portion, while also matching the profiles of the lower one and those of all of the recessed windows in the terracotta," says Marpillero. The rhythm of these thin columns, juxtaposed with the exposed concrete ones along the circulation spine, establish both visual continuity and variation.

MPA used a diagonal central spine that runs on an east-west axis as an organizing tool for the library's circulation and program spaces, which are identifiable by their brightly colored thresholds portals. An Adult Learning Center and related classrooms are below ground. A long checkout and help desk greets visitors in the lobby, leading them to a newsstand kiosk and the elm wood-clad Carnegie Reading Room that overlooks the community learning garden. On the second floor, teens get their own space behind a lit entry portal, while the third floor contains the children's library and multipurpose room. The Adult Learning Center and the multipurpose room are often open after hours, increasing opportunities for community programs, such as Tai Chi classes, dance workshops, and discussions of relevant civic issues.

"The idea is that the library is now an extension of the city: patrons encounter different spaces of different scales and identities as they walk through it," says Marpillero. As far as melting pots go, the Elmhurst Community Library is a near-perfect model.

ELMHURST COMMUNITY LIBRARY

Location: **86-07 Broadway, Queens, NY**
Owner/Developer: **New York City Department of Design and Construction (DDC)**, *New York, NY*
Architect: **Marpillero Pollak Architects**, *New York, NY*
Structural Engineer: **Severud Associates**, *New York, NY*
Mechanical Engineer: **ADS Engineers**, *New York, NY*
Construction Manager: **Stalco Construction, Inc.**, *Islandia, NY*
Structural Steel Erector: **Swingline Steel**, *Smithtown, NY*
Miscellaneous Iron Fabricator and Erector: **Mid Island Erectors, Ltd.**, *Middle Island, NY*
Curtain Wall Fabricator: **Pilkington Planar**, *Hauppauge, NY*
Curtain Wall Erector: **W&W Glass, LLC**, *Nanuet, NY*

TAKE THE METALS IN CONSTRUCTION MAGAZINE 2018 DESIGN CHALLENGE

The *Metals in Construction* magazine 2018 Design Challenge is a competition to generate ideas for a facade system that can play a major role in enhancing employee health and well-being at a speculative tech incubator on the Williamsburg waterfront. Have an idea for achieving this goal? Register for the challenge and earn a chance to win the $15,000 grand prize, publication in *Metals in Construction*, and a public exhibition of your work. *Metals in Construction* and a six-member jury of leading practitioners will award a $15,000 cash prize to the design judged to exhibit the greatest innovation, efficiency, and aesthetic integrity in achieving these objectives. The grand prize-winner and finalists will be announced and discussed at a half-day ideas conference at the TimesCenter in New York City on Friday, February 23, 2018. The deadline for entries is February 1, 2018. This year's competition is sponsored by the Ornamental Metal Institute of New York.

For more information and to register, visit metalsinconstruction.org.

Facade Tectonics Forum: NYC

On October 27 the Ornamental Metal Institute of New York hosted the Facade Tectonics Forum: NYC at The Times Center in New York. The forum is one of many initiatives by the Facade Tectonics Institute (FTI), whose mission is to carry out progressive and broad-based research in building facade technology. Divided into three sessions, the day's talks had the theme "Outside the Lines: Building Facades Redefine Urban Living in NYC." Session 1, The Inside, focused on the facade's effect on health, productivity, and lifestyle; Session 2, The Outside, focused on the facade's effect on urban habitat; Session 3, The Far Side, revisited the day's venue with a look at the data-verified successes of the New York Times Building. For more information on other FTI initiatives, visit www.facadetectonics.org.

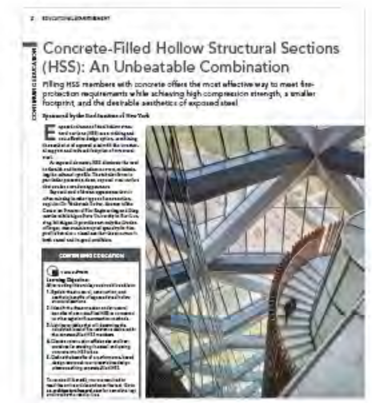
For more information about upcoming Institute-sponsored events, visit www.siny.org and www.ominy.org.

Christian Kerez: Definitions of Space at The Cooper Union

On November 14, Christian Kerez spoke at The Cooper Union as part of the school's annual lecture series. The lecture focused on architecture as a three-dimensional space, not in a closed, clearly defined way, but instead in an experimental way that opens up various approaches for defining and thinking about space. Born in 1962 in Maracaibo, Venezuela, Kerez has been a professor in design and architecture at the Swiss Federal Institute of Technology in Zurich since 2001, making full professorship in 2009. The lecture was sponsored by the Ornamental Metal Institute of New York.

AISC Louis F. Geschwindner Seminar

On December 8, the Steel Institute of New York sponsored The Steel Construction Manual, 15th Ed. and 2016 Specification Seminar by Louis F. Geschwindner, PhD, PE, at The Times Center. The 2016 AISC *Specification for Structural Steel Buildings* and the 15th Edition *Steel Construction Manual* are both available now. Geschwindner's talk discussed the important changes and clarifications that have been incorporated into these documents and examined the Specification chapter by chapter to highlight changes since its 2010 version. The talk also included design examples demonstrate the changes in the Specification, as well as how to apply useful design aids in the Manual.


Concrete-Filled Hollow Structural Sections (HSS): An Unbeatable Combination


VIBRATION CONTROL WITH STRUCTURAL STEEL

Continuing Education with *Architectural Record* and *Architect*

The Steel and Ornamental Metal institutes of New York continue their series of AIA Continuing Education articles with *Architectural Record* and *Architect*, with topics ranging from designing with concrete-filled hollow structural sections to controlling building vibrations with structural steel. More topics are available online at continuingeducation.bnpmedia.com and at architectmagazine.com via the Continuing Ed tab.

NYC College of Technology Lecture Series and Upcoming Events

Through the rest of the 2017-2018 academic year, the Steel and Ornamental Metal institutes of New York will sponsor an Architecture Speaker Series at the New York City College of Technology – CUNY. Visit www.siny.org, www.ominy.org, and Facebook for the latest information on these and other Institute-sponsored events.

Metals in Construction on YouTube

The newest addition to the magazine's YouTube channel follows Cooper Union's Steel Bridge team as it competes in the 2017 ASCE/AISC Student Steel Bridge Competition. The team is a dedicated group of individuals who combines hands-on work and theory to design, fabricate, and construct a 20-foot-long bridge made completely of steel. Along the way, members learn and practice welding, steel cutting, AutoCAD programs, and how to effectively manage a yearlong project as part of a team. The Steel Institute of New York is an annual sponsor of the team.

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The labor to erect the structural steel on projects featured in this publication was provided by the following labor unions:

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International Association of Bridge, Structural Ironworkers & Riggers
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New York, NY 10016
(212) 889-1320

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Thomas Callahan
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www.siny.org
Steel Institute of New York

www.ominy.org
Ornamental Metal Institute of New York

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

- 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

211 East 43rd Street, Suite 804
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