

METALS IN CONSTRUCTION

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

SPRING 16

MANHATTAN DISTRICTS 1/2/5 GARAGE / WHITNEY MUSEUM OF AMERICAN ART /
7 BRYANT PARK / NATIONAL SEPTEMBER 11 MEMORIAL MUSEUM /
HUDSON YARDS EAST PLATFORM / 330 MADISON AVENUE /
NEW COMPUTER SCIENCE BUILDING, STONY BROOK UNIVERSITY / BARCLAYS CENTER GREEN ROOF

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This page: Fernando Guerra; cover: Albert Vecerka/Esto

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Above The intersection point of the conical podium and tower facades of 7 Bryant Park.

Cover The facade of 7 Bryant Park, designed by Pei Cobb Freed & Partners.

EDITOR’S NOTE
Appearance and performance redux

RECENTLY, THE INSTITUTES THAT publish this magazine have seen rapid growth in the number of New York City projects that involve repositioned buildings. Owners are always looking for ways to increase their buildings’ marketability so that occupancy rates remain high. But as mid-century buildings in midtown age into obsolescence, and the need to appeal to millennials dominates workplace design, a more compelling case for this type of development exists today. Fortunately, advances in curtain wall technology have given architects freedom to create exteriors of almost limitless variation. And they come at a time when many curtain wall systems have reached the end of their service life. Recladding can not only give a building a new visual identity but also radically improve its energy performance in the process. These are the understandings that led this magazine to sponsor the 2016 Design Challenge to reimagine the facade of one of the city’s most recognizable icons, 200 Park Avenue. Readers can see the forward-looking results of this ideas competition on p. 52 of this issue. But there are many real-life examples of this type of innovation too. In the case of 330 Madison Avenue, featured on p. 34, a new exterior appearance was key to boosting market appeal. New curtain wall system and glazing increased the amount

of daylight reaching interior spaces while improving thermal comfort for occupants, enriching their overall quality of life. This is one of a number of important considerations for the millennial generation, which will soon become the largest sector of the nation’s workforce—by 2025 it will represent well over 40 percent of the total working population. No organization can afford *not* to recruit the best talent, especially the best talent from millennials. So it’s in every organization’s interest not only to learn how to attract and recruit millennials, but also to retain them. It is not lost on owners and designers that thoughtful planning and design, especially for a building’s exterior, is a good place to start.



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Manhattan Districts 1/2/5 Garage

A new toolbox for three Department of Sanitation garages conceals its operations behind an energy saving operable façade designed to stand up to the neighborhood’s architectural dynamism.

HOW CAN A MUNICIPAL GARAGE be a gateway to one of the toniest areas in Manhattan? That was the question posed by the Manhattan Districts 1/2/5 Garage, at the corner of Spring Street and West Street, which now houses three district garages for the New York City Department of Sanitation (DSNY). A project that could have easily been swept under the carpet in another, less visible neighborhood, the building sits prominently on the western edge of SoHo, overlooking Hudson River Park and the river beyond. The positioning is a result of the Bloomberg administration’s stance that it’s not only economically depressed neighborhoods that should have to deal with the nit and grit of Manhattan’s operations.

Ultimately, the challenge of meeting community and functional goals fostered a productive collaboration between the building’s architecture team, DSNY, and the Department of Design and Construction (DDC). Designed by Dattner Architects with WXY Architecture + Urban Design, the new 425,000-square-foot building accommodates more than 150 sanitation vehicles, personnel facilities for 200 staff members belonging to the 1, 2, and 5 sanitation districts, as well as centralized fueling, truck wash, and repair facilities.

“The collaboration with the Department of Sanitation and the architects at Dattner and WXY was extraordinary, creating an environmentally progressive building that meets the challenge of being a good neighbor in a vibrant community,” said DDC commissioner Feniosky Peña-Mora upon the building’s completion in early 2016. The garage was awarded LEED Gold as a benchmark project for New York City’s Active Design program, which promotes the use of architectural design to encourage movement and improved fitness among facility users.

The second, exterior skin of the garage’s façade wraps the curtain wall with perforated, metal fins, breaking down the mass of the full-block building into smaller, rhythmic elements with the goal of playing on light and perspective to create an ever-changing experience for workers inside as well as for passersby.

Huge truck ramps wind upward from street level through five levels of the building. The third floor has 30-foot ceilings to accommodate truck maintenance, and the fourth and fifth floors, used for parking, have 24-foot ceilings. The generous ceiling heights are meant to account for the worst-case scenario of a sanitation truck breaking in full tipping mode; they also allow for non-vehicular operations including offices, locker rooms, and meeting areas to be stacked at half-height on the building’s south side. There, hallways are banded by bright colors that jazz up the space within, and subtly show through to the exterior.

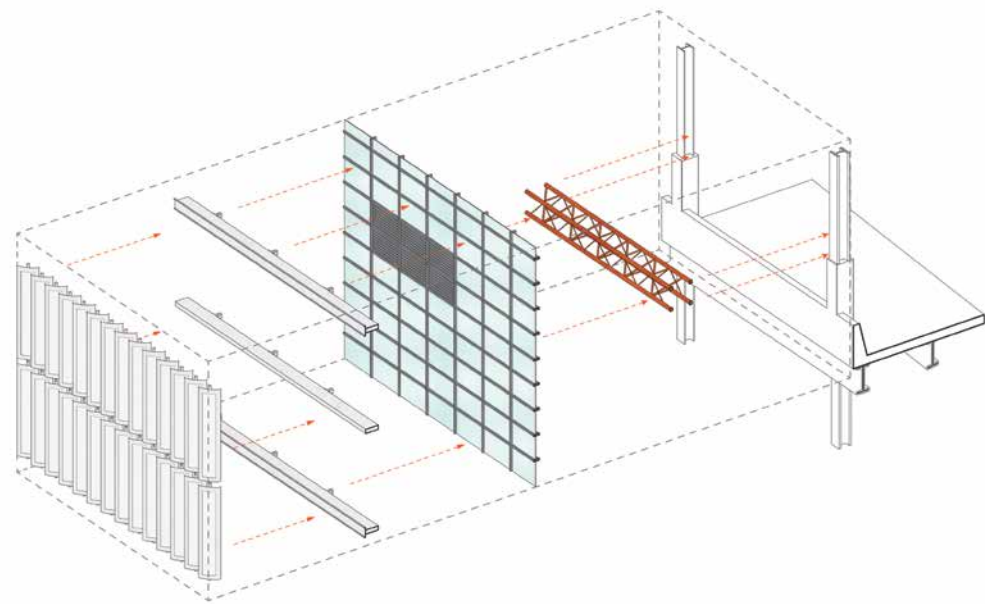
The façade evolved as a comprehensive design solution to multiple driving forces, according to Gia Mainiero, project manager for Dattner. One was the desire to bring abundant natural light into the facility without increasing heat gain, and a second was the concern that vehicular activity within the building be shielded from the surrounding community.

“The issue is the building looking clean and remaining clean,” says Mainiero. Choosing a very specific metallic gray for the curtain wall may seem like a tiny decision, but multiplies into a much larger effect because of the façade’s 400-foot-long western face.

“With the fins and their perforation, the idea was to give the people working here a dignified and pleasant working environment,” she adds. The fins allow that façade to take on a dynamic personality, creating a shimmering, lenticular effect if seen from within a passing car.

“That’s why we all ached over setting the angle right,” says Mainiero. “We wanted it open enough to achieve that sort of shimmery effect, as though the building is moving.”

At the south-facing personnel areas and the west-facing repair bays, the façade’s operable aluminum 30-inch fins continuously track the sun’s location—the building management system sets

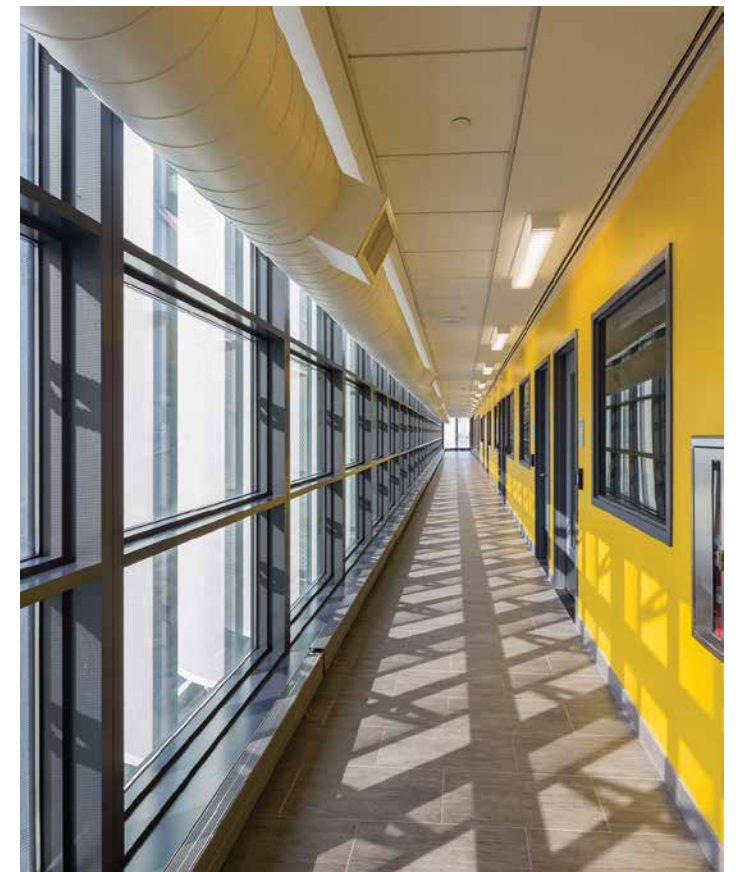


Clockwise from left An exploded detail of the operable curtain wall and truss structure from which it hangs. The building's west and south façades showing the curtain wall during fin installation (top) and after installation (below). The building's double-skin façade as seen from street level.



This spread photos: Wade Zimmerman; diagram: Dattner Architects; opening page and following spread: Wade Zimmerman

Right A view of the façade through a conference room window.
Below Painted hallways add a touch of color to the building exterior.



them perpendicular to the sun's azimuth to ensure optimal shading. The solar fins on the north and east elevations are fixed.

"The façade design developed through a series of computer models and solar analyses, followed by detailed investigations of appropriate materials and the creation of full-scale mockups," explains Mainiero. The 30-inch-deep fins vary in height from 12 feet to 15 feet. "The size of the solar fins was studied carefully, to ensure that they stood up to the 400-foot length of the building and maintained visual interest."

The fins' perforation pattern—including the percent of open area, perforation size, and spacing—was also studied extensively through samples and mockups. They are composed of a custom-perforated, shop-coated aluminum with a solid edge band (a product now being sold by the fabricator in a new product line).

These louvers create an organizational composition and a scrim, obscuring some of the messy business inside. They also screen the surrounding neighborhood, cutting down on headlight glare as trucks drive up the ramps inside.

"The right balance was found to allow views out, reduce overall weight, and maintain a robust appearance consistent with the building's design," says Mainiero. "Also, glass reflectivity was minimized to prevent extensive reflections of the sunshades and more patterns from occurring."

As with most complex façades, a high level of coordination and integration was required to support the project. In particular, the dynamic loading of the heavy equipment and vehicles within the building created slab deflections that exceeded those allowable by standard curtain wall systems. To address this condition, the architect, structural engineer The Burns Group, and façade consultant Front Inc. worked together closely to develop inventive structural anchoring details for both vertical and horizontal load supports. The curtain wall system is supported off of bright orange box trusses, an independent system connected to the building's structural columns, so it undergoes none of the live-load vibration or deflection of the structural slab. And "it's another opportunity to bring a pop of color into the space," says Mainiero.

The garage has quickly become an indispensable toolbox for the city's sanitation workers. But while fulfilling its duty to a place relentlessly in need of Sanitation Department resources, the building is also a strong addition to the architectural fabric of its neighborhood, never giving a glimpse of the trucks within. Even from above, the building adds to its surroundings with a 1½-acre green roof that reveals lush vegetation, rather than mechanical equipment, to occupants of taller buildings. The green expanse projects a defining message of the Department of Design and Construction's trailblazing projects for the city: highly visible is sometimes better. □

"The collaboration was extraordinary, creating an environmentally progressive building that meets the challenge of being a good neighbor in a vibrant community."

Feniosky Peña-Mora, Commissioner, NYC Department of Design and Construction



MANHATTAN DISTRICTS 1/2/5 GARAGE

Location: **Corner of Spring Street and West Street, New York, NY**
Owner: **NYC Department of Sanitation, New York, NY; NYC Department of Design & Construction, New York, NY**
Architects: **Dattner Architects with WXY Architecture + Urban Design, New York, NY**
Structural Engineer: **The Burns Group, New York, NY**
Design Curtain Wall Consultant: **Front Inc., Brooklyn, NY**
Mechanical Engineer: **Greeley and Hansen, New York, NY**
Construction Manager: **Turner Construction, New York, NY**
General Contractor: **DeMatteis/Darcon, Joint Venture, New York, NY**
Structural Steel Fabricator: **Owen Steel, Columbia, South Carolina**
Structural Steel Erector: **Stonebridge Steel Erectors, Morris Plains, NJ**
Miscellaneous Iron Fabricator and Erector: **FMB, Inc., Harrison, NJ**
Curtain Wall Fabricator: **Gamma USA, New Rochelle, NY**
Sunshade Fabricator: **Construction Specialties, Inc., Cranford, NJ**
Curtain Wall & Sunshade Erector: **Gamma USA, New Rochelle, NY**
Metal Deck Erector: **Stonebridge Steel Erectors, Morris Plains, NJ**



Left top Interior view of a west-facing gallery space.
Left center and bottom An 18,000-square-foot, column-free space is the largest open-plan museum gallery in New York City.



writers to a ship, the Whitney's steel-framed conglomerate of volumes and containers does look like it came into port from the Hudson River. Renzo Piano Building Workshop (RPBW), which worked in collaboration with Cooper Robertson, chose to hang the eight floors of galleries and supporting spaces off of the north and south sides of a massive, exposed precast concrete core containing elevators, circulation, bathrooms, and labs. The building's steel frame—part of the 28,000 tons of steel used in the building—is composed of hollow and solid columns, I-beams, and double tension cables fastened to cast stainless steel pressure plates designed by RPBW.

"The building is meant to be a little bit rough and tumble," says Nat Oppenheimer, executive vice president and a principal at Robert Silman Associates, which served as the structural engineering consultant. He added that Piano has called the Whitney "feral." "That's why there's so much metal involved. It's in the Meatpacking District, it's hugging the High Line," says Oppenheimer. At the same time, it's an incredibly refined building, with rigorous details and a strict adherence to a ten-foot grid.

The architects used the concrete spine as the dividing line in their plan and placed galleries to the south and offices and curatorial spaces to the north. Most of the façade—other than some floor-to-ceiling glass-walled galleries using a stick system and high-transparency, low-iron glass—is clad in 3 1/3-foot-wide, 3/8-inch-thick steel panels hung on an aluminum, unitized curtain wall system. In most places, the panels span the length of one floor, but on the south and west elevation where the façade of the upper galleries tilts inward, some of the panels are 66-feet-long (with meticulous welding so that seams are almost invisible). "They actually had to custom-make a suction cup machine to lift them up and tilt the panels. It was



Clockwise from top View from the lobby looking west before interior finish-out. The lobby under construction looking east. A detail of lobby cross-bracing. A column detail.

wild watching them put them on," says Christopher Payne, who is now a project architect for Gensler but was the exterior envelope job captain for Cooper Robertson's Whitney team.

Oppenheimer adds that creating steel panels of that length was a major feat, but curtain wall fabricator Joseph Gartner was up to the task. On the museum's eastern façade, an exterior staircase connects outdoor terraces on floors five through eight, providing spectacular birds-eye views of the High Line and allowing visitors to bypass the elevators or interior stair to circulate through the galleries. The external stair "was a main component of the design from the

outset," says Oppenheimer. Its metal grating mitigates ice in the winter, and potentially allows for year-round use.

The terraces extend the gallery space of the museum by allowing for large works of art to be anchored to the floor or suspended from 7-inch-thick precast concrete panels, some of which weigh more than 20,000 pounds. Cooper Robertson helped create a custom system of vertical and horizontal anchor points (they did so on portions of the west and north façades, too) for the installation of screens, canvases, or freestanding sculptures. The system is comprised of a dense pattern of stainless steel bolts providing attachment points in the façade panels, which can be tethered to or removed and replaced with eyehooks or other hardware. Additional local structural frame engineering from Silman accommodates the addition of a 600-pound pullout load.

On the terrace floors, to anchor art and prevent lifting during heavy winds, Cooper Robertson bolted a grid of cylinders typically used for yacht rigging to base plates, which in turn are fastened to the structure below. The cylinders sit flush with the roof surface, their screw mechanism allowing them to be raised as needed for anchoring. (Although inaccessible to visitors, Piano treated the museum's roof like a ninth exhibition space, celebrating five cooling towers by elevating them 14 feet and placing them on a galvanized, grated platform).

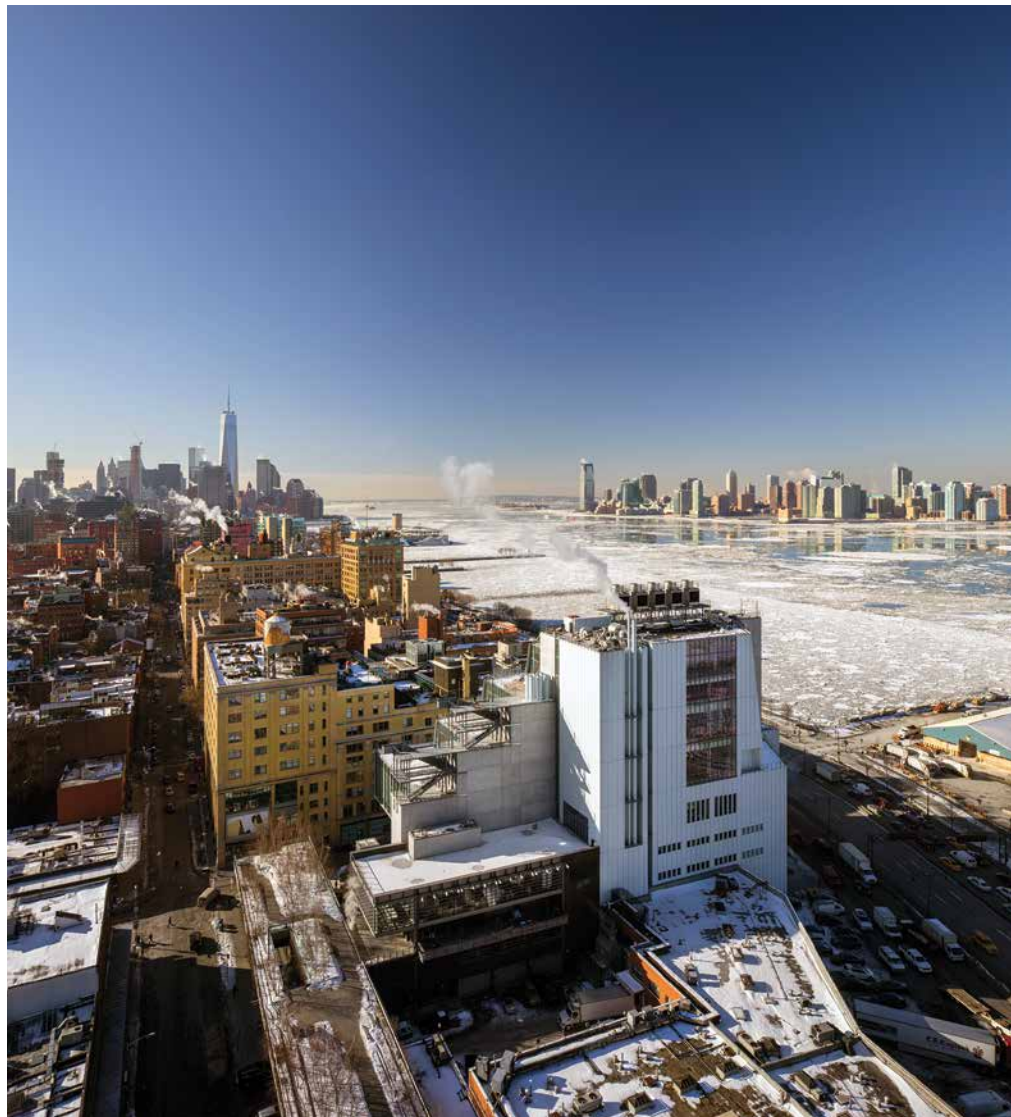
First encounters with the new Whitney begin in RPBW's glass-walled lobby on Gansevoort Street, with a restaurant, gift shop, and galleries open to the public and free of charge. Double-glazed window-walls are held in place by a tensioned cable system secured in the structural beams. Delicate columns inside the lobby and out are 15 inches thick. The ones

used inside are hollow structural sections (HSS). "They are solid on the outside because there are 2 million pounds of horizontal load, but the architects wanted to keep them slender," says Oppenheimer, referring to the fourth floor cantilever that extends over the plaza. Oppenheimer recalled that at a certain point, there was no column planned for that southeast corner. "These are pipes they use in nuclear power plants. They are not standard steel," he added.

To make their way to galleries or other spaces above, visitors have the option of riding the elevators, or climbing a delicate, suspended interior stair. The stair is supported off of brackets that extend from the steel structure through the precast concrete, and is hung on cold drawn carbon steel rods. The rods connect to springs in the basement to account for deflection on every floor. "We've done stairs like this where they are free, but we would

This page: Nic Lehoux; opening spread photo: Nic Lehoux; sketch: Renzo Piano/RPBW

This page: top: Nic Lehoux; bottom row: Kevin Schorn/RPBW



This page top An aerial view of the museum taken in February 2015.

This page above The museum's north elevation, showing proximity to the Hudson River that necessitated planning for extreme weather.

Facing A view from Gansevoort Street into Untitled, a restaurant located in the museum's ground floor.

have had to use bigger, chunkier stringers," says Oppenheimer. Instead, the simple plate stringers were an aesthetic choice. "The intent was to keep the tread and the underside very clear."

Some of the Whitney's most extraordinary interior spaces are its column-less gallery floors, which run the length of the building. The fifth floor is the largest column-free gallery in a museum in all of New York, at 18,000 square feet. "With enough money and time, it can be accomplished," says Oppenheimer. "The concern, which was mitigated, was whether we'd have enough room to fit the structure and the mechanicals." The solutions took

two years to work out, he adds. "The original parti was worked out in three months." The solution, in part, was to have big brace frames—trusses, really—on the office floors to pick up the load on the floors above.

The steel-framed gallery ceilings are rigged with custom yokes and wide-flange W5s, enabling curators to hang substantial loads from the gridded structure—up to 10,000 pounds from the meat of the beams.

On the Whitney's 8th floor, where visiting artists will hone their craft, serrated, north-facing skylights span between the ceiling beams and bring in daylight to enhance the apex of

the museum experience. The structural fins of the saw-tooth windows, developed by Heintges & Associates and Joseph Gartner, belie intricate detailing. "All these beams are coped like crazy to get ductwork in," says Oppenheimer.

Moving the Whitney downtown, to the edge of Chelsea's Meatpacking District, and the start of the High Line's trail, is a strong statement about where the city's "cool" capital is currently clustered at its densest. Thankfully RPBW's museum is fastidious in its construction and design, making it a classic that can withstand the city's changing winds. □

WHITNEY MUSEUM OF AMERICAN ART

Location: **99 Gansevoort Street, New York, NY**
 Owner/Developer: **Whitney Museum of American Art, New York, NY**
 Architect: **Renzo Piano Building Workshop, New York, NY**, in collaboration with **Cooper Robertson, New York, NY**
 Structural Engineer: **Robert Silman Associates, New York, NY**
 Mechanical Engineer: **Jaros, Baum & Bolles, New York, NY**
 Construction Manager: **Turner Construction, New York, NY**
 Curtain Wall Consultant: **R.A. Heintges & Associates, New York, NY**
 Structural Steel Fabricator: **Banker Steel Company, Lynchburg, VA**
 Structural Steel Erector: **J.F. Stearns Co., Pembroke, MA**
 Miscellaneous Iron Fabricator and Erector: **Post Road Iron Works, Greenwich, CT**
 Architectural and Ornamental Metal Fabricator and Erector: **Jonathan Metal & Glass, Jamaica, NY**
 Curtain Wall Fabricator: **Josef Gartner GmbH, Gundelfingen, Germany**
 Curtain Wall Erector: **Tower Erectors, Windsor, CT**

Photo: Nic Lehoux; drawing: ©RPBW

Nic Lehoux





Sixty-foot column-free spaces in the podium level are made possible by perimeter tower columns that transfer onto large, built-up plate girders at the 10th floor.

7 Bryant Park

With an innovative conical design, a luminous stainless steel and glass curtain wall allows a new office tower to be an extension of the neighboring park.

FROM INSIDE 7 BRYANT PARK, a new spec office tower designed by Pei Cobb Freed, visitors have a bird’s eye view of the ice skaters at Bryant Park and, if they could score an invitation come November, eye contact with the balloons in the Macy’s Thanksgiving Day Parade.

The panoramic views—made possible, in part, by 10-by-10-foot window modules—and a few other subtle gestures on the part of the architects and developer Hines make 7 Bryant Park a generous workspace. (Bank of China will lease the first 14 floors and the 28th, moving in later this year.) Those same moves are also what elevate the level of design and make the structural steel-framed building—what could have been a bland, rectangular glass tower—a good neighbor. “It was important to make this building a gesture to the park,” says Yvonne Szeto, a partner at Pei Cobb Freed. “That’s the greatest value of the site.”

The most obvious of those gestures are the two conical scoops that the architects carved out of the northeast corner of the 28-story tower; with their apexes appearing to touch, the inverted cones look like a geometric hourglass. Knowing that zoning required a setback at 150 feet, Szeto and her team designed one cone to begin there, at the 10th floor, widening as it stretches to the sky. They took advantage of the setback to create terraces on the north

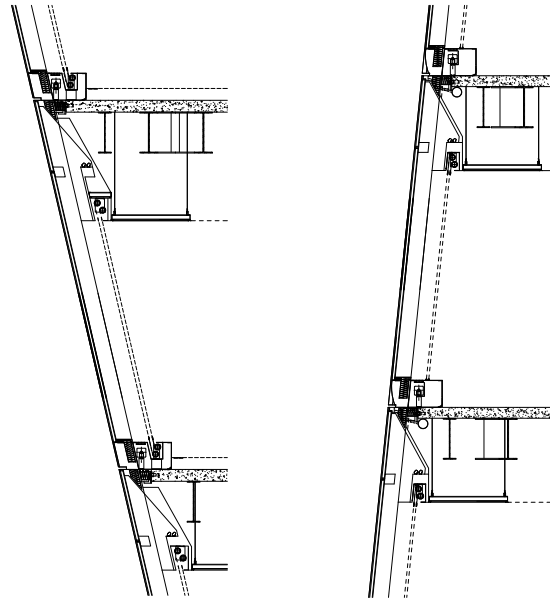
and east elevations of the 10th floor. (Another terrace extends from the 14th floor to the south.)

The other cone is the mirror opposite, descending from the 9th floor down to the entrance, where it terminates in a bowl-like canopy that shelters benches for the public and a water feature. “By carving at the bottom of the building, we’ve created a new public space that is an extension of the park,” says Szeto. “It’s a contribution of this private building. And carving at the top creates a new profile in the skyline. Any tall building should be a good citizen.” By cutting away from the corner of the building to create the plaza, Hines gave up what would have been valuable retail space in return for a better functioning building and the chance to make a civic gesture.

The elegant entrance canopy has an aesthetic simplicity that belies its structural feats. With a radial steel substructure that the architects said is so beautiful they hated to cover it up, the canopy panels are curved laterally and longitudinally. A quarter of the circle is glazed, allowing visitors a dizzying view to the cones above. The 48-foot-diameter canopy and its connection to the façade was tricky, says Jesse Chrismer, associate at Thornton Tomasetti, the engineer for the project. “The structural steel members can be seen through the skylight,” says Chrismer. “Because of this skylight, considerable efforts had to be taken to coordinate their appearance as exposed members, versus sizes and locations that were most effective structurally.” The canopy is supported by two cantilevering plate girders, which project perpendicularly from each adjacent façade and converge slightly off-center of the central, rigid



Clockwise from top left In the cones, the spandrels are frosted panes of glass illuminated by interior LED coves. Sections of the podium cone (left) and of the tower cone (right). The cones create uniquely curved window bays at each floor. The building's structural system consists of a concrete core with steel framing.



steel hub. The plate girders are 3 inches deep with 3-foot-thick flanges. The tapered main canopy framing radiates out from the central hub in 24-foot cantilevers. Smaller circumferential HSS framing provides rigidity and coincides with connection points for the cladding. At the skylight portion of the canopy the exposed members necessitated a different framing method. Here, curved HSS beams provide the primary support, with smaller radial infill framing stiffening the system and supporting the glazing.

The architects carried the conical motif inside the building, with triangles of limestone, white marble, and black granite on the floor, stone walls serrated in a V pattern, and concave conical lighting coves in the ceiling. A living wall at the rear of the lobby softens the look and brings a hint of the park indoors.

From a typical office floor, one can see how carefully the architects balanced the proportions of steel and glass on the curtain wall, which is made of Type 316 linen-finished stainless steel spandrels. The exterior of the window system is polished aluminum and the interior is painted aluminum with a Duracon finish. While most commercial buildings in Manhattan have a 5-foot vertical module, Pei Cobb Freed decided on floor-to-ceiling lites of low-E glass that are 10 feet wide and 7 feet high. Total panel dimension is 10 feet by 10 feet, divided by a suppressed muntin about $\frac{2}{3}$ of the way up. "It gives a more generous feeling on the façade," says Bruce White, associate partner. "On the inside you get a much more panoramic view—you don't have the jail bars of vertical lines." Hines agreed, knowing tenants would want open office plans and wouldn't need to necessarily need connect to mullions.

On the cone, where each curved unit is a different size, the architects conceived what they call the "scoop"—a horizontal aluminum incision on the exterior, between the glass and the top of the steel



Top left: Fernando Guerra; all others: Pei Cobb Freed & Partners; opening page: Albert Vecerka/Esto
Above left column: Albert Vecerka/Esto; above right: Fernando Guerra; following spread clockwise from top: Albert Vecerka/Esto; Fernando Guerra; Albert Vecerka/Esto

Clockwise from top The curtain wall features linen-finished stainless steel spandrels with integral gutters. The office tower offers expansive views of Bryant Park through floor-to-ceiling window modules. A recessed curve at the park-facing entrance to the building is crowned by a 48-foot stainless steel canopy that cantilevers over a public plaza.

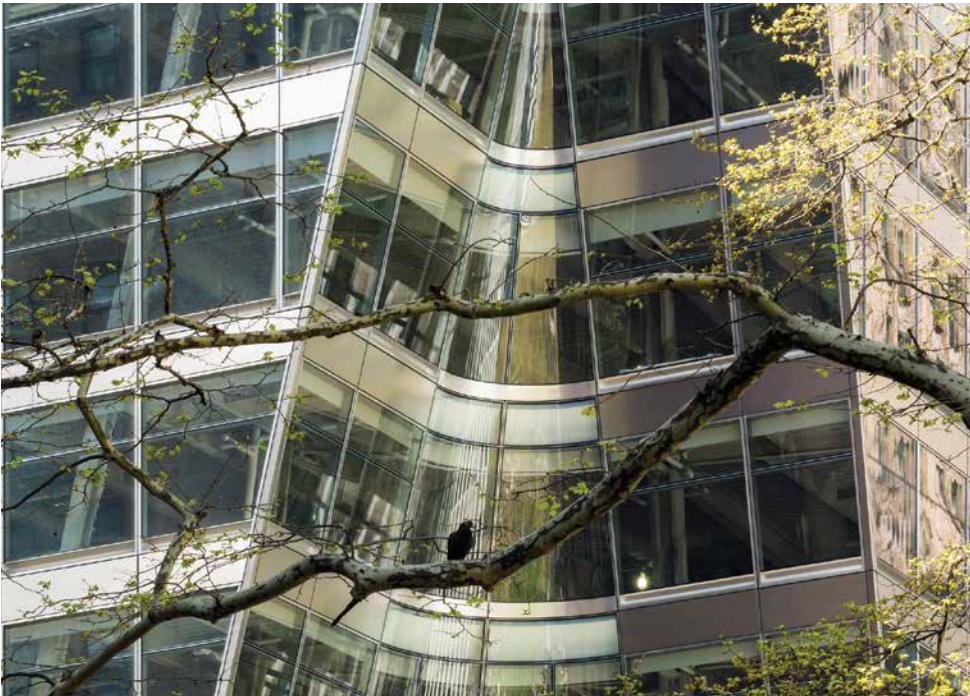
spandrel. The scoop helps with energy conservation overall (limiting the amount of glazing), while making the metal spandrel appear slimmer and dynamically reflecting light. Inside the structure, the architects installed a rear fascia to the top of the glass panes and inserted cove lighting fronted by a frosted glass panel. This casts a warm glow inside and creates a dramatic exterior lighting effect. Hines can change the colors and pattern as they wish (though they swear they have no desire to compete with Times Square).

Surprisingly, the cone resulted in only the expected challenges associated with sloping columns, according to Thornton Tomasetti. The perimeter columns go up about three or four floors and then they slope. Though White admits that they appear somewhat awkward, their positioning made the most sense structurally. Framing was cantilevered off varying sizes of sloping columns (the largest being a W14x655) to support the edge of slab around the cone shape. (There is no floor slab on the 29th level, which contains the mechanical room and where the architects were able to create a small roof terrace; therefore, long, curved, steel girts support the top of façade.) However, a more advanced modeling program with 3D capabilities was necessary because of

the volumetric component of the connections.

On typical office floors, the architects left the fit-out to the future clients. They transferred out columns where they could, leaving a clear span of 64 feet in the podium and 45 feet above the setback. "On the ninth floor, the steel beams are significant to deal with the setback," says Szeto. Her team also worked hard to pre-cope and pre-cut holes for all of the ductwork, so that ceiling heights could be maintained. A spiral stair is planned to connect the 10th and 11th floors, the executive levels for Bank of China.

In creating the entrance canopy and plaza for the building, Pei Cobb Freed had to do away with an existing New York City subway entrance. Mandated to absorb the entry, the architects convinced the Metropolitan Transportation Authority to allow them to reroute it to the northeast corner of the building, especially since they discovered that most people using the original entrance were headed in that direction anyways. The architects devised a simpler steel canopy that directs commuters down a staircase to the station. They clad the adjacent wall in a cheerful rainbow of tiles against jet mist granite. Just another dignifying element to a project that, while private, is democratic in its key design elements. □



Top The cones appear to embrace the adjacent park and animate the façade.
Above Thornton Tomasetti was able to re-engineer the mechanical room on the 29th floor to make space for a roof deck. Because there is no floor slab at the very top of the cone, long steel girts support the top of the façade.
Facing Extending another cone from the 10th floor to the top of the building creates a new profile in the skyline.



7 BRYANT PARK

Location: **7 Bryant Park, New York, NY**
Owner: **Bank of China, New York, NY**
Developer: **Gerald D Hines Interests, Pacolet-Milliken Enterprises, Inc., New York, NY**
Architect: **Pei Cobb Freed & Partners, New York, NY**
Structural Engineer: **Thornton Tomasetti, New York, NY**
Mechanical Engineer: **Jaros, Baum & Bolles, New York, NY**
Construction Managers: **Turner Construction, New York, NY**
Curtain Wall Consultant: **Pei Cobb Freed & Partners, New York, NY**
Structural Steel Fabricator: **W&W Steel, Oklahoma City, OK**
Structural Steel Detailers: **Thornton Tomasetti, New York, NY; W&W Steel, Oklahoma City, OK**
Structural Steel Erector: **W&W Steel, Oklahoma City, OK**
Miscellaneous Iron Fabricator and Erector: **Empire City Iron Works, Long Island City, NY**
Miscellaneous Iron Fabricator and Erector: **United Structural Works, Congers, NY**
Ornamental Metal Fabricator and Erector: **Jonathan Metal and Glass, Jamaica, NY**
Curtain Wall Fabricator and Erector: **Benson Industries, Inc., New York, NY**
Metal Deck Erector: **W&W Steel, Oklahoma City, OK**

National September 11 Memorial Museum





The museum designed to address myriad memories and experiences sits at bedrock, the result of design innovation and complex engineering 70 feet below where the Twin Towers once stood.

TO ENTER THE NATIONAL SEPTEMBER 11 Memorial Museum is to step back in time, to that fateful day in 2001. The descent to the underground structure starts at the airy entry pavilion, the only building on Memorial Plaza. The plaza itself, which occupies approximately half of the World Trade Center's 16 acres of hallowed ground in Lower Manhattan where the Twin Towers once stood, serves as a green roof to the museum's structure, its giant reflecting pools and a grove of more than 400 white oak trees a stark contrast to the brute concrete and twisted steel on display below.

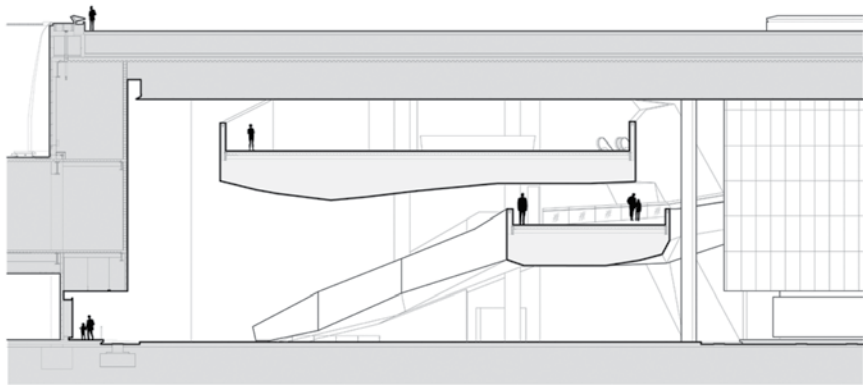
The entry pavilion and museum are actually two separate structures, by two different architecture firms. Both had to deal with programs and building

locations that changed dramatically over the course of more than a decade of planning and construction at Ground Zero. Davis Brody Bond (DBB), architect of the below-grade museum, had initially designed an above-ground entry pavilion by the West Side Highway. Oslo- and New York-based firm Snøhetta, who had originally been commissioned to design the International Freedom Center on the northeast quadrant of the site as part of Daniel Libeskind's master plan, saw that large cultural project inflate then diminish, then eventually disappear. Instead, Snøhetta became architect of the pavilion, which would eventually move to the east, between the footprints of the Twin Towers by Greenwich Street.

At the point Snøhetta got involved, DBB had already designed much of the museum, conceptually at least, and footings and foundations were well underway. The two firms coordinated work to ensure the below-grade structure was designed appropriately to take the loads of Snøhetta's building, an angular steel and concrete structure clad with stainless steel panels and glass that showcases two surviving 80-foot-tall steel tridents from the Twin Towers.

Above The Ribbon, a ramp that gently descends and guides visitors from the memorial plaza to the bedrock level alongside the preserved Survivors' Stair.

This page: James Ewing; facing page drawing and diagrams: Davis Brody Bond; opening spread: James Ewing



Above A north-south section looking west through the concourse lobby and Memorial Hall.
Below left A 3D image of architectural insertions into the World Trade Center site.
Below right A close up of the Ribbon model.

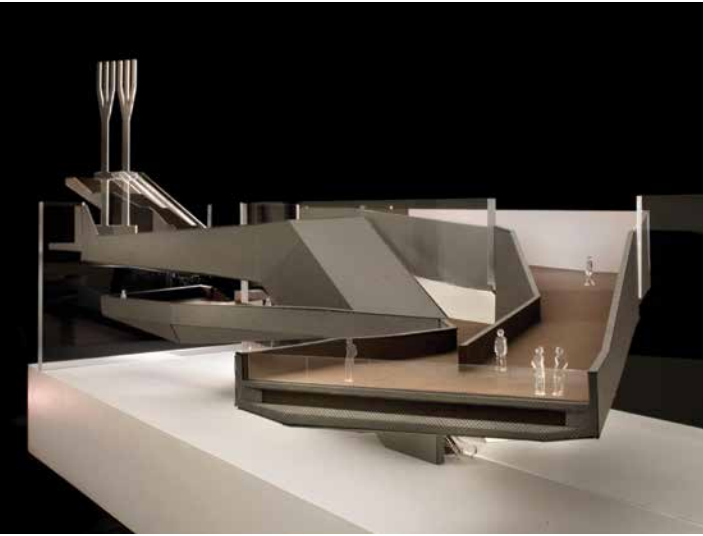
The entry pavilion shares its setting with Santiago Calatrava's new Port Authority Trans-Hudson (PATH) station, as well as with existing subway lines and secure parking facilities. Its structure straddles both the PATH station and the Memorial Museum, supported on only 12 points split between the station and museum, and on a reinforced concrete core to the south. Roughly 85 percent of pavilion columns are anchored to deep transfer girders extended from the system that supports the roof of the PATH mezzanine on the west side of Greenwich Street. The museum supports the remainder of the pavilion structure.

Careful coordination and analysis of the surrounding structural constraints was critical in identifying the limited support points for the pavilion, which resulted in many unusual spans and a unique steel framed structure with W36s and W40s throughout, according to Erleen Hatfield, a partner at Buro Happold, the pavilion's structural engineer. At the pavilion's north edge, an additional support point was required; however, the PATH station long span structure below could not support the pavilion loads. To provide the necessary support, a 22-foot-deep, full-story steel truss cantilevered from the pavilion core walls at level 3, providing a location to hang the floors below and effectively cantilevering a portion of the pavilion structure over the PATH station.

Similar constraints created unique challenges for the lateral stability of the pavilion, and affected its relationship to the museum structure. Because the reinforced concrete core providing lateral stability is directly above the PATH train tracks, transfer of lateral forces to the ground was difficult. Adding further complication, the long span PATH station structure was unable to accommodate additional lateral loads, so the lateral load was transferred to the museum below grade. To transfer the load, the pavilion is ringed with steel and reinforced concrete composite drag beams connected to museum shear walls.

Due to the museum's long spans and limited support points, the project required steel sizes as large as W40x503. More than 8,000 tons of structural steel was used in the 9/11 Memorial and Museum combined. (See articles on the entry pavilion structure and façade in *Metals in Construction's* Fall 2013 issue and at ominy.org/publications.)

The form for one of the museum's main architectural features, called the Ribbon, had also already been determined and materials selected when Snøhetta became involved. "That shift for us from the west side to the east side as an entry point had very little consequence on the part of the Ribbon itself and how it worked," says Mark Wagner, project designer and associate partner at DBB. "In fact, it





Left The 36-foot-tall steel member known as the Last Column in Foundation Hall.

Below "Impact steel," a portion of the North Tower facade that was twisted by a direct hit from American Airlines Flight 11.

Bottom Concourse-level floor plan (left) and bedrock-level floor plan (right)



made the connections a little easier for us."

A broad stair—part of Snøhetta's project—from the bright, daylit entry pavilion leads to the much more somber, wood-clad concourse lobby. There the Ribbon descent begins, providing a gently ramped path to slowly acclimate visitors to the experience to come. The faceted form winds between the aluminum-clad Tower Volumes—the other main insertion within the excavation that aligns with the footprints of the original Twin Towers and the pools above—and brings visitors to the bedrock level.

"At some point in the early discussions we talked about hanging the Ribbon and going through all these gymnastics to get it into place," recalls Wagner. "But later we committed to having a line of columns outside the aluminum volumes." DBB worked with WSP Cantor Seinuk on the overall structural design. A grid with columns spaced every 35 feet made traditional framing possible, with a steel-and-concrete deck to support the Ribbon. Along the south edge of the North Tower volume, which is the north edge of the Ribbon, a row of exposed columns allows the Ribbon to span between the wall and the columns and fill the space between the two.

The Tower Volumes, on the other hand, appear to hover in the expansive Foundation Hall, the main space of the museum. Throughout the design process, DBB met frequently with local community boards, firefighters, police officers, victims' families, and survivors groups. "One thing that kept coming back to us and was so powerful was the footprints of the towers themselves," says Wagner. "Because the way they saw it, if you were inside the building, you died. If you were outside, you lived."

DBB chose to float the volumes above those footprints so as to not create a traditional threshold, as if going through a door. Instead, visitors pass from a space with ceilings that are as high as 50 feet, to step under the weighty metal volumes. The footprints—the original box columns and footings—are preserved below.

The 15-foot cantilever, however, is relatively small given the available back span. It is supported by a very traditional structural grid and columns without the need for trusses, and is achieved simply with flat slab construction and reinforced steel.

One last major feature of the museum is an existing one. The World Trade Center's original slurry wall is a structural wall designed to be supported by lateral floor slabs—the original parking slabs below the towers. Without those lateral braces—and with the debris from the site that temporarily held it in place removed—the matter of how to hold the wall up became a big concern. Consulting engineers Guy Nordenson and Associates and Simpson Gumpertz & Heger devised a solution in which a 5-foot-thick

concrete liner wall was placed in front of much of the 60-foot-high, 270-foot-long slurry wall. For the 70-foot portion that was left exposed in the Foundation Hall, another structural wall was built on the back side of it, allowing a full-height segment of the original wall to be exposed while also providing adequate waterproofing and blast protection. The liner wall on the back face was created by a series of vertical beams or pilasters at the joints in the slurry wall individually cast in self-supporting, hand-excavated pits, which were then joined together.

The area by the slurry wall is the only location in the museum where there are deep trusses. That triangular-shaped area is over 100 feet across, without columns, at its widest point. There, trusses that are over 10 feet deep support the plaza above.

"When we started this project, we had this idea that spaces needed to be column-free, that we needed big open areas to continue that sense of void the visitor had going to the site before anything had been built," Wagner says. "But in the end, we had a very straightforward, conventional structure to support it all—some trusses, simple cantilevers, nothing overly complicated." And in the end, it's an elegant simplicity that allows the focus to stay where it should be: on the museum's personal meaning for each visitor that passes through it. □

Above Approach to the slurry wall overlook from the museum's introductory exhibit.

NATIONAL SEPTEMBER 11 MEMORIAL MUSEUM

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

Owner: **National September 11 Memorial Museum at the World Trade Center, New York, NY**

Architect: **Davis Brody Bond, New York, NY**

Structural Engineer: **WSP Cantor Seinuk, New York, NY**

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

Consulting Engineers: **Guy Nordenson and Associates, New York, NY;**

Simpson Gumpertz & Heger, New York, NY (Slurry wall); Weidlinger Associates, New York, NY (Blast design)

Construction Manager: **Lend Lease, New York, NY**

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

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

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

Metro Steel Erectors, Inc., Brooklyn, NY

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



Hudson Yards East Platform

Structural gymnastics abound as a city on stilts is constructed on Manhattan's West Side, all while hundreds of trains come and go beneath.

NEW YORK HAS NOT SEEN the likes of a real estate development project on a par with Hudson Yards since Rockefeller Center's fourteen buildings were constructed in the 1930s. A mixed-use real estate venture developed jointly by Related Companies and Oxford Properties, the site will include more than 17 million square feet of commercial and residential space, a cultural venue, 14 acres of open park space, a 750-seat public school, and a 200-room luxury hotel. Slated for completion in phases over the next several years, the new development is anticipated to draw more than 65,000 people daily. But almost none of them will be aware of one of the site's greatest feats: Nearly all of it sits atop two massive platforms that bridge 30 active Long Island Rail Road (LIRR) train tracks, three subsurface rail tunnels used by Amtrak, and a fourth passageway named the Gateway tunnel, which will help to double train capacity into New York City.

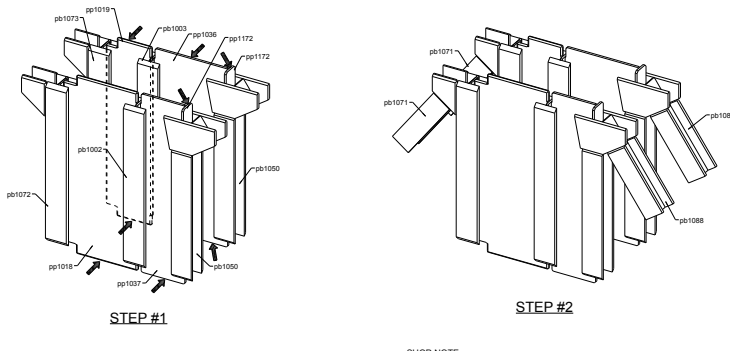
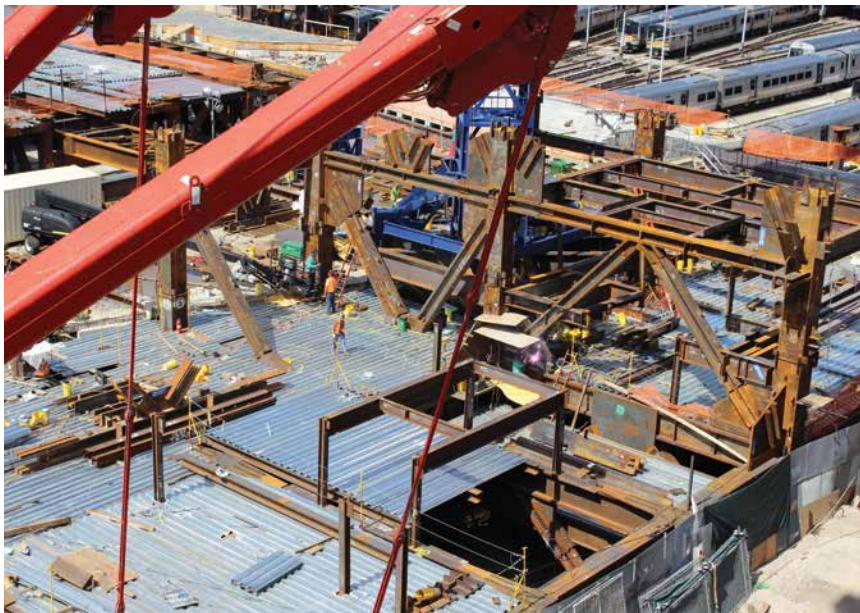
Of the two platforms, the structure over the Eastern Rail Yards does the most heavy lifting, supporting Hudson Yards' four massive skyscrapers and its main cultural, retail, and residential attractions. Those building foundations will extend through the platform and allow the new buildings to tower over

it, totaling 11,340,000 gross square feet of new construction when completed. The Eastern Platform, and the structures overhead, are supported by a total of 288 caissons, ranging from 4 to 5 feet in diameter and 20 to 80 feet in depth, which are drilled to reach bedrock in strategic locations between existing railroad tracks. The platform over the Eastern Yard uses 25,000 tons of structural steel.

The undertaking has required a rolodex of the construction industry's experts—many of whom worked together at a similar scale and level of coordination on the World Trade Center redevelopment in Lower Manhattan. Thornton Tomasetti is the platform's structural engineer, and Langan Engineering & Environmental Services is its geotechnical and environmental engineer. Arup is the site's life safety systems engineer.

Building what is essentially a small city within a city, the team had to deal with a layer cake of complicated site conditions and constraints. "Thornton Tomasetti didn't have a blank slate to start with," says Jeff Brown, vice president of operations for Tutor Perini Civil Group, the general contractor for both Hudson Yards and the Gateway project. "They had a lot of restrictions on where to put the foundations."

Over seven million square feet of construction are now underway. Preliminary preparations on the Eastern Yard platform began at the end of 2013 and caisson drilling started in March 2014. Erection of the structural steel columns, beams, and trusses began in Fall 2014, and the Eastern Yard platform will be completed soon.



Opening page Local 40 ironworkers installing the truss of the retail structure platform.

This page from top The development of Hudson Yards will create more than 23,000 construction jobs. The Hudson Yards platforms will cover approximately three-quarters of the Eastern and Western rail yards. Diagrams of the platform's D10 node.

Facing page top Construction progress in August 2015.

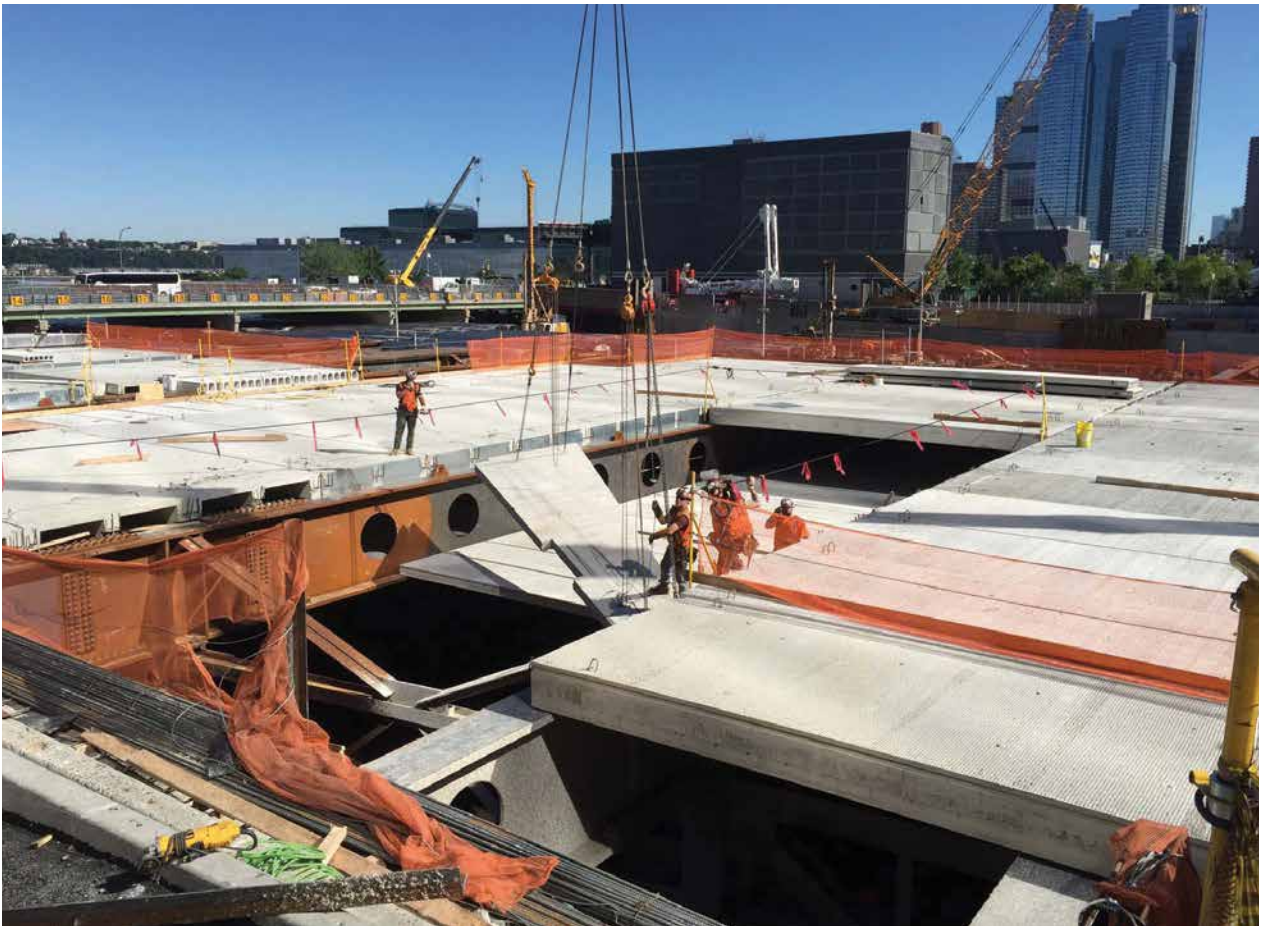
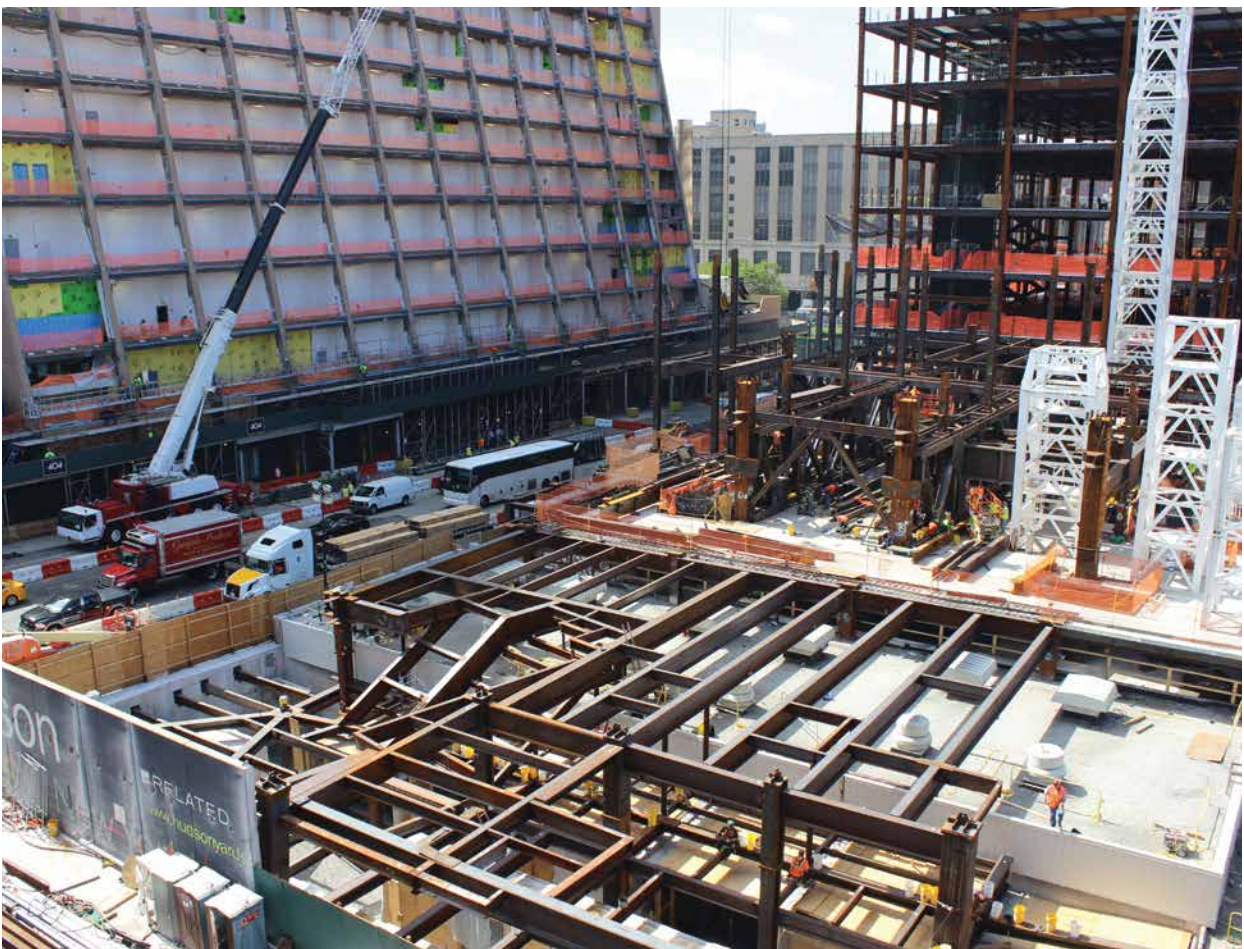
Facing page bottom Installation of a precast concrete slab on structural steel grows the platform toward the west.

One of the project team's biggest feats was maintaining the operation of the railyards at all costs—throughout all of the project's construction, the LIRR and Amtrak trains remain operational. To accomplish this, the site was divided into segments: In areas where the train tracks are straight, the team could take four adjacent tracks out of service continuously, leaving drills or other equipment in place. In other areas that are required for switching trains between tracks, they could sometimes drill a caisson for only two hours each night due to train schedules. It could take days or weeks to achieve the 30- to 40-foot depth required for some holes. Because any emergency at all in the train system, like a switch failure, could shut down construction, the Tutor Perini team credits a good working relationship with LIRR for the smooth progression of caisson drilling.

A web of utilities below the tracks added even more complexity. "The utilities are more dense than the trains," says Brown. He estimates the hand-drawn, ca. 1987 site drawings that were available prior to the project were accurate, at best, to within 5 feet. Added on top of that were complications involving the organizational, and legal, separation of the site's operators.

Even before finalizing a contract to construct a platform, Tutor Perini's Civil Group convinced its client, Related, to pre-excavate the site in order to understand the true layout of utilities located there. Looking at a diagram of caisson locations marked by green dots, Brown notes "every one of these was hand excavated—there was something in every single one." The project's utility relocation budget alone is estimated at \$12 million. Each time a new obstacle was discovered, Thornton Tomasetti altered structural designs for the frame of the platform to accommodate a new caisson location that avoided conflicts with both the existing tracks and the utilities below. This real-time design approach made another midstream change possible: Work was originally planned to begin at 11th Avenue and move east, toward 10th Avenue, but the plan was reversed to allow an early start on 10 Hudson Yards, which is now scheduled for completion this year.

Photos this page: Jennifer Krichels; diagram: Tutor Perini Corporation; facing page from top: Jennifer Krichels, Geoff Butler; opening page: Geoff Butler



Taking into account the location of tracks, underground tunnels, and utilities, only 38 percent of the site may be used for structural support of the 10-acre platform. With so much weight bearing on fewer than 300 columns, in some cases columns are as large as 32x32 inches, built up of 4-inch layers of steel plate that satisfies ASTM A572-65 and ASTM A1066-65. While a typical 4-inch, A572 plate produced in the United States has a yield strength of 50 ksi, steel plate manufacturer Dillinger uses a fabrication process that allows them to produce the same 4-inch plate with a 65 ksi yield strength. The column structures vary in diameter from 1 foot to 5 feet, 6 inches, and are drilled into the bedrock beneath the railroad tracks at an average depth of 40 feet below the surface. Approximately 3,300 tons of solid steel cores, the largest of which was 30 by 30 inches square, were fabricated from the 4-inch-thick plate; the longest is 87 feet; the heaviest weighs a whopping 71 tons.

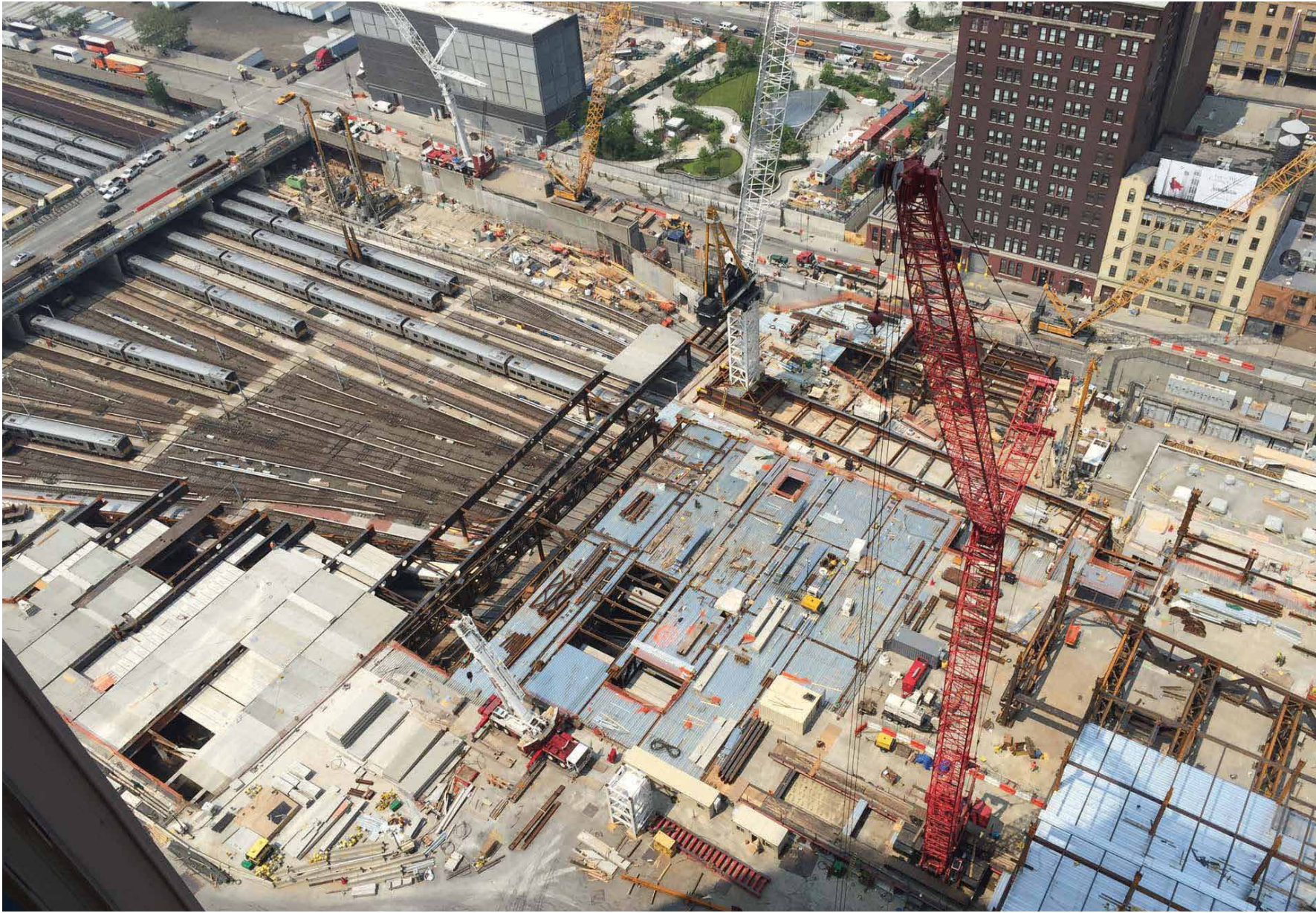
The platform's base structure clears the tracks by at least 17 feet, and ranges in thickness from less than 3 feet to up to 7 feet, depending on the architectural features of the planned plaza. For example, to meet city building requirements for resiliency, a truck-loading dock adjacent to 10th Avenue is fortified with W14x500 steel beams topped by 2-inch blast-resistant plate and an 8-inch concrete slab. In many areas, the platform houses a network of tubing carrying cooling liquids that will buffer the plaza's landscaping from the heat of the train yard below, which can reach up to 150 degrees.

On top of this, tall trusses support hung sections of a podium structure that connects 10 Hudson Yards and 30 Hudson Yards and will house a collection of shops and restaurants on multiple floors. Columns and other support structures for 30 Hudson Yards land between the rail lines below

it, while trusses supporting the tower's south face span the tracks up to 115 feet. Here, site constraints came into play yet again: Because railroad operations required the use of a tower crane to erect the throat trusses, and the weight of the throat trusses exceeded the capacity of the Favco 1280 (the largest tower crane currently available), Thornton Tomasetti split the trusses into a pair of trusses, allowing them to be set one at a time by the Favco 1280, and then tied together to form a box truss.

From a design and fabrication standpoint, the area of the platform called the D10 Node also required detailed coordination, says Terry Flynn, vice president of engineering for Tutor Perini Civil Group. "It's a large steel box with trusses connecting to it, and a column below it," he describes. "Because of the node's complexity, structural steel fabricator Banker Steel Company created a presentation of their fabrication plan for the node as, simultaneously, Thornton Tomasetti developed the design in a Tekla model."

As a general contractor, Tutor Perini has found itself in the midst of an alphabet soup of agencies: LIRR, MTA, and Amtrak, as well as the City of NY, the DOB and the DOT. Basically, one could joke, every public entity that a contractor might have to deal with to make a project successful for its client. But, motivated by a sense of progress, not to mention the unprecedented revenue the plan should bring the city, the players involved have created a cohesive operational machine that is driving the project forward, relatively on schedule. As a result, the Hudson Yards development holds the promise of a new model for urban development, one in which buildings, public amenities, and utilities work together to create a cohesive community on the previously disparate landscape of Manhattan's West Side. □



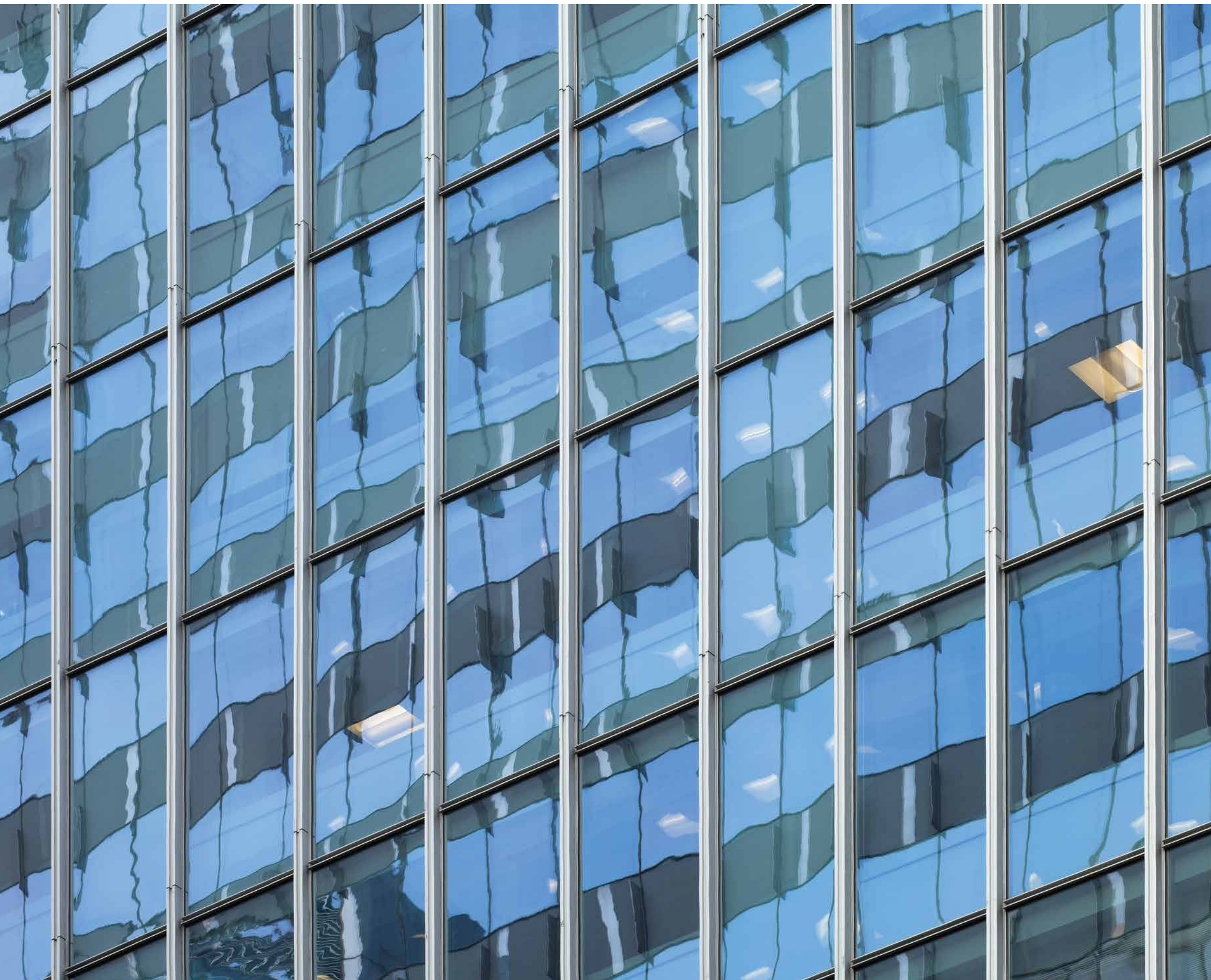
Left Hudson Yards construction in September 2015.
Above Platform trusses set west of the throat platform support the plaza.

This page: Geoff Butler; facing: Tyson Reist

Of the two platforms, the structure over the Eastern Rail Yards does the most heavy lifting, supporting Hudson Yards' four massive skyscrapers and its main cultural, retail, and residential attractions.

HUDSON YARDS EAST PLATFORM

Location: **Hudson Yards, New York**
Developers: **Related Companies and Oxford Properties Group, New York, NY**
Structural Engineer: **Thornton Tomasetti, New York, NY**
Geotechnical and Environmental Engineer: **Langan Engineering & Environmental Services**
Life Safety Systems Engineer: **Arup, New York, NY**
General Contractor (Hudson Yards Eastern Platform and the Amtrak Gateway project): **Tutor Perini Corporation, New York, NY**
Structural Steel Fabricator: **Banker Steel Company, Lynchburg, VA**; (caisson cores) **Owen Steel, Columbia, SC**
Structural Steel Erector: **Tutor Perini Civil Group, New York, NY**



330 Madison Avenue

Over-cladding the façade of a 1960s high rise with a modern curtain wall system improves performance, appearance, and property value.

BUILDING OWNERS IN MANHATTAN have always looked for ways to make their buildings more marketable to keep occupancy rates high while watching the bottom line for effective returns on their investments. Toward that end, older office buildings that are outdated in appearance and performance are increasingly the focus of repositioning into newly renovated, modernized facilities that meet the needs of the current market.

One such building is the 1963 Kahn and Jacobs-designed office tower located at 330 Madison Avenue between 42nd and 43rd Streets, just a block from Grand Central Terminal. Contemporary for its time, the 742,000-square-foot building used a curtain wall system that mixed single-pane glazing with opaque areas, creating an appearance of horizontal bands seeming to pass behind vertical mullions. The building is massed in three distinct vertical

portions. The lower area rises twelve stories and is built fully up to the property lines. A mid-section steps back on two sides for another six stories, followed by a slender upper section that is set back even further. The current owners, Vornado Realty Trust, were seeing good financial performance, but wanted to consider some upgrades to improve market appeal (i.e. more daylight, updated exterior appearance, more comfort near windows, etc.) and increase occupancy. They also recognized that the curtain wall system was nearing the end of its service life and wanted to improve both its overall performance and appearance.

Vornado enlisted the help of New York City-based MdeAS Architects, who have been creating a growing portfolio of building repositioning projects. As Dan Shannon, principal at MdeAS points out, “Every project of this type is unique. Each one stands alone in terms of its goals, its challenges, and its solutions.” Using that approach, they assessed the building, along with structural and curtain wall consultant Gilsanz Murray Steficek (GMS), to determine the condition of each of the existing curtain wall com-



ponents and the system overall. Among other things, they quickly determined that the existing single-pane glazing was problematic due to its energy inefficiency and the temperature discomfort it caused for people inside, and needed to be replaced. However, they also performed a structural analysis on the vertical mullions, which protruded out from the glazing plane, and determined that they were robust and structurally quite strong. These mullions were essentially rectangular aluminum tubular columns that ran the full height of each section of the building. This led to a further recognition that perhaps portions of the existing curtain wall system could be retained while others were selectively removed.

Armed with the information from their assessments and

analyses, the architects and engineers began to look at options. They settled on a very effective solution that allowed a new curtain wall system to be attached directly to the existing mullions as an “over-cladding” of the building. This design approach offered numerous advantages. First, it reduced the total labor and materials needed, contributing to cost control for the project. Second, it minimized or in some cases eliminated penetrations into the existing skin of the building. Third, it allowed for the new curtain wall system to be installed cleanly from the outside with demolition of the existing windows done after the fact from the inside. Finally, this approach minimized disruption to the tenants who would be occupying the building during construction. That

meant that the tenants would not need to relocate, in turn preventing vacancies or owner costs for temporary relocation.

The glazing of the new curtain wall received considerable attention. Mike Zaborski, project architect with MdeAS, points out that, “Working from the original mullion system, the new curtain wall had a 4-foot, 10-inch-by-11 foot, 8-inch glass module, typically with one glass panel for the full floor height.” The specified glazing is 1½-inch-thick double pane, insulated glazing units (IGUs) from Viracon to improve energy efficiency and indoor comfort. The outer lite is ⅝ inches (10 mm) thick clear, heat strengthened glass with a low-e coating (VRE-46) on the #2 surface. The ½-inch (13.2 mm) airspace uses a mill finish spacer and gray

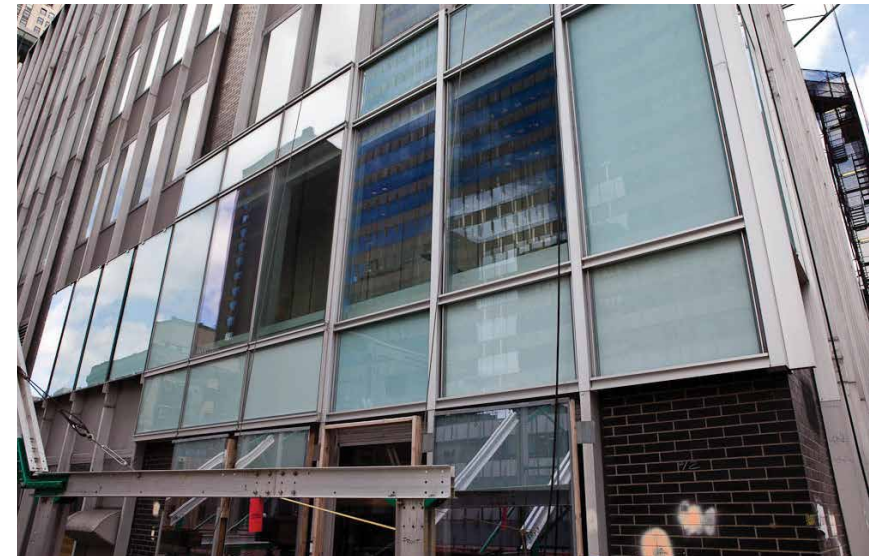
Above A detail of curtain wall replacement underway (left) and a view of the building just as the first new glazing units are installed (right).

Right Aligned with the original mullion system, the new curtain wall had a 4-foot, 10-inch-by-11 foot, 8-inch glass module.
Below The new curtain wall system is installed before existing windows were removed from inside the building.

silicone. The inner lite is ¼-inch (6 mm) clear heat strengthened glass. This combination provides a winter U-Factor of 0.30 (R-3.33) with a solar heat gain coefficient of only 0.28. Nonetheless, in the interest of enhancing daylighting into the tenant areas, the clear treated glass achieves a visible light transmittance of 43 percent.

In addition to the curtain wall work, the repositioning project scope also includes renovations to the main entrance lobby along with upgrades to all of the restrooms throughout the building. There were also improvements, adjustments, and modernization to the mechanical and electrical systems affected by the other work.

With the design worked out, the re-positioning team at Tishman Construction was engaged to carry out the \$100 million project. Over the course of two years (2010 to 2012) they used their experience from other such projects to manage significant construction work at the fully occupied site. Several factors were invaluable to the successful execution of the project. First, mock-ups were created of the curtain wall for each building section. Since the lower portion was built to the property line, the curtain wall assembly for this area needed to fit between the existing mullions in order to comply with New York City zoning requirements. The upper areas, which were set back, did not have this restriction, so the curtain wall could be mounted to the face of the existing mullions. Mockups of each of these



This spread and opening spread: MdeAS Architects



Left The completed facade as seen from East 42nd Street and Madison Avenue. **Facing page** As part of the building's repositioning, its main entrance and lobby were upgraded as well.

This spread: MdeAS Architects



systems allowed the team to determine the proper fit as well as test the strength of the curtain wall anchors under the various field conditions. That meant the final constructability details could be verified in addition to the final visual appearance.

Staging of the curtain wall sections on this zero-lot-line property was achieved by using the roof areas at upper story setbacks. In addition, suspended scaffolding units could be loaded with several panels at a time and either raised or lowered to their final destinations. During the over-cladding operation as many as twelve of these units were in place and operating over multiple shifts, which helped to speed overall construction time. The suspended scaffolding also offered flexibility and a noise abatement strategy in the event an area was off-limits on a particular day to accommodate tenant events or meetings.

The project's energy efficient glazing is taller by about 8 inches

at both the top and bottom compared to the previous glass panels, giving tenants markedly increased daylight and views. The lobby renovation and other upgrades were performed concurrently with the over-cladding of the façade, and produced similarly dramatic improvements. The owners saw the building quickly ramp up to 100 percent occupancy and have indicated that they are on their way to a strong double-digit return on investment.

Moving forward, Pat Hauserman, director of building repositioning with Tishman, notes, "There are 440 million square feet of commercial space in New York City. Of that, about 70 percent was built before 1980. The current and future market is in transforming these buildings to be energy efficient, sustainable, marketable, and updated." And as it stands now, 330 Madison Avenue is a prime example of how to successfully achieve those goals and blaze a trail for others following in its path. □

"The current and future market is in transforming these buildings to be energy efficient, sustainable, marketable, and updated."

Pat Hauserman, Tishman Construction

330 MADISON AVENUE

- Location: **330 Madison Avenue, New York, NY**
- Owner/Developer: **Vornado Realty Trust, New York, NY**
- Architect: **MdeAS Architects, New York, NY**
- Structural Engineer: **Gilsanz Murray Steficek LLP (GMS), New York, NY**
- Mechanical Engineer: **Goldman Copeland Associates, New York, NY**
- Construction Manager: **Tishman Interiors Corp., New York, NY**
- Curtain Wall Consultant: **Joseph Blanchfield, Gilsanz Murray Steficek LLP (GMS), New York, NY**
- Architectural Metal Fabricators and Erectors: **Coordinated Metals, Inc., Carlstadt, NJ; IDA Exteriors Inc., Derby, CT**
- Ornamental Metal Fabricator and Erector: **Melto Metal Products Co., Inc., Freeport, NY**
- Curtain Wall Erector: **W&W Glass, Inc., Nanuet, NY**



A pair of tapered W21s clad in cedar cantilevers 20 feet beyond the south elevation of the New Computer Science Building to provide a public entrance canopy.

New Computer Science Building, Stony Brook University

As computer science facilities around the country compete with each other for top talent, an open, light-filled design gives the discipline a more public face in Stony Brook.

From Alphabet to Zillow, computer science has transformed American business and gripped the popular imagination. As digital technology takes the center stage of economy and culture, so education spaces devoted to the field are stepping into the spotlight. “Historically computer science departments were quiet, introverted rabbit warrens, and more attention is being paid to these buildings as the discipline becomes more important,” says Stephen Dietz, a partner of Mitchell | Giurgola Architects. With the completion of the New Computer Science Building (CSB) at Stony Brook University’s main campus in Suffolk County, the New York-based architecture firm is supporting the move toward good, higher-profile design.

“Some people would say that universities are in a kind of Space Race to have the best facilities,” John Fogarty, Stony Brook’s director of capital planning, says of higher education’s recent focus

on upgrading computer science departments. In the case of the Long Island university, its well-respected program had been housed in part of a 103,000-square-foot wet laboratory dating to the late 1960s. In 2006 Fogarty determined that it was possible to renovate the existing building to accommodate booming student enrollment in computer science, but university leadership deemed it necessary to instead construct a building that reflected the computer science department’s top-20 ranking among public universities.

That the department’s original home was also emblematic of the rabbit warren may have motivated the about-face. “Computer science research labs were collaborative well before teaming became a popular mode of work, because they’re hands-on project environments where groups of people are working on a research grant dealing with cybersecurity or biomedicine,” Fogarty observes. Yet, as Mitchell | Giurgola partner Steven Goldberg says, “They had no sense of community in the mid-century building,” and he cites “double-loaded corridors that went on forever” as one of several physical causes of the feeling.

The desire to foster community, encourage chance meetings, and overlap disciplines under-



Above The facility's north-south volume rises three stories and includes graduate research labs facing offices and conference rooms. The programs are bridged by an atrium that encompasses 4,000 square feet devoted to circulation and casual communal use, and whose glazing makes visible W12s and W16s.

Facing top The entrance canopy projects from the roof of the two-story east-west volume; the canopy's nearest interior feels like an extension of this signature element, as most of the space appears dematerialized thanks to a painted aluminum and glass wall.

Facing middle Just beyond the public entrance, the second floor's steel-reinforced concrete slab has been opened and strung with energy-efficient pendant lights, to echo the adjacent atrium.

Facing bottom A north-south section drawing of the New Computer Science Building.

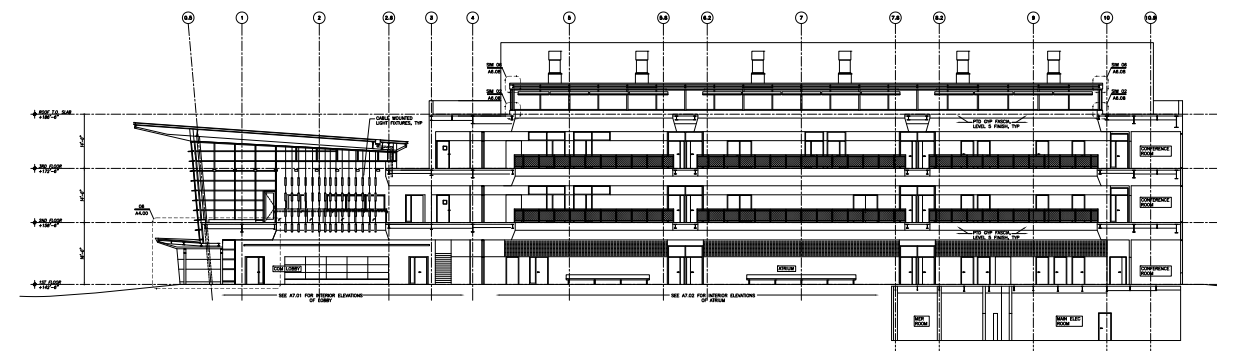
pinned the design of the New Computer Science Building, in turn, according to both Dietz and Goldberg. Mitchell | Giurgola distributed 72,000 square feet into an L shape whose stem follows a primary north-south axis. This longer, three-story volume is divided asymmetrically: Graduate research labs overlook Engineering Road immediately to the west; the spaces average 43 feet in span to facilitate collaborative work and project-by-project reorganization. Offices and conference areas spanning 12 and a half feet are placed directly behind the east elevation. A triple-height atrium featuring multiuse common spaces, walkways, and bridges unites the wide and narrow sides.

The L's shorter perpendicular bar encompasses undergraduate learning facilities—the focal point of which is a 100-seat auditorium at its western terminus—and offices. It fills two stories, stepping back above the auditorium to accommodate a rooftop terrace where building occupants can again congregate. The east-west volume moreover includes the public entrance, identifiable by a canopy that cantilevers 20 feet to the south. Brick and cedar cladding throughout the New Computer Science Building harmonizes with Stony Brook's woodland setting, and offers what Goldberg calls a “high-touch” counterpoint to the high-tech program. Mechanical penthouses are skinned in metal to seem less massive.

Of the final scheme, Goldberg says, “You’re never far away from anybody,” adding that the north-south atrium not only encourages mixing of student and faculty, but also “has something of a wow factor that manifests the university’s desire to attract the best.” Dietz remarks that, in addition to the rooftop terrace, the two-wing concept creates a courtyard between original and new computer science buildings that department staffers based in both facilities have enthusiastically embraced as an outdoor gathering spot. The building’s orientation, plan, and massing respond secondarily to the siting of mature trees and a much-depend-upon parking lot, the preferred relationship between different building populations and Engineering Road, and other conditions.

This nuanced effort had to be mindful of the State University Construction Fund’s rigorous budget, as well, notes Sheng Shi of New York-based Ysrael Seinuk, which served as lead structural engineer of the New Computer Science Building. “The project can save construction costs by just having enough mechanical basement space, with the rest of the building on slab-on-grade,” the partner says, and drove the use of a structural steel frame, especially in light of the research labs’ span. Dietz concurs, “There’s a real efficiency built into steel with composite metal deck, though you may gravitate toward concrete with buildings that are very sensitive to vibration, such as an optics or physics lab.”

For the computing labs, Shi says, “we’re using a W24 roughly 10 feet on center to control deflection.” (The typical dimension of these steel beams is W24x76, and W10s and W12s are specified for most columns throughout the building.) Lighter-weight W12s and W14s frame the more closely spaced offices, in the spirit of keeping costs down, while concentrated conditions warranted members as heavy as W24x250 to mitigate vibration in the third-floor labs located directly beneath the



This spread and previous: photos © Albert Vecerka / Esto; diagram this page: Mitchell | Giurgola Architects



“Some people would say that universities are in a kind of Space Race to have the best facilities.”

John Fogarty, Stony Brook University

mechanical penthouse. “Steel can much more easily handle variation in the floor plate,” Shi says of the all-A992 frame, which he deems “a normal type of steel structure.”

The New Computer Science Building does have its idiosyncrasies, and Shi points to the hybridized lateral system as just one example of the design team responding to a project-specific challenge. In order to keep construction costs in check, Ysrael Seinuk specified HSS10x10 and HSS8x8 braced steel framing everywhere but locations where the architecture demanded less intrusion. In those places—namely in the southern wing and third-floor administration areas—more open, albeit pricier moment frames provide stability. Other unique solutions include welding W30s and W12s together for the undergraduate auditorium’s 50-foot span, in order to

create a recess for the pavers of the rooftop terrace overhead, and tapering the W21s that top the public entrance to enhance the canopy’s cantilevered appearance.

“It’s amazing how versatile the steel allows you to be,” Dietz says of the New Computer Science Building’s various structural strategies. “The material does its job in a very elegant, quiet way.” That subtlety allowed Mitchell | Giurgola to create a building whose commitment to interaction and site-specific natural finishes put it in the company of thoughtful new computer science facilities at Carnegie Mellon, Cornell, and other schools. “There is this national trend of giving computer science a more public face,” Dietz says, “and for us that meant positioning this relatively new discipline as part of ancient academic culture.” □



Left to right The New Computer Science Building’s overall L shape yields an outdoor terrace that faces north and east, and which functions as a courtyard with the original computer science facility—still in use by the department—next door. A cedar pergola shades the east-west volume’s rooftop terrace, which Mitchell | Giurgola Architects created by terracing its second story.

This spread: photos © Albert Vacerka / Esto

NEW COMPUTER SCIENCE BUILDING, STONY BROOK UNIVERSITY

Location: **Stony Brook University, Stony Brook, NY**
 Owner/Developer: **Stony Brook University, Stony Brook, NY**
 Architect: **Mitchell/Giurgola Architects, New York, NY**
 Structural Engineer: **Ysrael A. Seinuk, P.C., New York, NY**
 Mechanical Engineer: **Joseph R. Loring & Assoc., Inc., New York, NY**
 Construction Manager: **URS Corporation, New York, NY**
 Structural Steel Fabricator: **Owen Steel Company, Columbia, SC**
 Structural Steel Erector: **AJ McNulty & Co., Inc., Maspeth, NY**

Barclays Center Green Roof

On hold for years, plans for the arena's green roof come to fruition with a structurally innovative, improvisational addition to the existing steel superstructure.

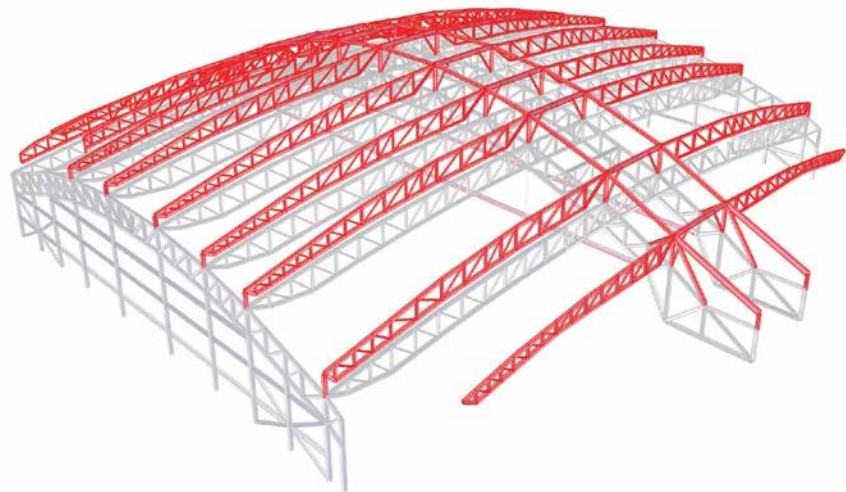
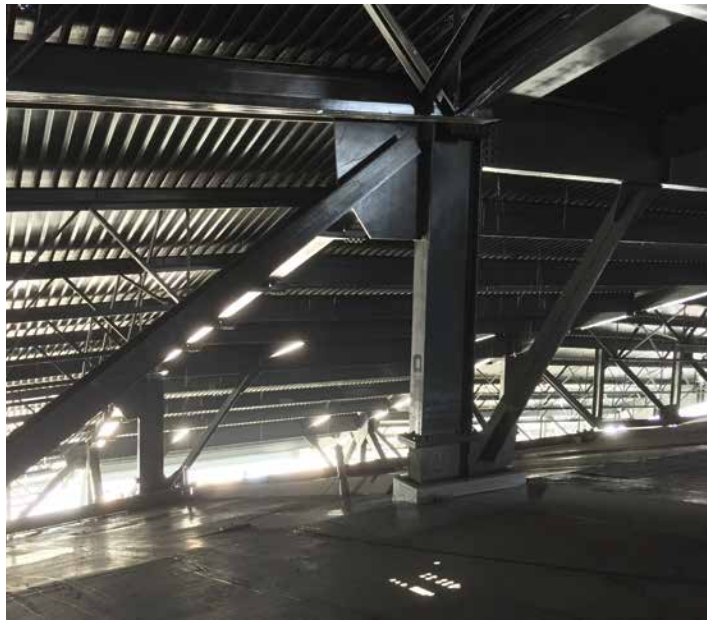
THE BARCLAYS CENTER WAS COMPLETED in 2012 as the first component of Pacific Park, a 22-acre mixed-use commercial and residential development in Brooklyn. Situated at the intersection of Atlantic and Flatbush Avenues, the iconic, undulating weathered steel skin of the arena reflects the industrial history of the surrounding neighborhood.

Initial plans for the arena had also included a green roof to further integrate the design into the surrounding environment. Although the green roof component was ultimately eliminated from the design, the arena was still able to achieve LEED Silver certification, becoming the first sports venue in the New York metropolitan area to achieve that status in recognition of its sustainable design. (See *Metals in Construction* Winter 2013 issue to read features about the facade and structure of the arena.)

One year after completion of the Barclays Center, Forest City Ratner Companies and Greenland Group entered into a joint venture for development of Pacific Park, a multi-use project formerly known as Atlantic Yards. This agreement also provided the necessary resources to allow the original vision for a green roof to become a reality. A green roof would help to reduce noise levels from the busy sports and entertainment complex while also enriching the views from the surrounding neighborhood and the planned residential towers.

The revival of the green roof presented a unique challenge for Thornton Tomasetti, who provided structural engineering design for the original arena and were brought back, along with the rest of the original team, to develop a design for support of the new green roof. "Although the foundations of the arena had been designed with an allowance for a green roof as a vestige of the original concept, most of the superstructure—including the long-span roof—was not designed to support the additional weight," explains Thornton Tomasetti associate Michael Bauer, P.E.

To minimize the extra weight that would need to be supported, SHoP Architects selected a lightweight sedum for the green roof. Sedum is a flowering plant that does not require watering or routine maintenance and can be limited to a maximum weight of 30 pounds per square foot—considerably less than other common types of roof plantings. To facilitate installation, the sedum was grown in 2-by-2-foot



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View of truss and joists flying over the existing arena roof during construction. A slide bearing assembly at the end of a secondary truss. The completed structure as seen from below after a rainstorm. Diagram illustrating green roof primary truss structures (red) overlaid on the existing roof truss structures (gray). View of trusses and joists from below the green roof, showing the small gap between the truss bottom chord and the crossbeam to the existing arena roof.
Facing page Trusses and joists during construction, facing toward the rail yard and Pacific Park development.

This page photos: Mike Bauer, Thornton Tomasetti; diagram: Thornton Tomasetti; opening spread: Forest City Ratner Companies



trays off-site in Connecticut and then transported to the arena for installation in the spring of 2015, with over 34,000 trays required to cover the 135,000-square-foot green roof.

An initial analysis determined that the added weight of the green roof system would require substantial reinforcement to the trusses, purlins, and steel connections throughout the roof, as well as additional reinforcing and secondary support for the roof deck. Furthermore, performing all of this work within the arena while maintaining an occupiable venue for dozens of monthly events would be next to impossible. It became clear that any viable solution would need to minimize the work required on the inside of the arena.

The main support elements of the existing arena roof are a pair of central tied arch trusses spanning 350 feet in the east-west direction. On the north and south sides of the roof, a series of eight secondary trusses, spanning 170 feet in the north-south direction between the central tied arches and the perimeter, provide support to allow for a column-free seating bowl. Girders and purlins spanning between the secondary trusses frame the remainder of the roof.

The design solution developed by Thornton Tomasetti for support of the green roof augments the existing pair of central tied arches with an additional chord 14 feet above the existing arch chord. The new arch chords are tied into the existing arches with a vertical element at each major panel point, along with diagonal bracing elements at the ends of the span. In doing so, the effective depth of the arch under live loads and the weight of the new roof is increased from 50 feet to 64 feet, with a proportionate decrease in member stresses. Moreover, the result-

ing heightened green roof surface is more visible from the street, and the resulting gap between the new and existing roof surfaces provides added benefit in curtailing noise emission.

Mirroring the original design, a series of new secondary trusses span from the new arch top chord to new stub-ups on the perimeter, directly overhead of the existing secondary trusses below. "With this arrangement, over half the weight of the new roof is supported entirely on the two central arches, while the remainder is supported at the perimeter," says Bauer. To avoid excessive thrust transfer into the existing structure from outward deflection of the new roof structure, nearly all perimeter support connections incorporate elastomeric slide bearings. "The end result is that a vast majority of the existing roof framing, including all existing secondary trusses and infill framing on the north and south sides, does not carry any load from the green roof."

While it was determined that the perimeter structure had sufficient excess capacity to accommodate the additional loads, the central pair of arch trusses required some local member and connection reinforcement. More crucially, the engineering team found that the existing wide flange tension tie members within these tied arches would be overstressed under the added load.

To avoid overstressing the existing tension tie members, each arch was retrofitted with a pair of 3 3/4-inch diameter 300-foot-long steel cables—a type and size of cable more commonly used in bridge construction. To provide a means to connect the cables and transfer the load into the existing structure, new 3-inch-thick cable gusset assemblies were welded to each side of the existing 3-inch-thick arch node



gusset plates. After completion and inspection of the reinforced nodes, the reinforcing cables were lifted into place during a two-day window between scheduled events, and several weeks later, a series of hydraulic jack assemblies were used to draw each reinforcing cable into over 300 tons of tension.

By tensioning the reinforcing cables, the force in the existing tension tie was reduced by a sufficient amount to allow for installation of the new roof. Key locations within the existing arch and tension tie were fitted with strain gages that could be monitored during the tensioning of the cables to verify the amount of force reduction in the existing tie and to confirm that the overall structural behavior was consistent with analysis model predictions. The strain gages were left in place and used to monitor changes in force levels in key members for the duration of construction.

Designing a long-span steel structure that could be erected over an active arena required an alternate approach to conventional shored construction techniques. Crane locations around the site were limited due to adjacent construction projects and the arena's location between two heavily-trafficked streets. Thornton Tomasetti worked closely with the steel fabricator and erector to develop a lightweight structure that could be quickly erected using three cranes situated around the perimeter of the arena.

To reduce their weight, ASTM A913 Grade 65 steel was used for all truss members, and mid-span shoring posts supported on the existing roof trusses below allowed each of the 170-foot secondary trusses to be erected in two segments with weights under the limiting pick capacity of each crane. Lightweight joists were used to provide infill framing, further reducing the weight of the overall structure and increasing the speed of erection. Exterior steel erection began in late 2014 and was completed by June 2015, with minimal impact to the arena's busy event schedule. Installation of the sedum trays was completed shortly thereafter, and the roof quickly became a popular destination for local bees, which made quick work of pollinating the vast field of flowering plants. From the street, amid the buzz of daily life in Brooklyn, the new expanse of green atop the Barclays Center provides a refreshing sense of openness amid the dense urban surroundings the arena calls home. □



Above View from the peak of the green roof towards downtown Brooklyn and Manhattan.
Above left Flowers spring from the deck along the edge of the green roof.

This spread: Mike Bauer, Thornton Tomasetti

BARCLAYS CENTER GREEN ROOF

Location: **620 Atlantic Avenue, Brooklyn, NY**
Owner/Developer: **Forest City Ratner Companies, Brooklyn, NY**
Lead Architect: **AECOM, New York, NY**
Design Architect: **SHoP Architects, New York, NY**
Structural Engineer: **Thornton Tomasetti, New York, NY**
Mechanical Engineer: **WSP Flack & Kurtz, New York, NY**
Construction Manager: **Hunt Construction, Brooklyn, NY**
Curtain Wall Consultant: **Front Inc., New York, NY**
Structural Steel Erector: **James F. Stearns Co., Inc., Pembroke, MA**
Curtain Wall Erector: **Egan Architectural, Yonkers, NY**

INSTITUTE NEWS AND EVENTS



WINNERS SELECTED FOR “REIMAGINE A NEW YORK CITY ICON” COMPETITION

The “Reimagine a New York City Icon” competition, the 2016 Design Challenge sponsored by *Metals in Construction* magazine and the Ornamental Metal Institute of New York invited architects, engineers, students, designers, and others from all over the world to submit their vision for recladding 200 Park Avenue (formerly the Pan Am Building, now the MetLife Building), which was built a half-century ago as the world’s largest corporate structure. On February 29, 2016, a jury composed of architects and engineers presented the results of the competition at a half-day conference at the Times Center in New York, where Nilda Mesa, the director of the NYC Mayor’s Office of Sustainability, gave a keynote address.

The panel of six competition jurors included some of the best known experts in sustainable design from the fields of architecture and engineering: Ben Tranel, AIA, LEED, of

Gensler; Areta Pawlynsky, AIA, of Heintges; Billie Faircloth, AIA, LEED AP BD+C, of Kieran Timberlake; Fiona Cousins, PE, LEED AP BD+C, of Arup; Sameer Kumar, AIA, LEED AP, of SHoP; and Hauke Jungjohann of Thornton Tomasetti.

The jury selected six finalists, each with its own outstanding merits. *Metals in Construction* with support of the jury decided to distribute the \$15,000 prize money equally among the six finalists. The winners included members from leading international architecture and engineering firms and organizations: VOA, Werner Sobek, SHoP, Heintges, CASE-RPI, StudioTJOA, FXFOWLE, Thornton Tomasetti, Dagher Engineering, AECOM, and Lemay. Their innovative concepts are now on display at metalsinconstruction.org/2016winners.

The mandate of the competition was to reimagine 200 Park Avenue with a resource-conserving, eco-friendly enclosure—one that creates a highly efficient envelope with the lightness and transparency sought by today’s office workforce—while preserving and enhancing the aesthetic of the building’s heritage. The competition, which was

managed by *Metals in Construction*, opened in September 2015, and deadline for final submission was February 1, 2016.

The 2016 “Reimagine a New York City Icon” competition was inspired by the President’s Climate Action Plan and the Architecture 2030 Challenge. Meeting the aggressive goals for energy reduction established by these programs will require energy retrofits of existing building stock on a widespread scale. With this in mind, designers commissioned to replace antiquated façades on notable office towers will need to strike a balance between preserving what is truly architecturally significant and integrating components that can offer higher energy performance.

At the end of the event, Gary Higbee, editor of *Metals in Construction*, announced the magazine’s upcoming 2017 Design Challenge. Next year’s challenge will be sponsored by the Steel Institute of New York, which together with the Ornamental Metal Institute of New York has published the magazine for the New York design and construction industry since 1982.



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* in 2016, with topics ranging from responding to new energy goals with façade design to detailing

structural steel buildings for optimized acoustics. More topics are available online at continuingeducation.bnppmedia.com and architectmagazine.com via the Continuing Ed tab.

CHECK US OUT ON FACEBOOK



Visit the Institutes’ Facebook pages to stay informed about news and upcoming events. In recent news, Cooper Union’s steel bridge team placed first at the 2016 ASCE Metropolitan Section Conference steel bridge competition with support from the Steel Institute of New York. Follow their progress online as the team heads to the AISC/ASCE 2016 National Student Steel Bridge Competition in Provo, Utah, May 27–28.

EVENTS



On March 11, 2016, the Steel Institute of New York sponsored “Offices 2025: Meeting the Challenges of Growth in New York City.” Part of *Commercial Observer*’s breakfast series, the panel discussion included Jay Badame of Tishman Construction, an AECOM Company; Jessica Lappin of Downtown Alliance; Larry Silverstein of Silverstein Properties, Tom Vecchione of Gensler, and moderator Michael Zetlin of Zetlin & De Chiara, LLP.

Visit the Steel Institute of New York and the Ornamental Metal Institute of New York at siny.org and ominy.org for the latest information on Institute-sponsored events.

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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

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