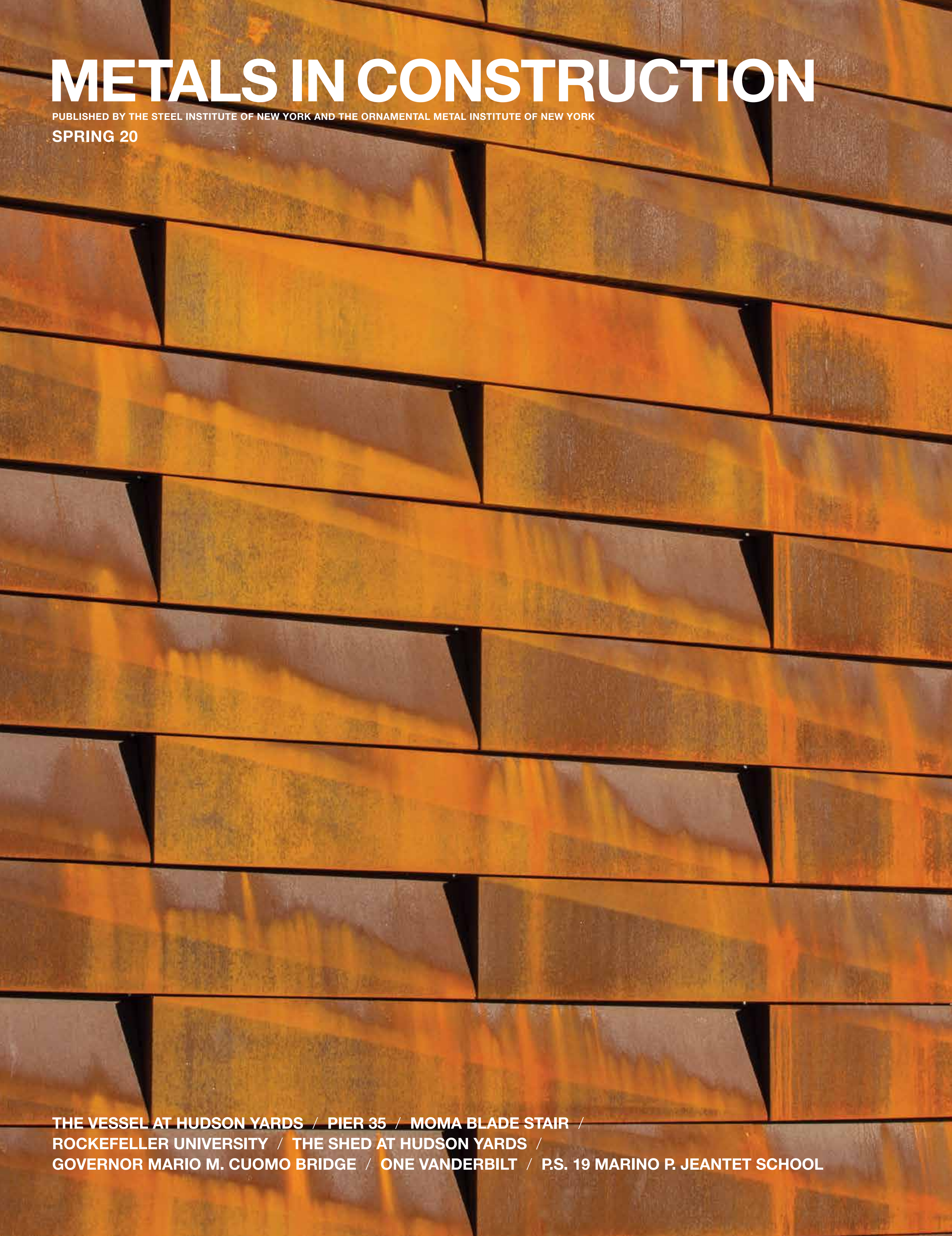
METALS IN CONSTRUCTION

PUBLISHED BY THE STEEL INSTITUTE OF NEW YORK AND THE ORNAMENTAL METAL INSTITUTE OF NEW YORK
SPRING 20



THE VESSEL AT HUDSON YARDS / PIER 35 / MOMA BLADE STAIR / ROCKEFELLER UNIVERSITY / THE SHED AT HUDSON YARDS / GOVERNOR MARIO M. CUOMO BRIDGE / ONE VANDERBILT / P.S. 19 MARINO P. JEANTET SCHOOL

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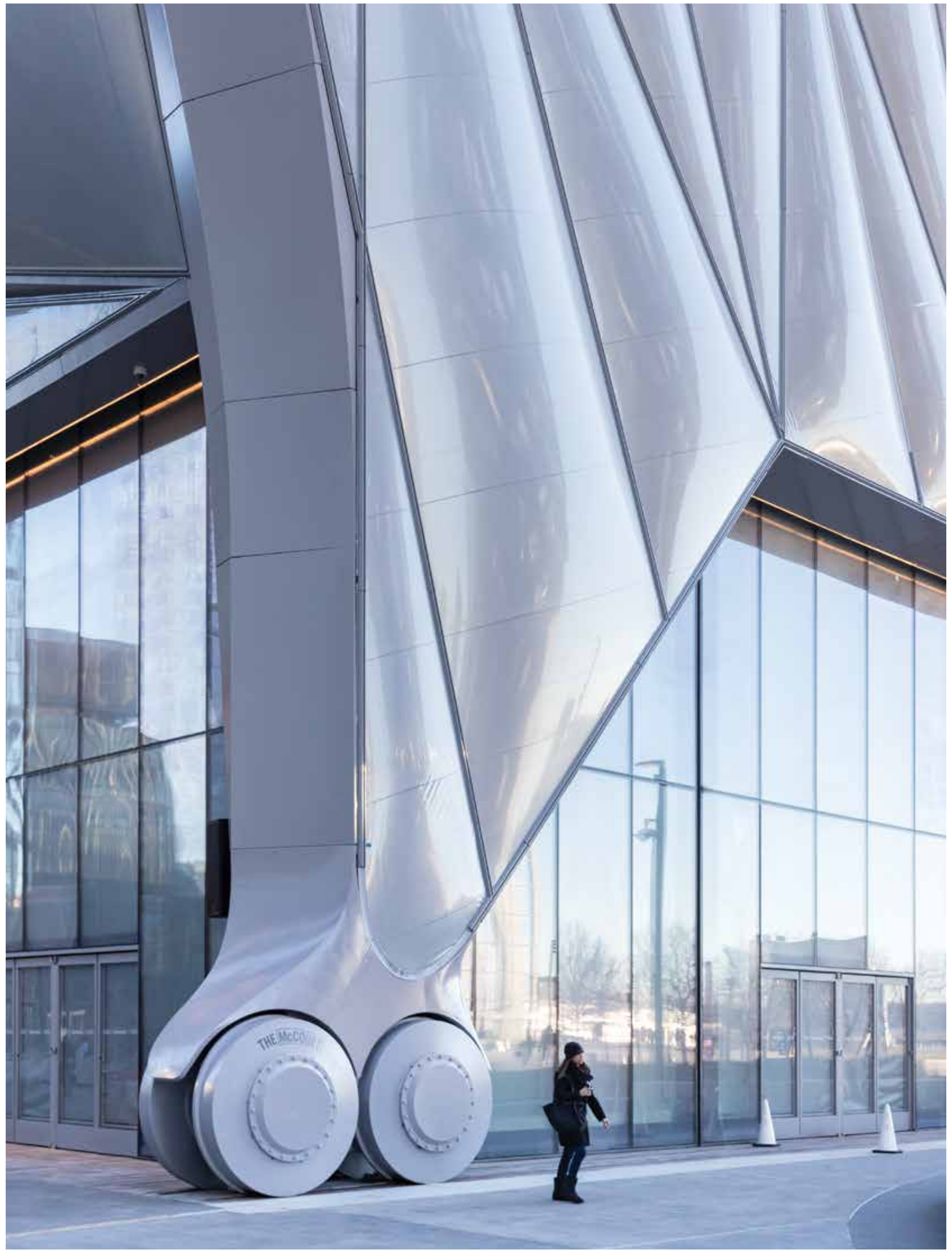

Published by The Steel Institute of New York and The Ornamental Metal Institute of New York

Above The wheeled base of The Shed, designed by Diller Scofidio + Renfro with Rockwell Group.
Cover A detail of the weathered steel facade of Pier 35, designed by SHoP.

Cover: SHoP Architects; this page: Iwan Baan

EDITOR'S NOTE
Reimagining Our City

Readers know that the magazine features noteworthy building projects involving work by members of the Steel and Ornamental Metal Institutes of New York—contractors engaged in the erection of structural and ornamental metals. They may not know that it also hosts an annual competition, the *Metals in Construction* magazine Design Challenge, to generate ideas for combating global warming in the built environment. This year marks the fifth year of the challenge and continues to attract designers from all over, many of whom have been recognized for their competition entries well past the life of the competition. You can view past winners and design briefs of at **metalsinconstuction.org**.

Each challenge explores different ways in which designers and building owners can address the concerns of climate change. Research shows that climate change is caused in large part by carbon emissions resulting from not only the operation of buildings but also the production, transport, and installation of materials to construct them. The 2016 competition, "Reimagine a New York City Icon," recognized the challenge faced by owners of historic buildings in designing a resource-conserving, eco-friendly enclosure while preserving and enhancing architectural heritage. The following year, the competition highlighted the importance of addressing embodied energy in creating sustainable enclosures. The goal was to explore possibilities for reducing building mass, and therefore embodied energy, by employing a hybrid frame and skin structure. The 2018 challenge focused on well-building issues. Researchers probing beyond workplace aesthetics are learning that air and water quality, thermal control, and especially visual access to outdoor environments can directly improve employee well being, increasing productivity. Enlightened businesses realize that increasing worker productivity by just 1 percent will result in a return on investment for these features in a relatively short amount of time. Last year, the 2019 design challenge sought ideas for making foot travel a more attractive, engaging component of walking from the transportation hub of the newly adapted Moynihan Train Hall to Hudson Yards, the city's largest development since Rockefeller Center. Studies project that 100,000 workers will travel from the rail station to offices there each day. This year's Challenge, "Give an Aging Office Tower a New Identity," focuses on the city's Climate Mobilization Act and its requirement for buildings to add energy-efficient features essential to reducing carbon emissions. Even the 75 percent of the city's high-rise office buildings that are more than a half a century old and will still be standing at the Act's 2030 target date must comply. The challenge is to envision design solutions for both undertaking these improvements and enhancing the buildings' visibility in the leasing marketplace. To learn more about this year's challenge and the winning entries, turn to page 52 or go to our website. Though the ideas competition doesn't result in built work, we think you will see how the conversations initiated by each winning entry are vital to the success of our city, and the projects in these pages, as we move forward into a more carbon-conscious era.

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The Vessel is clad in a polished stainless steel that was coated to resemble copper.

The Vessel at Hudson Yards

Heatherwick Studio's nickname-garnering form gives visitors a variety of superb views, a slight risk of vertigo, and a workout. Its design and construction team solved tricky problems of rigidity, safety, and buildability to create an urban mini-environment where visitors can climb into a realm of surprise.

IMAGINING A NEW URBAN typology—neither a building nor a sculpture, not quite infrastructure yet not purely art, as much empty space as metal—may have been the easy part. The real challenge with the Vessel, notes engineer Eli Gottlieb, managing principal at Thornton Tomasetti, was in the execution: orchestrating the symphony of forms and voids that makes this "public space that's cascading" not only striking but stable and safe. From dimensional planning to construction strategy to material choices to vibration analysis, Gottlieb reports, the process required exceptional coordination amid technical and procedural innovation. "I don't know that there are that many precedents for what this is," he says. "How do you create a staircase that takes the public realm and lifts it up into the air around it?"

Asked by Related developer Stephen Ross to design a sculpture for the Hudson Yards development, and resistant to the convention of dropping an ungainly decorative object into a plaza, Thomas Heatherwick and colleagues decided to sidestep the implicit competition with works like Anish Kapoor's Cloud Gate (the "Bean") in Chicago's Millennium Park. Heatherwick, in a recent televised discussion with Dezeen's Marcus Fairs, asked, "How could we make something that brought people together, that didn't block a space, so that you could look at each other as well as look out? Could we make a room, and could we let you use your body to navigate that?" The resulting structure, holding 800-1,000 people at once on 16 levels with 80 landings, 154 flights of stairs, and nearly 2,500 steps, is a complex response to a simple desire: "We wanted to make a social device."

The Vessel raises a subterranean model now well-known to be Heatherwick's chief influence, the stepwells of Gujarat and Rajasthan, India, into an aboveground lattice of staircases and landings allowing improvised ascents, descents, and circulation through the space above the Hudson Yards platform. Since it opened in March 2019, it has drawn torrents of tourists and a full range of rhetoric, from awestruck to scathing. Complaints about the Yards as a pseudo-urban theme park, its public subsidies for private interests, its initial photo-rights policy (quickly changed), or the perceived inutility of stairs to more stairs have not slowed the flow of Instagram-snapping climbers. Its silhouette serves as a glyph for the Yards as a whole. Love it or hate it—New Yorkers are already doing plenty of both—the Vessel is an instant icon.

It's hardly a vessel in the sense of a container; it's fully porous to the winds off the Hudson, though rigidly built, with a stressed-skin box structure, interior ribs, and orthotropic decks (the inner and outer staircases) cantilevered off the central interlayer spine. Comparing its box elements to "airplane wings and fuselages or boat hulls" and its decks to boat and bridge construction, not buildings, Gottlieb outlines a sequence of challenges that the team had to overcome.

The first involved basic geometric details: "How many staircases? How narrow does it start? How wide does it get at the top? How tall is it?... Do you start with four staircases or five staircases at the bottom of it? When you get to the top, is it still the same number?... Is there some kind of different cascading pattern that happens where the mesh becomes tighter?" The engineers and architects used

parametric models in an iterative collaboration to determine dimensions and spacing, settling on an odd-rhythm pattern with a pentagonal base and seven expanding decagonal levels in plan, cup-shaped in section and pinecone-profiled in elevation. It rises, Gottlieb explains, from "a ring that's about 45 feet in diameter at the base to a ring that's 150 feet in diameter in the top. That's a lot of stretch happening in this whole assembly." As the structure of rising and falling staircases slopes outward, "you have to be watching out for headroom issues as you're coming down a staircase, making sure that there's enough rise, and the staircases you're shifting enough so that you actually have space to be able to flow through it," he adds.

"Then once you solve that, you start thinking about the structural challenge of actually building this," Gottlieb continues. "As a team, we studied everything from being a full stressed skin, where the staircases are part of the whole stressed skin, to the final solution that we came up with, which is that just the central box, what we call the interlayer, is a stressed skin, and the staircases on either side are separate orthotropic decks." The staircases do not spiral, Guggenheim-ramp-style, or cascade all the way to the bottom, but compose individual rings, so that "all of their forces need to be transferred to the interlayer to get down.... It became more efficient for us to allow them to be orthotropic decks, which then allowed us to explore how the copper-colored finish material would actually be fabricated and installed."

One decision that simplified fieldwork was to use a custom prefabricated module called a "dog bone": a primary landing plus stair segments leading up and down on each side, with staircases spliced together at mid-run. Fabricated in Italy, the dog bones were brought in by barge and trucked from the West Side Highway just a few blocks, minimizing clearances for transportation. "Erection actually ended up being controlled by flow of material to the job site, as opposed to the speed of erection on the job site," Gottlieb reports; each dog bone went up in a few hours. The full assembly comprises 75 primary dog bones, 10 special dog bones at the base, five pedestal pieces, and six special pieces for the south-side angled spine and ADA-compliant elevator, the one way visitors with mobility challenges can ascend the structure. The entire Vessel uses 96 steel members.

Material research for the skin ranged from "bonded bimetallic materials to individual cupronickel alloys," finally settling on a cladding of polished stainless steel, deposition-coated to resemble copper and polished to mirror-like reflectivity. The hard-coat deposition is durable enough to withstand salty air blowing in off the Hudson without corroding or forming a patina. "It should maintain its color and its reflectivity over time," Gottlieb says, with normal cleaning. Scratchiti or other forms of vandalism are unlikely, since most of the cladding is out of reach; 12-foot level-to-level heights, plus vigilant security around the concrete base plinth (the only area where visitors come close to the polished surface), ensure that malcontents will not leave their marks.

This spread Erection of The Vessel in October 2017.

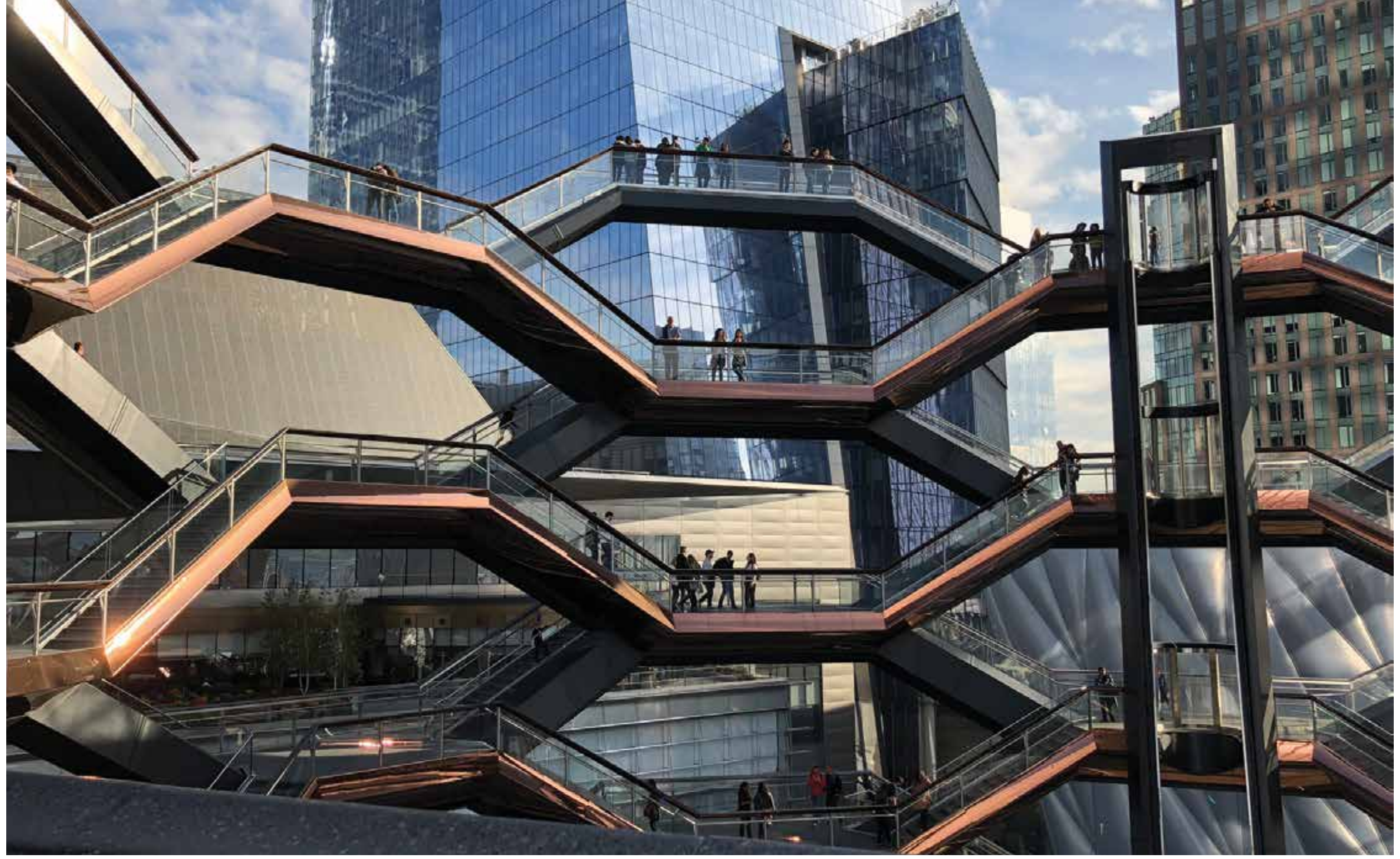
Opening spread: courtesy Michael Moran for Related-Oxford; this spread: courtesy Ornamental Metal Institute of New York

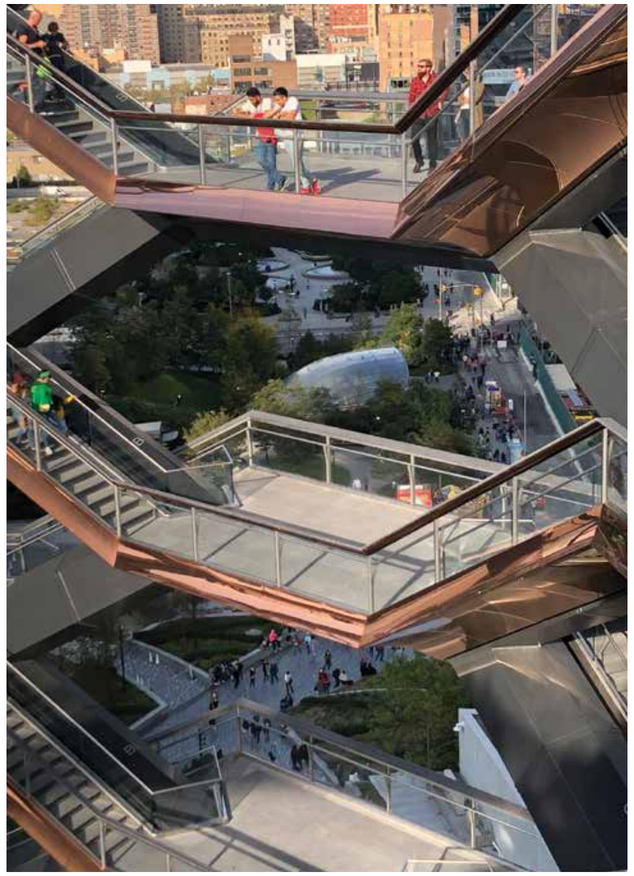
Prefabrication was extensive enough to allow not only the distinctive cladding but preinstallation of details such as shoes for handrails and mechanical systems (pipes, drainage, lights, speakers, wiring) concealed inside the structure. All bolts are interior as well; "you actually have to climb inside [the dog bones] to make up the connections between them," Gottlieb says. "That allowed us to get a very refined geometry fitup on them, and in fact the whole structure went together within a few millimeters, [needing] almost no adjustments in the field to the shims that were actually designed into it." The overall look is seamless, as sleek as a cinematic spaceship.

Almost nothing in the Vessel is vertical except for the edges of stairs, the seams of the safety glass panels, and the cab (though not the movement path) of the elevator. Its entire aesthetic appears to defy verticality, an anomaly in its hyper-vertical city. With this non-orthogonal geometry transferring loads at angles, and a relatively small base bearing its weight, the design team took exceptional steps to stabilize it, accommodating visitors' fear of heights or sensitivity to vibration under seismic or wind forces. Vibration tolerance being partially a matter of perception and expectations in context, Gottlieb notes, it was essential to keep this potentially lively structure as stable as possible.

"You can imagine it works a little bit like a vertical spring, because of the natural cascading through it," he notes. "That's been analyzed and designed to be able to take all those vertical stress loads down, and it does act as a cantilever from the bottom." The narrow pinch point at the base rests on a 12-foot-tall steel box element, the pedestal or plinth, below the walking surface (organized around a central blue light used for eerie photographic effects). The elevator pit and a mechanical room lie beneath the pedestal, which "bolts down to a steel grillage of three-foot-deep fabricated plate girders that form a continuous mat, effectively, underneath the entire width of the Vessel. Those then in turn sit on a set of major primary steel elements that span to columns and caissons that go down to grade underneath. So there is a complicated foundation for this base, but the base of this is a very stiff assembly; it's all bolted down and tied together under tension, [with] high-strength bolts that hold it all down.... It is designed to be able to resist all those wind loads and all those seismic loads as a cantilever off of that base that has very solid foundations all the way to rock underneath it."

To ensure that crowd behavior cannot compromise the structure's strength or stiffness, the engineers analyzed various extreme unbalanced-load scenarios, such as a concert or other event on the plaza that would cause all occupants to stand on one side or the other, large-scale races to the top level, or rhythmic movements that could create a resonance phenomenon, like the mass lockstep that gave London's





This page and facing Visitors occupy the new structure, which can hold up to 1,000 people on its 16 levels. The walkable sculpture encompasses nearly 2,500 steps.

Millennium Bridge its "Wobbly" nickname. "We actually went to a testing facility that RWDI [Rowan Williams Davies and Irwin] has up in St. John's, Newfoundland, and recreated what the visuals would be like on the Vessel, looking off of it into the surrounding neighborhood, and recreated what the movements... or the acceleration and vibrations would be like, and actually ran the entire design team and the ownership team through what those different experiences might be," says Gottlieb.

One technology commonly used in much taller buildings adds to the Vessel's stability: ten tuned mass dampers (TMDs), averaging 12,000 kg each, designed and fabricated by the German firm GERB and installed by Cimolai. "We tuned them in the field," Gottlieb reports, measuring how the structure moved when excited by people jumping, then adjusting the TMDs to cancel motion. "I've been up there with one of my coworkers who doesn't love heights that much," he says; this colleague pronounced the Vessel "actually pretty comfortable in the end."

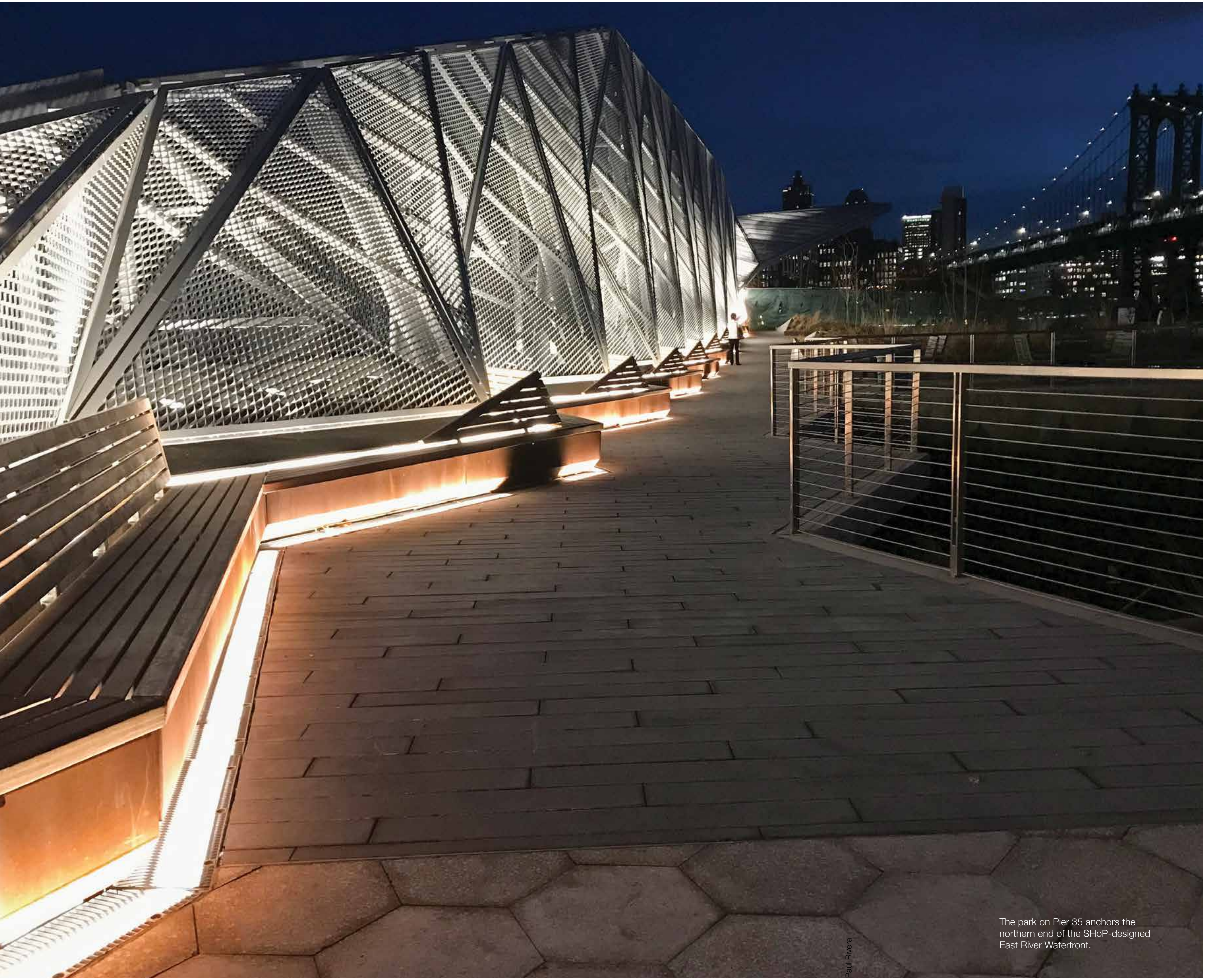
Integrated project delivery is sometimes an organizational buzzword; in the case of the Vessel, it was a practical response to the conditions of the project, where prefabrication solved problems of a tight site and a novel design. "We weren't just imagining the end structure, but we were imagining, 'How do you actually assemble this?' and having the contractors at the table with us from the very beginning," Gottlieb says. "Everything was designed to be totally integrated to be as efficient as possible, which allowed us to minimize the materials, optimize construction speed, and deliver on the tightest tolerances."

The perspectives the Vessel allows are intriguingly unfamiliar, verticalizing pedestrian life, looking both outward and inward in ways no other Manhattan sites allow. (They may also be evanescent, since the view of the Hudson and New Jersey is likely to shrink in several years when the Western Yard adds seven more buildings.). A purposefully collaborative process, advancing the arts of offsite construction and quality control, seems appropriate for a "social device" that scales up and condenses a common action—passing other people on stairs—to generate a multidimensional human and urbanistic spectacle.

This page: Bill Millard; facing page: Related-Oxford

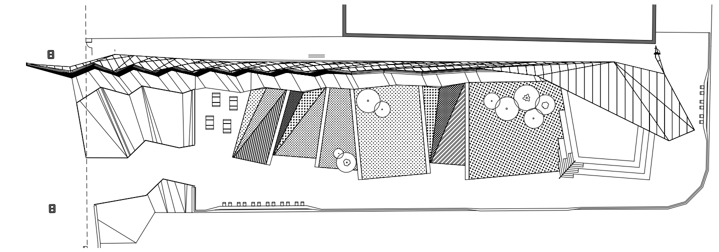
THE VESSEL AT HUDSON YARDS

Location: **Hudson Yards, New York, NY**
Owner: **The Related Companies**, *New York, NY*
Lead Architect: **Heatherwick Studios**, *London, England*
Architect of Record: **Kohn Pedersen Fox**, *New York, NY*
Structural Engineer and Engineer of Record: **Thornton Tomasetti**, *New York, NY*
Design Engineer: **AKT III**, *London, England*
Construction Manager: **AECOM Tishman**, *New York, NY*
Structural Steel Fabricator: **Cimolai, Monfalcone and Porcia**, *Italy*
Structural Steel Erector: **W&W Steel Erectors**, *New York, NY*
Structural Metals Consultant: **Catherine Houska Consulting, LLC**, *Pittsburgh, PA*
Architectural Metal Fabricator and Erector: **Monumental Inc.**, *Bethpage, NY*
Ornamental Metal Fabricator: **Permasteelisa NA**, *Windsor, CT*
Ornamental Metal Erector: **Tower Installation LLC**, *Windsor, CT*



Paul Rivera

The park on Pier 35 anchors the northern end of the SHoP-designed East River Waterfront.



Pier 35

A collaboration between SHoP, ARUP, and Ken Smith Workshop extends open space to an urban porch at Pier 35 on the Lower East Side of Manhattan.

FROM ITS EARLIEST PROJECTS, SHoP's reputation grew through an urban intervention-style digital design possessing a captivating visual complexity moderated by a warm material palette. In their early 2000 PS1 Pavilion and 2001 Hangil Book House, the effect would be accomplished with individual cuts of wood articulating torqued screens. In their recently completed Pier 35 park on the Lower East Side—like their 2012 Barclays Center, 2018 American Copper building, and U.S. embassy compound in-progress in Tegucigalpa, Honduras—twisting forms and saturated colors are achieved through metallic surfaces, in this case folded panels of weathered steel welded in a syncopated pattern and anodized aluminum screens gradually being overtaken by vines.

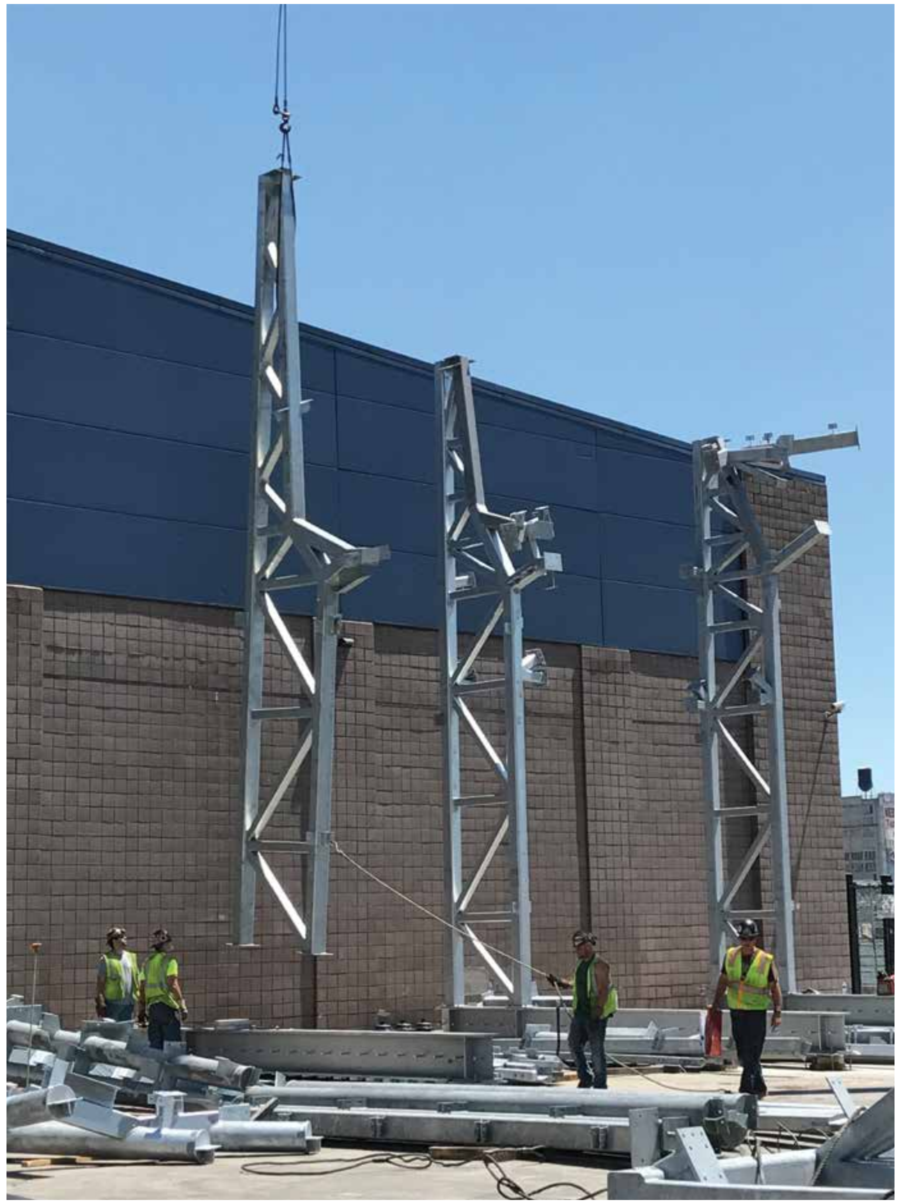
Originally envisioned as part of a 2003 waterfront masterplan by SHoP following the destructive impact of the World Trade Center attacks on Lower Manhattan, the design for Pier 35's park emerged from meetings with the local community board expressing the desire for more sunlight and open space in this dark stretch of East River waterfront dominated by concrete embankments and the elevated FDR freeway.

"For the esplanade, the majority of it is under the FDR drive, so you don't get a lot of areas that are open to sun or have a lot of outdoor green space," says Cathy Jones, design team member and project manager for SHoP. "That was a primary desire that the community have more open green space in this area."

A Department of Sanitation facility takes up most of the adjacent Pier 36 with a large warehouse, and Pier 35 had previously been used to store snow plows. Through a collaborative design process alongside engineers at ARUP and landscape architects Ken Smith Workshop, SHoP created a visual separation between the park from the storage facility with a shed-like pavilion along a slice of the pier, which unfolds into a dedicated space for planters, benches, grassy lounging areas, and a stepped balcony with swings overlooking the East River and the Manhattan Bridge.

"The Department of Sanitation isn't the most park-like thing to be next to when you're building a park," Jones says. "The concept was that we wanted to go up in height to mask that and focus one's view toward the water, not toward the Department of Sanitation. In doing so we wanted to make it visually stimulating and have a sculptural quality to it."

Five types of vines of different colors creep up the mesh along the length of the pier. Part of the structure sits on a freshly poured planter bed for the vines. "We were able to take the idea of a wall but turn it into a green wall, so we



This spread Erection of the screen's structural steel in August 2018 involved complex geometries anchored to an angled pier. Drawings show the structure's south elevation (above) and west elevation (left).

refer to it as a green billboard back to the city," says Jones.

At its highest point, the steel-framed wall along the old sanitation building is 35 feet above the pier, sloping down at either end. The engineering involved aligning the structure with the pile caps below of the reinforced concrete pier superstructure, transmitting the loads down to wooden piles. Wind loads along the shore were the strongest force to contend with apart from the structure's weight.

"We didn't have to do any significant modification or improvement of the pier itself," says Cliff McMillan, ARUP's project director for the pier project. "The frames are framed in a north-south direction to give enough overall dimension to them in that direction in order to be able to resist the wind load bending….The geometry was not too difficult to accommodate."

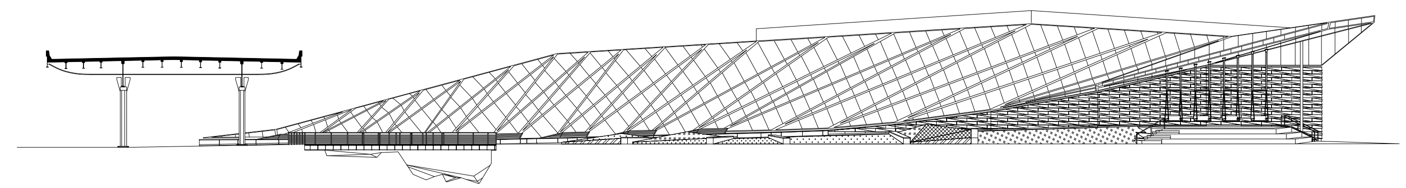
The fabrication and installation, however, involved complex overlapping geometries: multiple angles and a warping surface had to be fitted onto an angled pier. Anchor bolts had already been installed by a previous contractor, so the foundation had to be 3D-scanned along with the anchor bolts and modeled in 3D to make sure the structural steel lined up with the existing foundation.

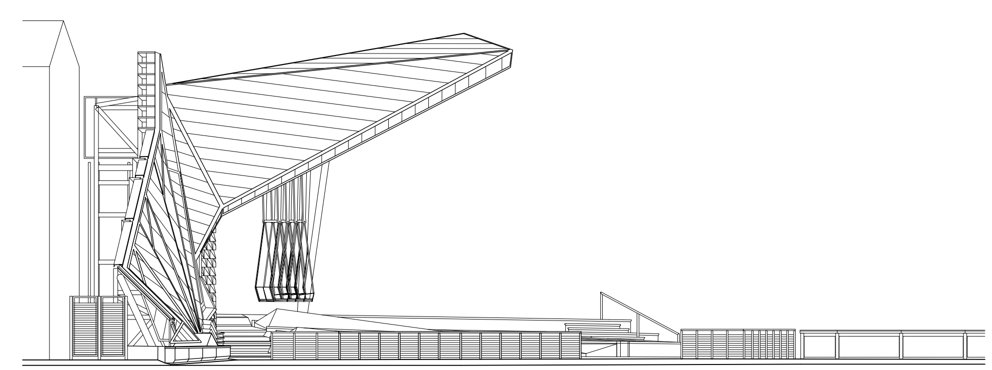
"Even our subcontractors we had them use 3D programming because everything is on an angle and every angle is different," says Mishel Mako, senior project manager at Hunter Roberts, who managed construction. "2D drawings would not give you—even when the architect would check the submittals sit was done in 3D. It was a beauty the way we orchestrated it."

The galvanized steel structure—fabricated by STF in Schenectady, New York, and installed by Imperial Ironworks—had to be pre-assembled in the shop and brought on site to be fitted and adjusted before being sent to the galvanizer and brought back for installation. Then the backing frame assembled by Westchester Metals in Yonkers had to perfectly line up with the

Opening spread: courtesy SHoP; this page: Hunter Roberts Construction Group; closing spread: courtesy SHoP

Photographs: Hunter Roberts Construction Group; diagrams: courtesy SHoP; following spread: courtesy SHoP





structural steel bolt holes—between 40 and 80 holes for each piece. Finally, expanded aluminum screen supplied by AMICO, composed of 1,100 pieces of mesh, all of different sizes, had to be fitted onto the armature.

"The big challenge of course is this living wall," Mako says. "Everything that was installed on site had to be prefabricated. You couldn't cut or change anything on site, because the materials were either galvanized steel, anodized aluminum, or weathered steel—like the rusty steel. Everything had to be measured ten times and when it came, had to be fit perfectly."

A row of porch swings hangs from the end of the pavilion, angled toward the Manhattan Bridge. "You have a porch and lookout point at the end with porch swings that sit and look out at the water, because the views are pretty spectacular," says Jones. "You're getting really fantastic views of Brooklyn, the Manhattan and Brooklyn Bridges, and you can even see the Statue of Liberty. Because of the way the island turns at that point, it's almost as if you're in the water itself."

Weathered steel beneath the pavilion's overhanging rooftop is shipped from facadeTek in Indianapolis, where they sprayed the panels with water to rust the surface. As rain streams through the baffles, parts of it are developing fresh rust, giving it a red-hued glow. "In general, we're using things like concrete that has a robust lifespan and can also endure public use," says Jones. "Galvanized steel and stainless steel railing as well: they're all materials that have to be chosen to withstand the waterfront and getting constant spray."

The collaborative team of SHoP, ARUP, and Ken Smith Workshop also designed the 1.5–mile East River Waterfront Esplanade from the Battery Maritime Building up to Pier 35. The esplanade project painted underside of the FDR light purple to ameliorate the darkness below the heavy structure when passing from neighborhoods to the waterfront. Plantings, biking and walking paths, restaurant pavilions, dog runs, and exercise and seating areas populate the underpass and a marine platform along the water's edge.

"This part of the [esplanade] project is probably one of my favorites because of the materiality, and it's something that was designed and is going to change over time," Jones says. "It's not like it just stops when the project opens, and it will also keep changing with the people that use it, so I find that to be pretty awesome."

The Pier 35 landscaping integrates some features of the esplanade, but it also required some special considerations. The plantings are a variety of salt water tolerant dune grasses, trees and bushes that grow wildly in the plant beds and flow over a beveled bridge to the pier.

"The vines are doing really well—there are about five different types so you have a different palette—so you're going to get different colors as they start to fill in," Jones says. "A lot of the other plantings are of a waterfront nature: you have a lot of dune grasses, things that are saltwater tolerant."

Beneath it, a stepped tidal slot cut out of the pier forms a demonstration mussel habitat, funded by a special grant from the State Department. An unreinforced concrete tidal basin with a texture cast into it, topped with rocky surfaces, outcroppings, and crevices, is designed to encourage the growth of algae and marine life. "That was a nice feature that hearkens back to the water and the environment of the water as a part of the narrative of having this outdoor open green space," Jones says. "There are crevices for little marine critters to get in there."

Pier 35 does not appear to figure into the East Side Coastal Resiliency planned to remediate storm water surges anticipated along the Manhattan side of the East River, but it's another thing that will change as the esplanade gets rebuilt in the coming years. For now, Pier 35 is designed to withstand.

This spread The 35-foot-tall, 300-foot-long screen as seen from the East River Waterfront. The structure conceals a Sanitation Department shed at the adjacent Pier 36.

PIER 35

Location: **Pier 35, New York, NY**
Owner: **NYC Economic Development Corporation (NYCEDC)**, *New York, NY*
Architect: **SHoP Architects**, *New York, NY*
Structural Engineer: **Arup**, *New York, NY*
Construction Manager: **Hunter Roberts Construction Group**, *New York, NY*
Structural Steel Fabricator: **STS Steel**, *Schenectady, NY*
Structural Steel Erector: **Imperial Iron Works, Inc.**, *Bronx, NY*
Ornamental Metal Fabricators: **Westchester Metal Works** (3D galvanized panels/stainless steel railing), *Yonkers, NY*; **facadeTek** (weathered steel panels), *Indianapolis, IN*; **Amico** (aluminum mesh), *Rochester, NY*
Ornamental Metal Erector: **Westchester Metal Works Inc.**, *Yonkers, NY*

The Blade is a six-inch vertical spine that hangs from the museum's sixth floor to structurally support stairs and landings, leaving the structure free of lateral bracing.

MoMA Blade Stair

Acting as a threshold to the museum's recent expansion, the stair's minimal expression was achieved through structural innovation that allowed a vertical steel spine to hang from the roof structure to support stairs and landings without lateral bracing.

WHEN THE MUSEUM OF MODERN ART opened its expanded campus to the public last October, one part of the addition was exhibited to anyone who passed on the street, whether or not they planned a visit to the galleries. The Blade Stair, as the museum and architects Diller Scofidio + Renfro (DS+R) call it, hangs like a four-story sculpture within the new glazed atrium of MoMA's west-end expansion, offering a tableau of museumgoers to all passersby. It is a design worthy of its surroundings; the entire 155,000-pound (or about 70-metric-ton) staircase is suspended from structural steel within the expansion's sixth-floor ceiling via a 6-inch-wide vertical stainless-steel-clad wall that fully supports the stairs and landings, leaving the entire structure free of lateral bracing.

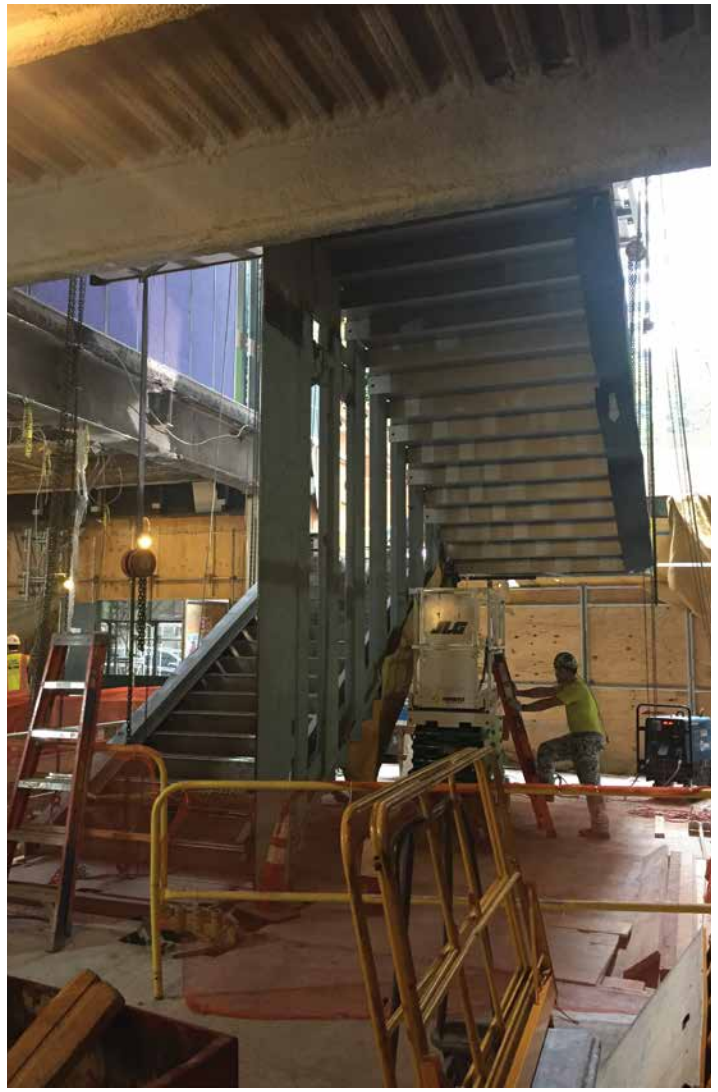
"In essence the stair is a facade element," says Chris Andreacola, associate principal for DS+R, who worked in collaboration with Gensler on the museum's expansion. "One of the motivations behind it and other parts of the facade, is the opening up to the street of MoMA, which they didn't really have before." Highlighting activity within the museum was a big motivating factor for the design, adds Andreacola, so the stair is arranged so that landings (and the people on them) are visible through the frameless glass facade. Inside, being able to take in daylight and the streetscape offers museum visitors a respite from their circuit through the galleries. The expansion added more than 40,000 square feet of gallery space that allows for increased flexibility in the type of exhibitions the museum can host (for example, a new double-height studio will host live programming, film, and performances). New street-level galleries on the expanded ground floor are free and open to the public, a gesture by the museum to bring art closer to the streets of Midtown.

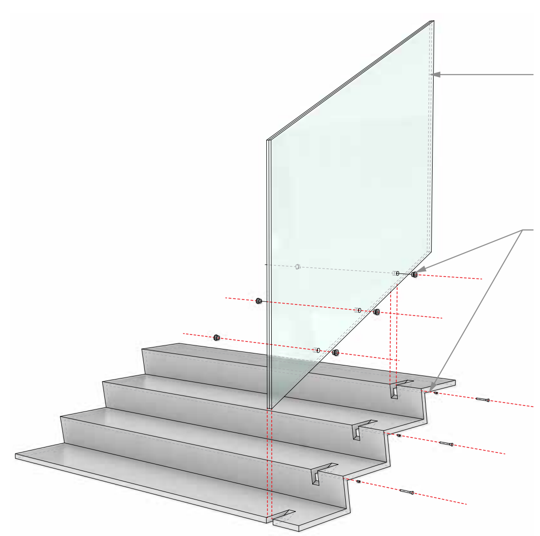
The expansion to the west of the existing museum features a stack of vertically interlocking galleries of varying heights. This volume required a new vertical core, creating a functional need for the stair and two adjacent elevators. The decision to create the most minimal stair structure possible was in line with the way the rest of the facade was designed on the West 53rd Street elevation, where a similarly floating custom entry canopy welcomes visitors into a double-height space where they can see through to 54th Street. "The canopy and that facade at the studio and gallery spaces just to the west of the blade stair are all hung," says Andreacola. "A lot of that was about really leveraging tension and being able to hone things down minimally so it's efficient to hang these things."

The desire to avoid having to connect and dead-load a staircase into every floor of the expansion drove the Blade Stair's spare form. After DS+R developed the initial idea to hang the stair with Brian Falconer, a principal with the project's structural engineer, Severud, they entered into a design-assist relationship with Dante Tisi, a custom metal fabrication firm with offices in the U.S. and Argentina, who in turn worked with engineers at Eckersley O'Callaghan to further develop the Blade Stair concept.

By hanging the stair from the sixth-floor ceiling structure, the design team was able to create a single 6-inch-wide wall on which to hang stairs and landings. "Instead of having bending elements that take loads at every floor, you have a single tensile element that allows that minimalism, and that distilling down of the stair to its really essential parts," says Andreacola. "The design and engineering project was to keep eliminating elements rather than trying to manipulate elements."

Esteban Erlich, a project manager with Dante Tisi, agrees that the most challenging aspect of





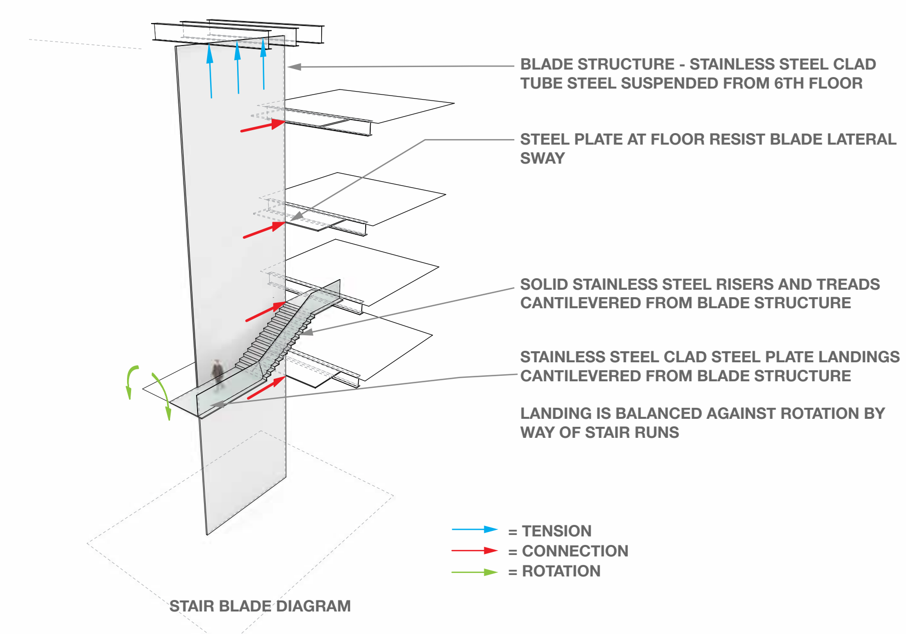
This spread, clockwise from top The stair's minimal glass handrail as seen from below. A diagram of the five-story stair. A diagram of the stair's guardrail; the glass is clamped to the ¾-inch solid stainless steel riser with threaded stainless steel pressure pins. The stair's Blade cladding, installation, and treads and risers and interior tube steel structure in the fabrication shop.

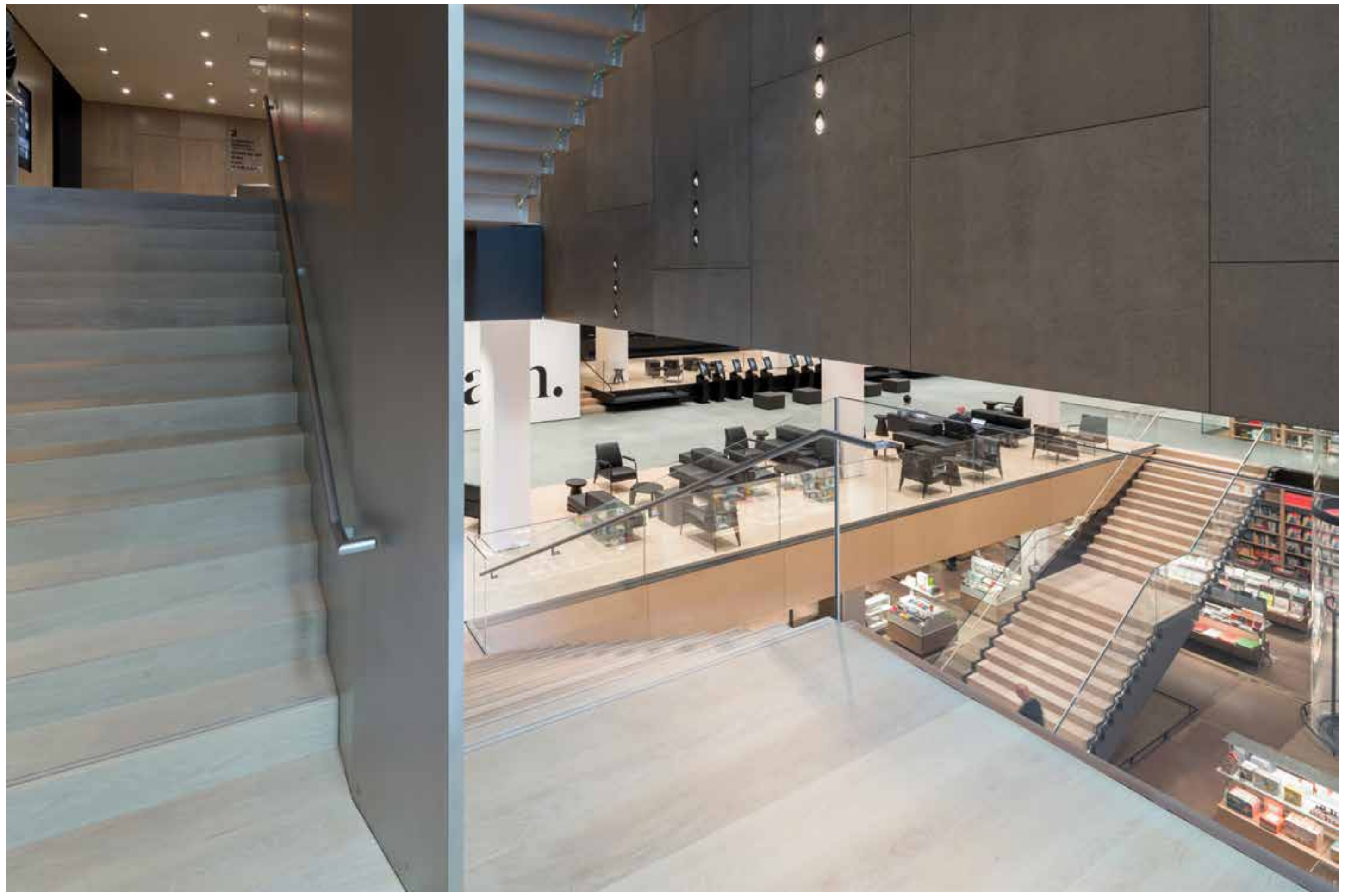
Opening spread: Brett Beyer; photos this page: courtesy Dante Tisi; diagram courtesy of Diller Scofidio + Renfro

Photograph: Iwan Baan; diagram: courtesy of Diller Scofidio + Renfro

the design was that it was suspended from the 6th floor and free-standing on three sides, but adds "the structural analysis of stairs has changed a lot in the last few years—the analysis of vibrations and frequencies done by Eckersly O'Callaghan was very sophisticated."

"With these landings that are basically cantilevered off the blade, the challenge was how to deal with the sway of the bridge as a pendulum, if you will," says Andreacola. Slotted connections through the stair runs limit the lateral movement of each landing. The runs are essentially beams that provide stiffening for the landing element that is close to the facade, and far away from any connection. Landings were lightened as much as possible to limit acceleration, and ultimately the stair's distillation to its most essential parts—treads, risers, and handrails—gives it the appearance of floating in mid-air. "How minimal can you make it?" asks Andreacola, adding that the biggest limitation was the maximum size possible for transport and installation. The blade itself was composed of 4-foot-by-4-foot assemblies; these were installed a stair run at a time then field-clad with finished stainless-steel panels. Within these, the Blade wall is comprised of 12-inch-by-4-inch steel tubes hung vertically and spaced 12 inches apart. Dante Tisi





fabricated the stair treads and risers in structural stainless steel, then bolted these to either the face or back of each tube, creating the run of the stair. "They are like beams cantilevered off the tubes," says Andreacola, "then the tread is added to stiffen it and provide lateral support."

For an installation where every component is exposed, finishing details were crucial. "The most challenging aspect of the installation was that all the components fit very tightly together, with very little tolerance, both in the joints in the wall panels as well as in the hairline joints of the solid stainless steel steps," says Erlich. The team realized that welding the ¾-inch treads and risers created so much heat that it distorted the stair's finish, so Dante Tisi mechanically fastened the treads and risers and then plugged the fasteners to create a smooth surface with crisp edges.

The stair's glass handrail, which consists of a single piece of glass for each stair run, went through a similar paring-down process. "Since there's a natural triangulation at a tread riser we were able to take advantage of that and get rid of unnecessary bulk," says Andreacola. The triangulation allowed the laminated, low-iron glass balustrade, which has a heat-strengthened inoplast interlayer, to be clamped with three stainless-steel compression pins at every tread riser. Andreacola says that modern glass technology, improved from even a few years ago, lets designers add significant stress to certain points, allowing the pins to work with reduced clamping contact area.

Ric Scofidio, who co-founded DS+R with Elizabeth Diller, also added, or subtracted, one final detail to the stair: a chamfered edge on the nose of the Blade closest to the stair runs, creating an edge profile that is about an inch wide rather than the 6-inch width of the rest of the hanging wall. "If you go down the stairs that chamfer takes you around the landing to the next run of stairs," says Andreacola.

Rather than clamorous, the experience of using the metal stair is remarkably serene. Finishes like white oak cladding on the stair treads and risers and microperforated gray birdseye maple help to create a sort of absorptive vessel, preventing sound from migrating into nearby galleries from the stair's atrium space. Much like in the galleries themselves, "You don't feel overwhelmed," says Andreacola. "There are things to look at along the way. It doesn't burden you with the fact that you're going up a stair, as you would feel in an enclosed stair." On any given day, he adds, "I don't see many people waiting for the elevator."

The Blade's chamfered edge is a detail designed to minimize the appearance of the hanging steel wall. At the stair's base, the museum's new ticketing area and sunken retail store can be seen. **Facing** The west-end expansion's curtain wall and West 53rd Street entrance.

This page and facing: Iwan Baan

MOMA BLADE STAIR

Location: **11 West 53rd Street, New York, NY**
Owner: **The Museum of Modern Art**, *New York, NY*
Architects: **Diller Scofidio + Renfro**, *New York, NY*; in collaboration with **Gensler**, *New York, NY*
Structural Engineer: **Severud Associates**, *New York, NY*
Consulting Structural Engineer: **Eckersley O'Callaghan**, *New York, NY*
Mechanical Engineer: **Jaros, Baum & Bolles**, *New York, NY*
Construction Manager: **Turner Construction Company**, *New York, NY*
Curtain Wall Consultant: **Heintges Consulting Architects and Engineers**, *New York, NY*
Structural Steel Fabricator: **Dante Tisi**, *New York, NY*
Structural Steel Erector: **Metro-Tech Erectors**, *Flushing, NY*
Miscellaneous Iron Fabricator: **Dante Tisi**, *New York, NY*
Miscellaneous Iron Erector: **Metro-Tech Erectors**, *Flushing, NY*
Architectural and Ornamental Metal Fabricator: **Dante Tisi**, *New York, NY*
Architectural and Ornamental Metal Erector: **Metro-Tech Erectors**, *Flushing, NY*
Curtain Wall Fabricator: **Frener & Reifer America, Inc.**, *New York, NY*
Curtain Wall Erector: **Utopia Construction Corp. of New York**, *Maspeth, NY*

Adjacent to the new building, the East River Esplanade was reconstructed with new landscaping, furnishings, and a sound barrier between the highway to provide a safe and resilient environment for the public realm.

Rockefeller University

Rockefeller University's new state-of-the-art laboratory facility was assembled in 19 midnight installments as 19 prefabricated steel modules were transported across the East River.

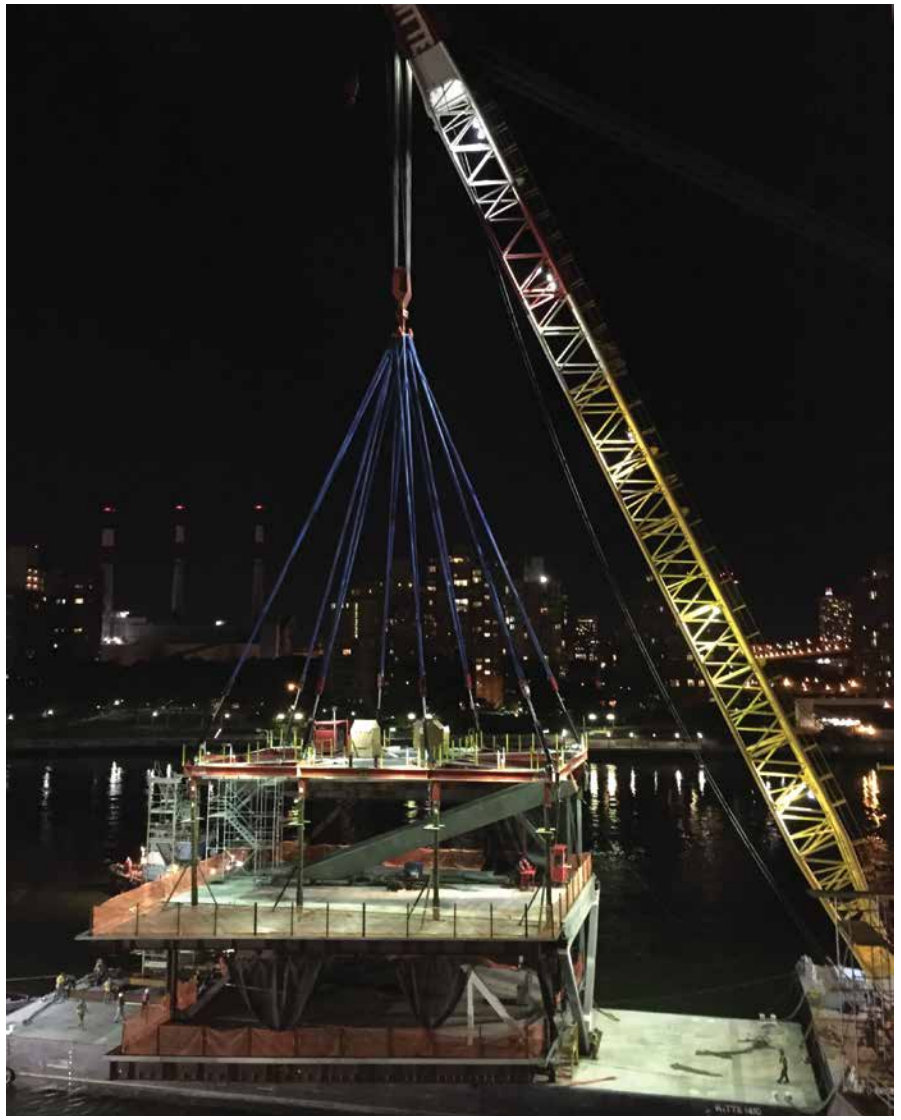
ROCKEFELLER UNIVERSITY WAS facing a quandary. As a leader in biomedical research, it sought to significantly expand with new state-of-the-art laboratory facilities, but was essentially out of real estate. Fortunately, the university owned the air rights on FDR Drive's east side, which allowed it to commission the design of a 900-foot, three-story building, designed by Rafael Viñoly Architects (RVA), that would rise along and over the highway.

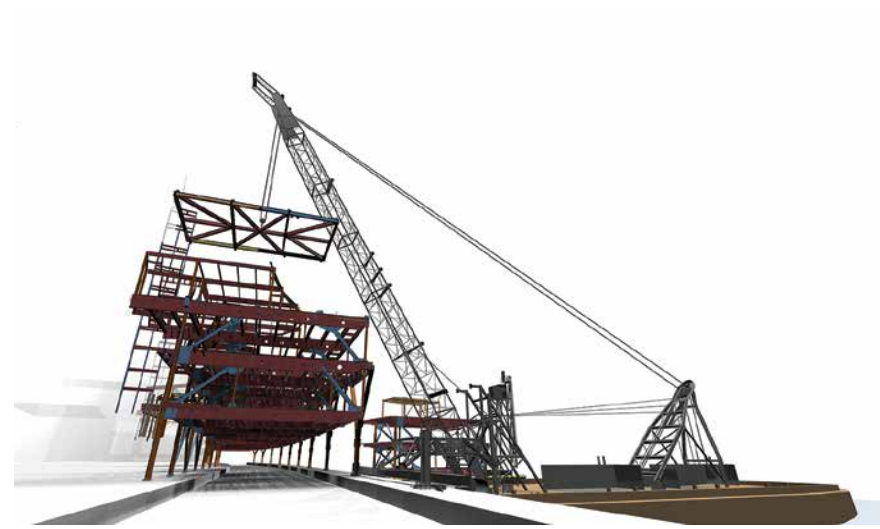
The new 180,000-square-foot building, known as the Stavros Niarchos Foundation–David Rockefeller River Campus, spans almost three and a half city blocks and aggressively addresses the vibration- and thermal-control needs of the laboratory. But perhaps the most unique challenge was erecting the large, long structure on a site with the East River on one side and a limited staging area on the other.

"We basically had to build a bridge over a hundred-foot stretch of the FDR," says Jay Bargmann, Vice President and Managing Partner of RVA. "It was our idea to prefabricate the building. It seemed to me very odd that you could build a temporary bridge over the FDR and then stick-build a building over it; you were still jeopardizing traffic and having to transport materials to a difficult site with that method." Bargmann says the project's structural engineering team at Thornton Tomasetti jumped on the idea of prefabricating the building off-site. Construction manager Turner also came on board with a project manager, Curt Zegler, who "really pushed the idea forward once he understood it," he says.

The building team's creative solution involved prefabricating 19 steel-framed modules at the off-site staging area—each approximately 92-feet by 48-feet on three-levels, complete with cast-in-place concrete on two levels, fireproofing, sprinkler systems and conduits—and then transporting them on a barge across the river. Because the modules already weighed close to 800 tons each, ductwork and concrete deck were installed on-site.

The prefabricated approach, "was the safest way to build the building and it was the least disruptive to the community and the city as a whole," says Bargmann. "Reducing construction time also reduced the cost," says Bargmann. In a traditional construction workflow, materials would have had to come across the George Washington Bridge and across the one point of access from the FDR to Rockefeller's Campus. But prefabricating the modules off-site shaved approximately 12 months off the project schedule and saved $20 million to bring the total project cost to $500 million. In addition, this approach minimized risk—i.e., exposure to passing vehicles during construction—and created a highly integrated environment with RVA, along with Thornton





Above One of the 19 three-story prefabricated modules is craned from the barge and readied for installation.
Top A model of the installation.

Tomasetti, Turner, construction consultant Lehrer, and steel fabricator Banker Steel, working closely together to fine-tune the design and complex prefabrication, transport, and erection processes.

"Over two and a half months in the summer of 2016, one module was lifted each of 19 nights using a Chesapeake 1000–a rare, 1000-ton barge crane," explains Sherry Yin, an associate principal for Thornton Tomasetti. To optimally stabilize the modules during transport, a temporary support system was installed and anchored to the deck of the barge. "The barge crane was only able to operate during a steady slack tide, and since the lift had to coincide with the FDR closure from 12 a.m. to 5 a.m., there were specific days on which the lifts could take place."

During each crane hoist, a module was supported by 16 computer-controlled cables that would keep the load completely level, explains Bargmann. "That was tested on the staging site in New Jersey so the computer knew what tension or load had to be carried in each level. They repeated that when they got to the site." With no overtime or contingency allowed because of the tides and FDR closure window, "You couldn't be an hour late," he adds. "It's a remarkable compliment to the team that did the erection."

During the day, strict safety measures were employed during construction to ensure the safety of the more than 175,000 vehicles driving down one of Manhattan's busiest roadways on a given day. Dictated by the vehicle clearance on FDR and the need to match existing campus elevations, two-story Y columns were spaced at 96 feet on center on the building's east side. They are supported on pile caps with multiple mini piles, in place of large caissons, due to limited capacity for equipment on the esplanade. The columns on the drive's west side are spaced at 48 feet on center, according to Yin.

"The primary superstructure consists of two levels of high-strength plate girders spanning up to 92 feet over the FDR Drive that are linked by diagonals so that both plate girders, each approximately 5 feet deep, act together like a truss," she explains. "This also supports a green roof on the third level."

Top Supported by 10 "Y" columns overlooking FDR Drive and the East River, Rockefeller University's new 180,000-square-foot laboratory building spans almost three and a half city blocks.
Above A Tekla model of the three and a half block expansion facing south.

In all, the David Rockefeller River Campus has added two acres, four buildings, expansive laboratory space, landscaping and beautiful East River views to Rockefeller University's existing 14-acre campus. Two curvilinear glass pavilions—one housing dining facilities and the other for offices—emerge from the gardens that cover two levels of labs below. The structure's long, slender form is accented by horizontal brise-soleil that shield the glass curtain wall, best viewed by Roosevelt Island's shoreline on the East River.

The floor-to-ceiling glass provides a great view of the River while carefully calibrated ceiling heights enable daylight to enter deep into the interior where automated roller blinds shield the scientists from glare.

Although the zoning of the University's land would have permitted a more vertical solution, the architect opted for a stretched-out, horizontal design for optimized research collaboration and flexibility with future laboratory changes and needs. The layout consists of two open floor plans, approximately 740 feet long. They are divided by a lounge space for informal meetings and coffee breaks to encourage interaction amongst researchers.

For specialized equipment requiring enclosed rooms, those are positioned along the wall adjacent to the existing campus with the scientists' offices reserved for the prime real estate facing the water. Meanwhile, a middle zone with roughly 90-foot-deep floor plates are used for lab benches. Under the raised floor sits the extensive power, data and gas infrastructure required of a 21st century laboratory. The casework and floor system are designed on a 2-foot-by-2-foot grid for a readily reconfigurable, "plug and play" setting.

While the new addition is primarily used as laboratory space, the University has added a health and wellness center and an interactive conference center with a glass facade facing a broad lawn.

As noted, minimizing vibration was a major issue for the world-class laboratory. With its long spans, the building was particularly vulnerable as issues like rumbling vehicles along the highway and indoor foot traffic could easily impact sensitive equipment and skew research results.

"The rules of thumb frequently employed for vibration analysis were not going to be adequate," relates Lin. "We approached the design by performing detailed dynamic analyses of the overall structure and tuned the sizes to satisfy the vibration limits required by the laboratory."

The long-span structure also presented a thermal movement issue. Addressing this involved ensuring a complete load path for thermal and lateral loads which consists of a 1,000-foot-long diaphragm resisted in the short direction at four middle points. "A com-

prehensive thermal analysis was performed to ensure no excessive stress induced in structural components," she explains. "The two shorter Y columns at the northern end are released from diaphragm constraints via application of a spherical sliding pad."

Thornton Tomasetti also developed a special drag member using plates welded to the top of steel beam/girder to eliminate conflict and minimize the connections.

In addition, the team faced a few challenges in working with the west-side foundation, which was on the rock adjacent to an existing schist wall. Close and extensive collaboration with the Turner and subconsultants on-site solved issues such as higher rock elevation, overlapping with the Schist wall, and circumventing conflict with existing underground utilities and fixtures.

Lending some perspective on the magnitude of this project, Thornton Tomasetti Senior Structural Engineer Thomas McLane, P.E., says that before the steel could be moved and put into place, the initiative involved years of designing and thousands of shop drawings requiring careful review. "You don't see too many projects of the same scale with Y columns, cantilever diagrams, and modular construction," he explains. In terms of the prefabrication, module transportation and on-site erection, the team describes the project as a Herculean effort.

Bargmann echoes this sentiment: "Necessity is the mother of invention. This was the only way to make it happen in a safe, cost-effective way." And ultimately, exemplary projects don't happen without enthusiastic clients. "The university should be congratulated for having the vision," he says. Recognizing the project's most innovative building and design, the Society of American Registered Architects granted it a 2019 Nation Design Merit Award.

Clockwise from top The expanded campus as seen from the East River. Offices and common spaces feature beautiful views of the river and the Queensboro Bridge. Extensive power, data and gas systems under the raised floor meet the lab's current and future infrastructure needs.

ROCKEFELLER UNIVERSITY

Location: **Rockefeller University, New York, NY**
Owner: **Rockefeller University**, *New York, NY*
Architect: **Rafael Viñoly Architects**, *New York, NY*
Structural Engineer: **Thornton Tomasetti**, *New York, NY*
Mechanical Engineer: **BR+A Consulting Engineers**, *New York, NY*
Construction Manager: **Turner Construction**, *New York, NY*
Construction Consultant: **Lehrer**, *New York, NY*
Curtain Wall Consultant: **Entuitive**, *New York, NY*
Structural Steel Fabricator: **Banker Steel**, *South Plainfield, NJ*
Structural Steel Erector: **New York City Constructors**, *New York, NY*
Miscellaneous Iron Fabricators and Erectors: **FMB Inc.**, *Harrison, NJ*; **Empire City Iron Works**, *Long Island City, NY*
Architectural Metal Fabricator and Erector: **David Shuldiner**, *Brooklyn, NY* (trellis and handrails)
Ornamental Metal Fabricator and Erector: **Champion Metal & Glass**, *Hauppauge, NY*
Curtain Wall Fabricator: **Oldcastle Building Envelope** (Levels 1 and 2), *Hauppauge, NY*; **Sentech Architectural Systems** (Level 3), *Austin, TX*
Curtain Wall Erector: **The Jobin Organization**, *Hauppauge, NY*
Metal Deck Erector: **New York City Constructors**, *New York, NY*

The Shed as seen from the adjacent High Line.

The Shed at Hudson Yards

With a broad brief for a cultural facility the DSR/Rockwell team enlisted top-notch collaborators to produce a muscular, fine-tuned kinetic structure. Its steel-ETFE combination combines high performance and striking aesthetics.

OUTSIDE THE HUDSON YARDS CONTEXT, the name The Shed sounds informal, practical, and auxiliary. Sheds customarily serve larger buildings—storing tools and materials, providing workspace—and initial plans for a "culture shed" within the Yards could be read as implying that the arts were an afterthought. After city officials decided to repurpose the intended West Side Stadium/2012 Olympics site as a multiuse district, recalls Robert Katchur, principal at Diller Scofidio + Renfro (DSR) and project architect on the Shed, "they knew that to draw a full neighborhood, they would need a cultural component, but they didn't know what it was." Yet the Shed, a response to the city's RFP steered by architects rather than developers, flips the script and seizes the spotlight: though arguably an appendage to the 15 Hudson Yards tower from the commercial perspective, the Shed became an instant icon when it opened in April 2019.

The Shed is dedicated to experimentation and high-culture-meets-low hybridization in the visual and performing arts, and its profile is appropriately novel as well. Its 120-foot-tall shell, a hard/soft textural combination featuring translucent ethylene tetrafluoroethylene (ETFE) cladding on a mobile structural-steel diagrid frame—rolling on six assemblies of 6-foot-long steel bogies, either to enclose a 17,000-square-foot performance space (The McCourt) or to expose the same area as a 20,000-square-foot open plaza—has no precedents in New York. In both the eye-catching kinetic component and its harbor, the fixed Bloomberg Building, which includes its own fine-tuned operable features, the Shed offers a tangible expression of the flexibility its leaders intend to foster in new artworks.

The Shed's shapeshifting form stems partially from the anomalous conditions of its planning, Katchur observes. Since the Yards district was conceived before the 2007-08 financial collapse but designed after it, when one developer had backed away and arts endowments were at a low ebb, the Shed arose in a kind of organizational void. "We were playing architect, client, and financier for a while," Katchur recalls, with encouragement from city development official (now Shed chairman) Dan Doctoroff and then-Mayor Michael Bloomberg, as well as a 2010 National Endowment for the Arts grant to Hudson Yards Development Corporation, but with no major cultural institutions stepping up to occupy the city-owned site. The absence of a conventional client afforded the partnership of DSR and Rockwell Group considerable freedom to develop a performance-driven, infrastructure-based parti. Elizabeth Diller, Katchur, and others recurrently describe the organizing principle as "all muscle, no fat."

Diller and David Rockwell teamed up to answer the city's RFP with a proposal that responded to scaling-up trends among worldwide cultural centers, Katchur says, as well as the city's interest in a space large enough to host major events like Fashion Week. Asking open-ended questions—"How can you make a building that will transform itself and be able to be what it needs to be for the moment, when you can't really picture what the next 15 or 25 years are going to bring?" and "What role would it fulfill in a city that already has 1,200 cultural institutions?"—the team crafted both a design and a business plan.

In the schematic-design stage, the architects also asked decision-makers and technical personnel from other institutions about their own experiences. Drawing on existing facilities' input, DSR based the Shed's details and proportions on operational concerns. The McCourt facade's vertical lift doors are large enough for trucks to enter from the plaza for direct loading onto the stage, a feature that also greatly expands fire egress capabilities, notes senior principal Scott Lomax of Thornton Tomasetti (TT). TT's engineers are experienced with arenas and convention centers, which also rely on broad trusses to create large column-free spaces; the Shed structure, with its stiff external frame plus interior trusses and secondary members, can support 120 tons of rigging above the performance spaces, with the entire ceiling available as an occupiable theatrical deck.

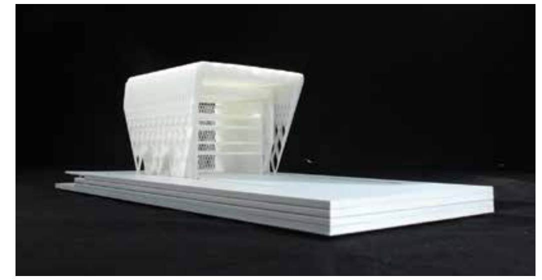
Strength and flexibility are not limited to the McCourt. The eight-story fixed building stacks two double-height gallery areas on levels 2 and 4, topped by the Kenneth C. Griffin Theater on level 6, and the Tisch Skylights and Lab on the top floor. The two gallery levels have folding Bator doors, which when retracted connect space to the McCourt that can add raked balcony seating, expanding the main space's capacity to 3,000; opening Level 2's adjacent gallery expands the McCourt's area to nearly 30,000 square feet. Castellated beams allow 100-foot clear spans in the double-height galleries; vibration-isolation slabs

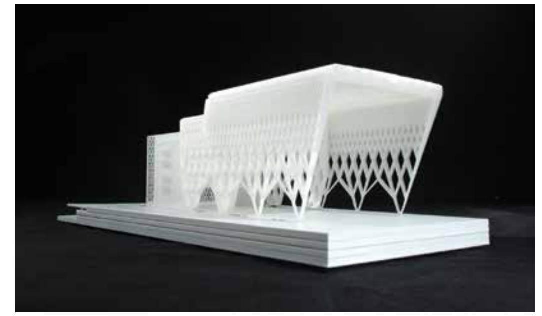
increase these spaces' acoustic and programmatic autonomy, and strong points in the floors and ceilings allow construction of thin cantilevered walls to create more intimate spaces. While the McCourt shell's operability is the Shed's signature feature, the entire building is engineered for reconfiguration.

A key decision at the schematic-design stage, Lomax reports, was that "we would like to express the structure, not have a structure that would then be hidden by cladding." The movable shell is a three-sided box (north and south walls and an east facade) "acting like a portal frame, very similar to a gantry crane"; the diagrid's acute angles show how the structure achieves lateral stability as the vertical members carry gravity loads. The main vertical and diagonal elements are composed of curved and doubly-curved steel plates in a monocoque design, he notes, with crisp edges and flat, smooth surfaces. "It's basically a trapezoidal section," Lomax continues, "with the exception of the nodes, built up with plate thicknesses ranging from 5/8 of an inch to about two inches. The balance of those plate thicknesses is partly the engineering demand: obviously, it needs to stand up [and] have the right amount of stiffness, and it's a balance between strength and stiffness ... but part of it was also driven by a deep understanding of the fabrication process."

The steel fabricator, Lomax notes, chosen after the team compared three test mockups of a challenging full-scale node, was closely involved with the design team in determining measures that would safeguard the design vision without soaring expenses. "It's very high-end steel work," he says; "it's exposed plate work. It does come with a premium—it's not the same as doing standard conventional plate work—but it doesn't mean that you cannot still control the economy of that process." One risk with monocoque designs, he explains, is "you go so thin on the external plate, and then you have a welding behind it, that sometimes you see the effect of that welding; it's called the hungry-horse effect, where you see that ribbing." Conferring closely within the team about procedures and dimensions, "we've reduced welding by not having internal stiffeners, or reduced the number of internal stiffeners, and we've made their life easier, because during the fabrication process they do not need to worry so much about distortion during the welding process." The idea "that the lightest structure is always the cheapest structure," Lomax says, is a misconception; "by understanding the craftsmanship of how something is going to be built, and understanding what a fabricator needs to go through to control that process, we can actually add material, reduce complexity, and get a better-quality product."

The shell's four single-axle and two double-axle bogies are made of 8-inch-thick plates totaling 25 tons of steel, supporting the whole mobile shell on eight points. (In detailed negotiations with the Department of Buildings, Lomax reports, TT demonstrated that "any one of those supports could deflect, and it wouldn't impact the building's ability to stand up.") The bogies roll on MRS 221 rail, the largest gauge commercially available, assembled in transportable-length pieces and thermite-welded onsite into two continuous 273-foot tracks. "The whole idea was to have the plaza as clean as we possibly could," Lomax notes, "which meant that up on the top of the fixed building we have these rack-and-pinion drive systems, and on those drives runs this rack and pinion that is connected to the trusses up in the roof." The sled drive that moves the shell comprises twelve 15-horsepower motors (the resulting 180-hp system has been loosely compared to a 134-hp Toyota Prius engine, though its output is closer to that of a Jeep Compass or a Mazda 6, a few horsepower below a Mini Cooper). A centering device atop the assembly absorbs horizontal stresses, helping stabilize the system under wind loads.





Clockwise from top A concept model of The Shed in closed (top) and open (bottom) positions. The exposed structural steel awaiting installation of the venue's ETFE facade. A structural section of the steel at the fabrication plant, with person for scale.

Opening spread and this page: Iwan Baan

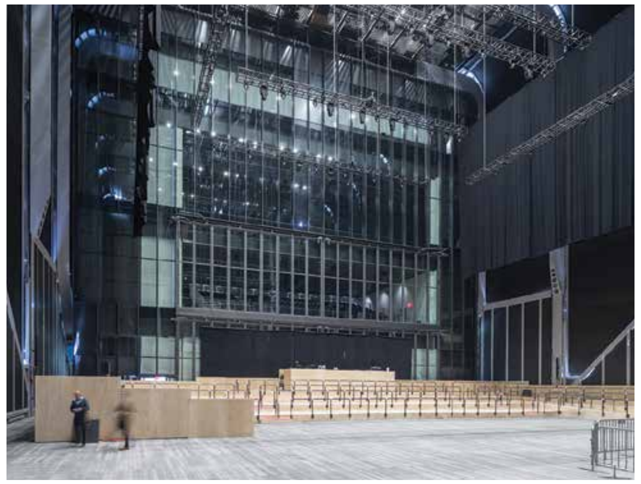
This page photography: Iwan Baan; models: © Diller Scofidio + Renfro; following spread, clockwise from top: Iwan Baan, Iwan Baan, Timothy Schenck

ETFE cladding, Katchur says, was a logical selection as a thermal insulator with 1/100th the weight of glass. Considering "the movements that we would induce by making a moving building," he says, "if you did that out of glass, you would be really wrestling with the size of the joints and the way in which the components were going to fit together." Panels of ETFE (up to 70 feet long, some of the largest ever manufactured, arranged as 146 three-layer cushions and two with four layers) clip onto structural members with aluminum-framed extrusions and are inflated by four air-supply units with variable-speed main and backup fans; sensors adjust the air pressure to weather conditions. The shell's distinctive soft-white tone results from variation in the layers' colors: a print pattern for the top layer, a white middle layer with 29% opacity, and a transparent bottom layer.

ETFE, Katchur adds, allowed "a terrific embodied-energy savings, in a sense that it performs equitably to glass" thermally while sparing the load burden. "It's impossible for us to have an entirely reliable statistic without designing a glass version of this thing, but I would wager that we probably saved 25% of this raw steel tonnage on the project by selecting ETFE."

The gains in lightness and thermal control with ETFE come with an acoustic downside. To help keep street noise out and music in, the team specified blackout shades massive enough to absorb sound as well as darken the interior. They also borrowed from sailing technology, applying an acoustic mass onto a carbon fiber sail. "It could roll up onto a mandrel motor, much like you'd find in the marine world for a jib on a sailboat," says Katchur. "A furling motor is inside of a steel tube, and then the shade wraps around it, so we have a 3/4-inch ABS [acrylonitrile butadiene styrene] plastic hat attached to a carbon-fiber tail, connected by about 5 or 6 pounds a square foot of acoustic mat."

The Shed is too new a typology for most local fire and safety codes to apply. "There are not codes written for moving buildings," Katchur notes; "you have cranes' and derricks' and bridges' codes, and



you have building codes .... How do you fire-rate a wheel?" The team "developed a great working relationship with the City of New York," he says, hashing out new applicable standards in detailed negotiations. Since ETFE, although fire-retardant, would disappear quickly in the event of a fire a performance based design (PBD) approach was developed with the Department of Buildings. "This approach combined the inherent redundancy of the structure with detailed fire modeling and recognizing that, sans ETFE, we have an outdoor structure," says Lomax. "Using this methodology we determined that the fire protection could be simplified with intumescent coating only applied up to the door headers and spray-on protection in the mechanical deck. This was a significant savings in terms of time and money and preserved the appearance of the exposed steel diagrids."

As the Shed—its official title trimmed after Poots came on board and noted that the word "culture" seemed redundant—evolves to define itself in mission and form, perhaps its punchy name works best as a verb. Musicians refer to solitary practice, learning material and developing chops, as "woodshedding" or simply "shedding." This building—perhaps the one part of Hudson Yards that invites the whole public in, the one with a chance to overcome the wider project's cycle of hype and blowback—sheds preconceptions on multiple levels (programmatic, structural, material, civic) and gives New Yorkers more than another cultural playground. It's built to give us things to think about.

THE SHED AT HUDSON YARDS

Location: **545 W 30th St, New York, NY**
Owner: **The Shed**, *New York, NY*
Lead Architect: **Diller Scofidio + Renfro**, *New York, NY*
Collaborating Architect: **Rockwell Group**, *New York, NY*
Owner's Representative: **Levien & Company**, *New York, NY*
Construction Manager: **Sciame Construction, LLC**, *New York, NY*
Structural Design, Facade Engineering, and Kinetic Engineering Services: **Thornton Tomasetti**, *New York, NY*
MEP and Fire Protection Consultant: **Jaros, Baum & Bolles**, *New York, NY*
Energy Modeling Consultant: **Vidaris**, *New York, NY*
ETFE Fabricator: **Vector Foiltec**, *Bremen, Germany*
Structural Steel Erector: **Stonebridge Steel Erection**, *South Plainfield, NJ*
Miscellaneous Iron Fabricator and Erector: **F.M.B. Inc.**, Harrison, NJ
Architectural and Ornamental Fabricator and Erector: **Cortina Glass LLC**, *Clinton, NJ*
Curtain Wall Fabricators: **Cortina Glass LLC**, *Clinton, NJ*; **Vector Foiltec**, *Bremen, Germany*
Curtain Wall Erector: **Cortina Glass LLC**, *Clinton, NJ*
Metal Deck Erector: **Stonebridge Steel Erection**, *South Plainfield, NJ*

Six-foot-tall, double-axle bogie wheels enable The Shed, designed by Diller Scofidio + Renfro with Rockwell Group, to open or close its six-story structure depending on event needs. **Facing** The Shed's versatile performance space.

The bridge as seen from Westchester County.

Governor Mario M. Cuomo Bridge

The original Tappan Zee Bridge, revolutionary in its day, was well past the end of its operational life. Its challenging site called for structural creativity, a modern cable-stayed design, and careful environmental precautions.

TRANSPORTATION PLANNERS WOULD NOT ORDINARILY, all other factors being equal, select the space between South Nyack and Tarrytown as the site for a bridge across the Hudson. It's 3.1 miles across, the river's second widest point, with a structurally challenging topography carved by glacial recession tens of thousands of years ago. Bedrock is some 220-270 feet below mean sea level at midriver; in a pre-glacial river channel near the western shore, the bedrock lies 700 feet below. There are, to put it mildly, easier places to build.

The chief reason the 1955-vintage Tappan Zee Bridge (TZB) was financial. It was the closest site to the city outside a 25-mile radius from the Statue of Liberty; by law, any bridge within that area would be within the Port Authority's jurisdiction, meaning New York and New Jersey would split the toll revenue. Gov. Thomas Dewey preferred to direct that stream toward the newly created authority for the New York Thruway. Hence, drivers got a bridge that sent them over the water for three miles but kept the tolls in the state.

Engineered with ingenuity and frugality during a Korean War-related materials shortage, the TZB used a military structural technology known as Phoenix caissons, a series of eight buoyant concrete breakwaters set in riverbed rather than on rock, the brainchild of chief engineer Emil Praeger. The TZB was planned to last 50 years and was showing its age well before the 2007 collapse of Minnesota's I-35W bridge focused national attention on decaying infrastructure. Originally designed to carry fewer than 40,000 vehicles per day, it was averaging 138,000 by the early 2000s (roughly the same ca-

pacity as the deadly I-35W bridge), and its nonredundant design meant that failure of any member could put the entire bridge in danger. Construction attorney Barry LePatner, author of the infrastructure-hazards exposé *Too Big to Fall* (Foster Publishing, 2010), referred to the TZB as the "scary of scaries." With its narrow lanes and no shoulders, by 2007 it also had over twice the average collision rate per vehicle mile as the rest of the Thruway system.

Its replacement, the twin-span Gov. Mario M. Cuomo Bridge, represents a different kind of innovation. It couldn't have moved closer to the city—the site is effectively locked in by approaching roads and regional development since the fifties—but its design and construction reflect the dramatic progress in the field and the evolution in civic priorities since the Eisenhower era. Each span has four lanes for general traffic, a breakdown/emergency shoulder, and a dedicated bus lane; the westbound (northern) span also gives pedestrians and cyclists a 12-foot shared-use path with six overlooks offering river views.

Like many striking bridges built in recent years (including, locally, the new Kosciuszko span featured in *Metals in Construction*'s Spring 19 issue), the Cuomo Bridge uses a cable-stayed design, once arresting, now nearly as familiar as it is economical. The project's innovations are in realms beyond the striking aesthetics: ease and pace of construction, Intelligent Transportation Systems (ITS), structural health monitoring (SHM), and attention to long-term environmental effects. The site's multiple challenges have once again been mothers of invention.

"The iconic Governor Mario M. Cuomo Bridge is a state-of-the-art transportation facility that will meet the needs of Hudson Valley residents and visitors for the next century and beyond," comments project director Jamey Barbas of the Thruway Authority. "This landmark crossing symbolizes New York's resolute commitment to transforming and modernizing its infrastructure." Fast-tracked as a High Priority Project by the Obama administration, it has carried full bidirectional traffic since September 2018.

For a project of this scale, after issuing an RFP in 2012, the New York State Thruway Authority chose a design-build strategy and a multidisciplinary consortium, Tappan Zee Constructors (TZC), comprising engineering and construction firms Fluor, American Bridge, Granite Construction Northeast, and Traylor Brothers, along with design firms HDR, Buckland & Taylor (now part of COWI), URS (part of AECOM), and GZA. (The TZC project team collectively contributed some of the information for this article through the Thruway Authority in lieu of personal interviews.) It is one of the nation's largest design-build transportation projects, marshaling this method's efficiencies to overcome the site's unique challenges.

The Hudson Valley's geology called for extensive geotechnical studies, including more than six dozen soil borings of the riverbed, revealing layers of clay, silt, sand, and glacial till covering bedrock below the river, with a deep valley of clay under the western half. This led the designers to bypass buoyant caissons and select a structural system based on piles consisting of steel tubes filled with steel-reinforced concrete; the process used over 30,000 tons of rebar. Most piles rest on bedrock, while others (longer and with greater surface area) use the friction of the deep clay to create supportive tension, which TZC estimates will withstand at least 100 years of load-bearing.

All photos: New York State Thruway Authority

Above Traffic crosses the Governor Mario M. Cuomo Bridge in March 2019. **Facing page** Barge-based cranes raise the final sections of main span steel in September 2017.

The piles of the main span above the deep-water navigation channel are unified in pile caps, the largest of which is longer than a football field, consolidating the strength of scores of piles into a single structure. Smaller pile caps support the approach spans on either side of the main span. In 2013, TZC performed load testing with massive weights, up to 7 million pounds, the equivalent of about 2,000 cars, ensuring that the pile system had adequate carrying capacity before construction began. Lowering the huge caps precisely and in sync required a computer-guided jack system, factoring in the river's tidal flow.

The eastbound span is 87 feet wide; the lane for self-powered users makes its westbound counterpart 96 feet wide. Eight 419-foot concrete towers stand at five-degree angles from vertical, leaning outward to create a distinctive aerial profile and bearing "192 stay cables that would stretch 14 miles if laid end-to-end," according to the TZC team. The cable-stayed area is 2,230 feet long, and the cables support a total of 74 million pounds of steel and concrete.

TZC used modular construction procedures, preparing major segments of the foundations, roadway, and superstructure safely off-site on land, including structural steel assemblies up to 410 feet long. The largest of the project's cranes had a 328-foot lifting arm capable of raising loads up to 1,900 tons. TZC purchased this huge device, originally built for use on the San Francisco-Oakland Bay Bridge and named the *Left Coast Lifter*, and moved it 6,000 miles from California via the Panama Canal, renaming it *I Lift NY* en route before it reached New York Harbor in January 2014. Months of testing and customization prepared it for service on the Hudson that April, raising nearly 100,000 tons of structural steel (including 140 girder assemblies and four main span cross-beams) as well as precast concrete foundations, substructure, and 120 road deck panels. After the first span opened in August 2017, *I Lift NY* also saw action removing sections of the old TZB; its final operation in May 2019 was to remove the old east anchor span after its controlled demolition that January, part of the process of disassembling the obsolete bridge for recycling and reuse at other locations across New York State. TZC credits *I Lift NY* with shortening construction time from original estimates by months and saving millions of dollars on the project.

Today's bridges take active roles in guiding traffic, not just carrying it. The Cuomo Bridge's ITS, a complex of sensors and communication channels, monitors conditions on the twin spans and automatically informs Thruway Authority staff of disruptions. Information about collisions, closed lanes, winter pavement conditions, or other sources of trouble goes out to motorists through electronic signs on the bridge and landings, directing drivers away from hazards and reducing risky last-second lane shifts.

The ITS also connects the Thruway Authority with law enforcement, first responders, and tow-truck operators. As a component of the authority's wider traffic-control network, the ITS helps synchronize both preventive maintenance and repair work, reducing disruptions.

Information technology also generates useful data about the bridge itself. Over 300 sensors in the SHM system—a complex of inclinometers, ultrasonic distance censors, fiber optic gauges, 3D accelerometers, and GPS instruments – measure corrosion, temperatures, climatic conditions, vehicle weights and counts, cable strain, tower sway, and expansion joints' reactions to load patterns and vibration. Gantry-based automatic tolling, by either EZPass or photo/mail systems, spares drivers a slowdown to fish for cash. The roadway lighting comprises dark-sky-compliant LED fixtures, cutting light pollution in the scenic Hudson Valley while saving an estimated 75 percent in energy costs over older lighting technology.

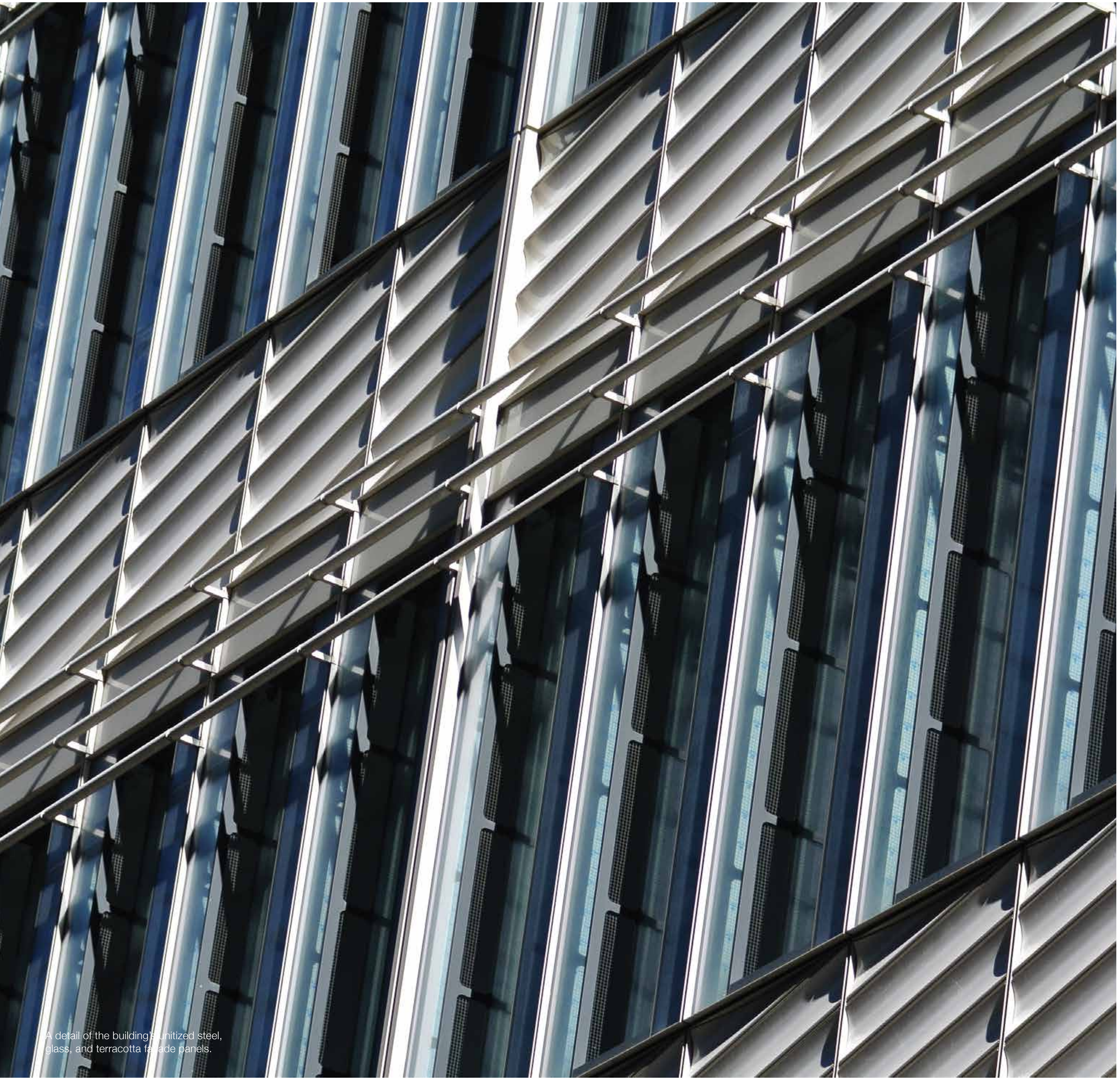
In a region with history of environmental damage and remediation (the bridge is downriver from General Electric's dredging operations for polychlorinated biphenyls), the impact of construction on local ecosystems has been a key priority. Construction equipment met strict Environmental Protection Agency emissions standards, using ultra-low-sulfur diesel fuel and tailpipe particulate filters. To control underwater noise and vibration during pile driving, the crew created a bubble-curtain system, sliding aluminum rings over pilings and pumping pressurized air through the rings to create a cloud of bubbles that absorbed the energy of impact, reshaping pressure waves, lowering the noise level by more than 10 decibels, and deterring fish from swimming into the hazardous area. Dredging was timed to avoid interrupting spawning and migration seasons. The Thruway Authority consulted with scientists from the NY Harbor Foundation's Billion Oyster Project and placed more than 400 oyster-reef structures in a five-acre zone near the bridge to support restoration of this ecologically beneficial filter-feeding species. A nesting box atop one bridge tower has attracted peregrine falcons, another important species whose prey includes pigeons; since pigeon waste is acidic enough to corrode steel and concrete, the falcons' deterrent presence is a win/win for humans and birds.

One substantive critique of the bridge addresses a decision made on a political level, not by architects or engineers: one of the 21st century's largest projects chiefly accommodates the dominant transportation mode of the 20th. Public transit on the bridge is limited to bus service; both a planned bus-rapid-transit line and the pedestrian/bike path have been delayed. Early studies, including 2011 Ove Arup reports on cost estimates and feasible alternatives prepared for the state Department of Transportation, the Thruway Authority, and the Metropolitan Transit Authority/Metro-North, evaluated structural options that would include Rockland-Westchester commuter rail; the February 2014 final recommendations by the bridge's Mass Transit Task Force notes that commuter and light rail were considered but "included as long-term recommendations." TZC reports that the bridge "was built with the structural capacity to handle light/commuter rail in the future. The future rail line would be located between the two spans." This isn't the first or last time financial concerns led to a decision that delayed a more future-oriented design component. But the most intelligent transport systems in the long run, many environmentalists, urbanists, and economists maintain, might not involve automobiles at all. While Hudson Valley residents enjoy driving across their new bridge, they may also dream of the day it offers them other transportation options as well.

GOVERNOR MARIO M. CUOMO BRIDGE

Location: **South Nyack (Rockland County) and Tarrytown (Westchester County), New York**
Client: **New York State Thruway Authority**, *Albany, NY*
Architects and Engineers: **Tappan Zee Constructors, LLC**, *Tarrytown, NY*
Lead Designer: **HDR**, *Omaha, NE*
Structural Engineer: **HDR; COWI**, *Lyngby, Denmark*
Geotechnical Engineers: **GZA**, *Norwood, MA*; **URS**, *San Francisco, CA*
General Contractor and Construction Manager: **Tappan Zee Constructors, LLC**, *Tarrytown, NY*
Construction Manager: **Tappan Zee Constructors, LLC**, *Tarrytown, NY*
Structural Steel Fabricator: **Hirschfeld**, *San Angelo, TX*; **High Steel**, *Lancaster, PA*; **Canam**, *Saint-Georges, Québec*
Structural Steel Erector: **Tappan Zee Constructors, LLC**, *Tarrytown, NY*
Miscellaneous Iron Fabricators: **L&M**, *Bath, PA*; **Upstate Steel**, *Buffalo, NY*; **County Fabricators**, *Pleasantville, NY*
Miscellaneous Iron Erectors: **Tappan Zee Constructors, LLC**, *Tarrytown, NY*
Architectural Metal Fabricator and Erector: **UAP**, *New York, NY*; **EW Howell**, *New York, NY*

The Hudson River's main navigation channel is clear following the dismantling of the old bridge's main span.



A detail of the building's unitized steel, glass, and terracotta façade panels.

One Vanderbilt

Despite its scale, complexity, challenging site, and high-performance features, the 67-story project is moving ahead of schedule and under budget. Partners on the project attribute this achievement to tight coordination, a steel-first sequence, and an all-star design and construction team.

NICK DAVIS LEADS A CREW working on high floors at One Vanderbilt. With deep family roots in Ironworkers Local 580, he has the craft of construction in his DNA; working for Permasteelisa's installation component, Tower, he made foreman in just five years. After observing a welder perched on a perilously cantilevered hydraulic lift 57 stories above 42nd Street, he supervises two journeymen and an apprentice in guiding curtain-wall units into place. These 1,750-pound unitized panels of steel, glass, and terracotta are brought by elevator to the floor below, then hoisted up one last level by crane, with an 180-degree rotary flip on a count of three right before placement, so the cable-attachment points put tension on metal rather than the ornamental terracotta spandrels. "We can't send them out how we usually would, face down," Davis notes; "So that's face-up, so now we have to send them out and actually rotate them in air … It's an extra step on every panel."

Moving patiently between tasks, getting the details right efficiently, and taking the time to explain them to visitors, Davis typifies the personnel working on this project: on top of his game, at ease with the complexities of the job. His and his colleagues' expertise is part of the reason One Vanderbilt is ahead of its projected schedule and under budget. (Demolition at the site began in 2015, the groundbreaking occurred in October 2016, and the topping-out date was originally set for January 10, 2020; the team reached that milestone on September 19, 2019, and estimates for the temporary certificate of occupancy now run from August to October 2020.) As the key factor making this pace possible, says Edward DePaola, president and CEO of Severud Associates, "I think it's a combination of the right design and construction team," and "they've got to put the best people on it…. It's real dedication and the ability to think and perform way beyond what's normal."

Coordinated design and construction planning, DePaola points out, sped this project from the outset. As he and others noted at a panel discussion about One Vanderbilt for the American Institute of Steel Construction (AISC) on September 26, this was neither a design-bid-build nor a design-bid project, but what he calls "just an enhanced design with detailing."

"The project wasn't simply fast tracked; it was 'faster' tracked," said KPF's Technical Director, Andrew Cleary. Since the Project schedule required early bid sets to be issued well in advance of a more typical fast track timeline, the design team worked with Tishman and detailers from the major trades during the early design phases to expedite development of a coordinated parametric model. "If we identified and resolved one conflict before construction began, we were able to justify the price of the detailers being engaged pre-award." Cleary noted. "If we resolved two conflicts, we were already ahead of the game. The fact that a project of this complexity has repeatedly achieved all the major construction milestones on time is a clear testament to the tight collaboration that the Design and Construction Teams forged from the outset of the design process."

General contractor Tishman hired independent detailers for each trade before subcontractors were on board, DePaola recalls: "We had a structural steel Tekla modeler working for Tishman, actually building the Tekla model as we were designing…. We supplied only up to Revit; we gave them Revit information; they did Tekla, which is much more accurate than Revit as it relates to exact beam lengths [and] ability to put all the bolts and welds right into the model." When Banker Steel and other contractors came on board, the Tekla model saved them all months of work. "Steel was going to be fabricated," DePaola says, "so that [the other subs] had to be thinking of things a year in advance of when they normally would, and everybody pulled their weight."

This advantage required unprecedented early-phase coordination, beyond what many teams could handle. Mechanical engineer Christopher Horch of Jaros Baum & Bolles (JBB) recalls the extensive revisions addressing intertwined architectural and business concerns. As a spec developer building,

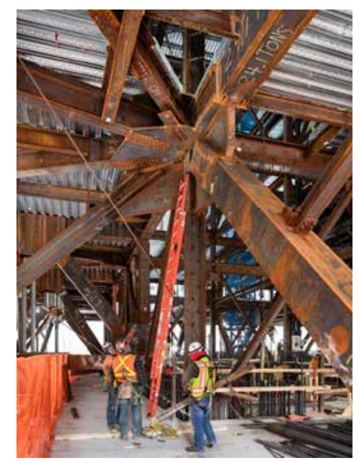
One Vanderbilt needed extreme flexibility from the MEP standpoint, depending on which tenants would sign on, now or in the future; as a major tower located next to Grand Central Station, it needed to preserve sightlines and street-level plaza space. The electrical transformers are located alongside the large chiller plant and other major MEP systems on the 12th floor rather than at sidewalk level, and KPF designated a 5-foot plenum on the perimeter of mechanical floors (the fourth, fifth, and 12th), along with vertical intake/exhaust slots by Permasteelisa rather than conventional large gray louvers, so that these floors would visually read no differently than office floors by day or night. With all of those moves, square footage for MEP was squeezed.

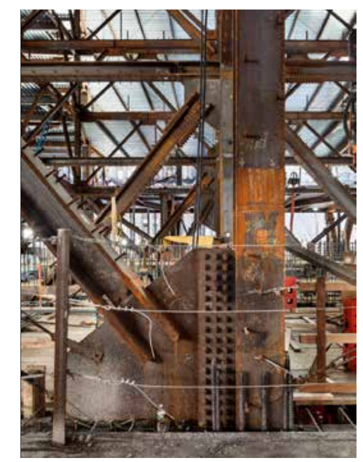
Consequently, Horch says, "during our schematic design phase, they were changing the building almost on an hourly basis," at one point increasing floor-to-floor height by 2 feet at the 12th floor. "It was a big change, but it was able to be absorbed, because we were only in DD [design documents], and those things get flushed out over time. If we had not done that level of detailing, we would not have caught it until construction, and it would have had a major impact on the schedule and cost." The efficient procedure also gave bidding contractors such confidence, he adds, that "the bids came back … within a few percentage points of each other on all trades from an MEP perspective, which is also unheard of."

"When Tishman put this out for bid, they gave them the Tekla model for the whole building," DePaola says, "with a handful of typical connections throughout the building, but with the bottom six levels detailed, and they said to the bidders, 'This is it, guys. If you can't do these details, if you're going to come back and say you want to change X, Y, and Z, you've got to tell us how much longer that's going to mean to your schedule, compared to if you took it exactly the way we gave it to you. And speak now or forever hold your peace.'" The contractors made the commitment, enduring weekly meetings for a year and a half, locking in details down to the level of coordinating structural steel and ductwork in elevator lobbies. "We were asking them to commit to that geometry when they were in DD, and most architects wouldn't even be thinking about the lobby elevators until near the end of construction documents."

Previous spread and installation sequence: courtesy Ornamental Metal Institute of New York; left: © Raimund Koch

Black-and-white photographs: © Liane Curtis; color photographs: Severud Associates Consulting Engineers, PC

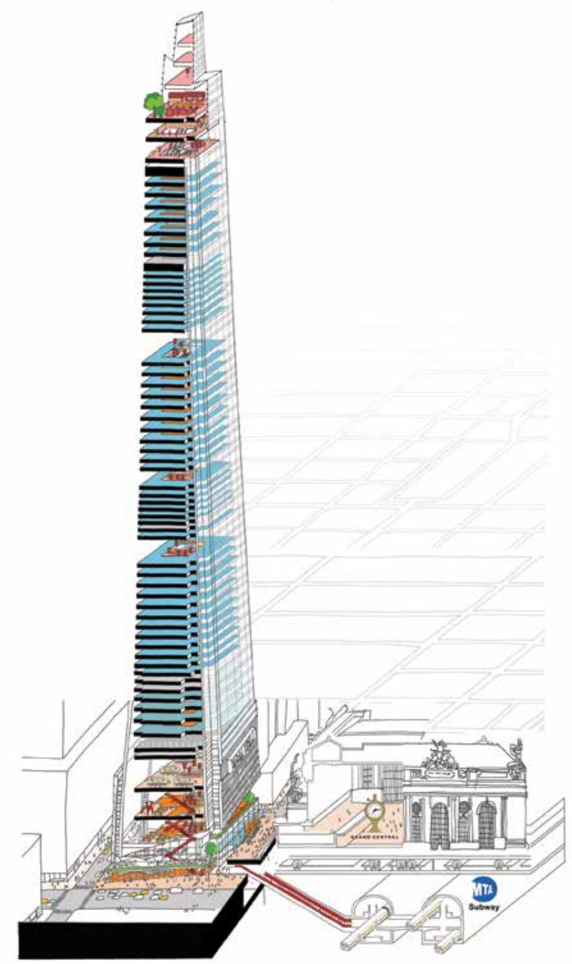




This page, clockwise from top An early morning panoramic view, facing west, of the building's mat foundation. Ironworkers prepare to install some of the building's structural steel members. Column splice at the podium transfer floor. The sixth-floor transfer truss node at the southeast corner of the core.
Facing page The installation sequence for each facade panel includes flipping it in mid-air to protect the terracotta element from the weight of the panel. The partially completed facade as seen from Vanderbilt Avenue.

One Vanderbilt is a hybrid building with a concrete core and a steel frame around its perimeter. It thus needed to solve the recurrent problem of steel and concrete components rising at different speeds. DePaola recalls other projects that had to give concrete contractors a head start on steel contractors, leading to scheduling challenges as well as structural ironworkers safety objections to working below another trade. Here, Severud drew on its experience with Philip Johnson and John Burgee's IDS Center in Minneapolis (1972), a pioneering project in steel-first construction, to erect steel ahead of rebar, interior and exterior formwork, and concrete shear walls. "We worked out a different type of form system, so that the inside is a climber and the outside is hand-set," DePaola recalls. "On this job Navillus did the concrete, and they were right there; we never slowed down. Everything worked like clockwork." The project's foundation work included a 4,200-cubic-yard single continuous pour in February 2017, a 27-hour operation that marked the largest such pour in the city's history—"like somebody coordinated a ballet," DePaola told the AISC audience.

One Vanderbilt will be New York's fourth highest building (after One World Trade and two ultrathin residential buildings under construction on 57th



Street). Its adjacency and underground connection to Grand Central make it the ultimate in transit-oriented development—particularly when the Long Island Rail Road enters the station under the East Side Access plan a few years from now—as well as a high-visibility emblem of the newly rezoned Midtown East commercial corridor. Though any commercial building on this scale attracts scrutiny over pedestrian traffic, shadows, and aesthetics, One Vanderbilt's design respects its Beaux Arts neighbor and its street-level neighborhood, forgoing maximum square footage in favor of a tapered form admitting light onto the street and the new car-free Vanderbilt Plaza, attaining a floor-area ratio of 30 (and realizing higher target rents on high floors to offset area sacrifices, based on view analyses from real-time parametric analyses and drone photographs; "once the leasing guys saw this," Cleary said, "you could hear the breath getting sucked out of the room"). The building looks to be a model of 21st-century integrated management as well as advanced thinking in design, sustainability, and habitability. When it opens next year, its managers won't be the only ones whose breath is taken away.

Editor's note: This is the first in a two-part series about One Vanderbilt's construction. The second part will appear upon the building's completion.

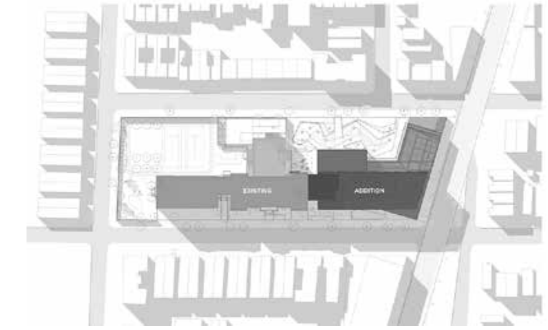
ONE VANDERBILT

Location: **1 Vanderbilt Ave, New York**
Owner and Developer: **SL Green Realty**, *New York, NY*
Architect: **Kohn Pedersen Fox Associates (KPF)**, *New York, NY*
Interior Architect: **Gensler**, *New York, NY*
Structural Engineer: **Severud Associates**, *New York, NY*
Mechanical Engineer: **Jaros Baum & Bolles (JBB)**, *New York, NY*
Civil Engineer: **Langan Engineering**, *New York, NY*
Development Manager: **Hines**, *New York, NY*
Construction Management and Modeling: **Tishman, an AECOM Company**, *New York, NY*
Curtain Wall Consultant: **Vidaris**, *New York, NY*
Structural Steel Fabricator: **Banker Steel Company**, *New York, NY*
Structural Steel Erector: **NYC Constructors**, *New York, NY*
Miscellaneous Iron Fabricators and Erectors: **Post Road Iron Works Inc.**, *Greenwich, CT*; **KKG Construction**, *Lake Success, NY*
Architectural Metal Fabricators and Erectors: **Coordinated Metals**, *Carlstadt, NJ*; **Vision Enterprise of Queens**, *Westbury, NY*
Curtain Wall Fabricator: **Permasteelisa Group**, *New York, NY*
Curtain Wall Erector: **Tower Installation**, *New York, NY*
Metal Deck Erector: **NYC Constructors**, *New York, NY*

Photographs this spread: © Raimund Koch; diagram: © KPF

One Vanderbilt's facade with Grand Central Terminal's crowning sculpture in the foreground.
Facing page from left The building as seen on the skyline next to the Chrysler Building. A site diagram of One Vanderbilt and its connection to Grand Central.

A 97,000-square-foot addition to the north of the original school building complements the scale, massing, and fenestration of the 1923 structure.

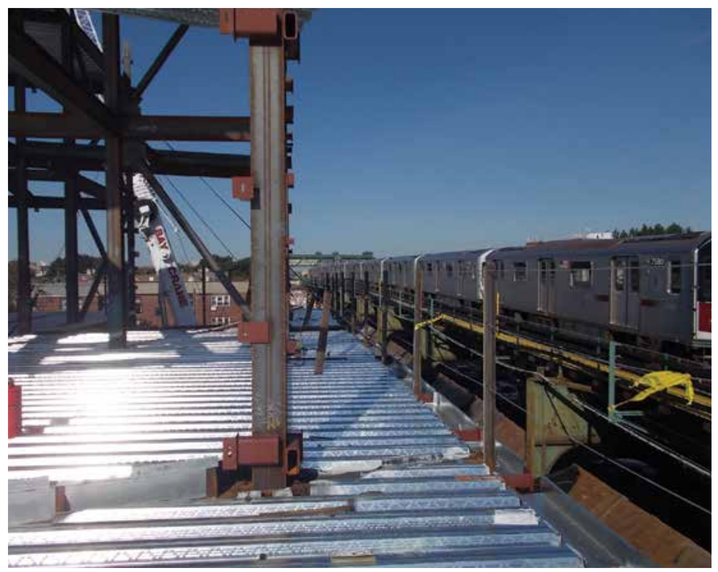


P.S. 19 Marino P. Jeantet School

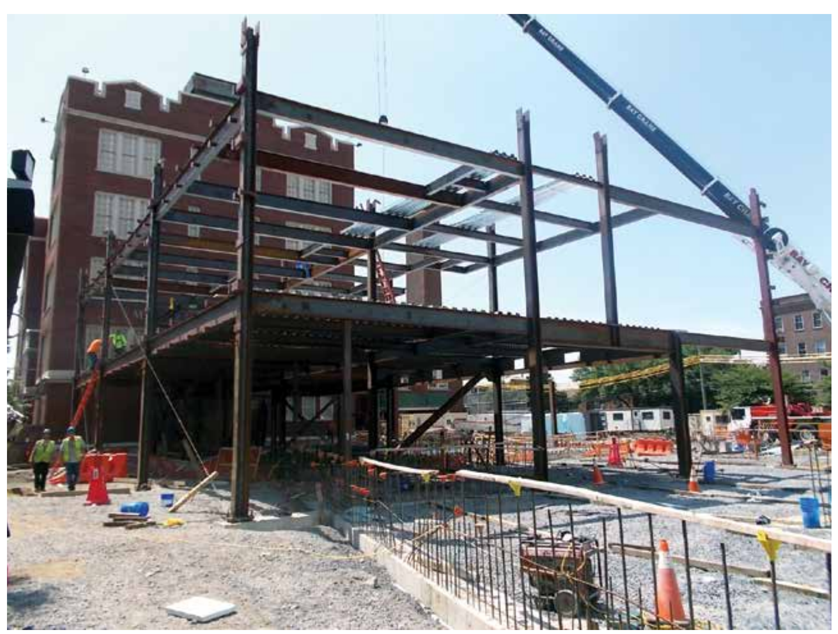
For one of New York's most overcrowded schools, MBB leveraged the flexibility of structural steel to create a 97,000-square-foot addition to house new classrooms, a gymnasium, and two cafeterias for nearly 2,000 students.

P.S. 19 Marino P. Jeantet School in Corona, Queens, had been overcrowded for decades when Murphy Burnham & Buttrick Architects (MBB) won a School Construction Authority contract in 2017 to double the square footage of the historic 1923 structure.

By September of 2018, the fast-tracked project was complete. Rather than try to expand the footprint of the existing Collegiate Gothic-style building, MBB designed an efficient and complementary structural steel addition, joining the two structures with a shared core. (In 2019, the architects modernized classrooms and upgraded systems in the 1923 building.) "You try to build as economically and quickly as possible and steel enabled us to do that," says Jeff Murphy, a founding partner of MBB. "Instead of having an extensive basement, we chose to do a small basement for some of the mechanicals, but by and large we built this slab on grade. It was really just steel going into footings on most of the building."



An adjacent train line made erecting the steel structure a challenge, requiring flagmen provided by MTA and specialized staging.



Previous spread: Frank Oudeman; this page: courtesy MBB

This page from top: Frank Oudeman; drawing courtesy MBB; following spread: Frank Oudeman

Right, from top Two long-span cafeterias on the ground floor receive daylight from a band of glazing that creates a friendlier street presence. Wood ceiling panels and a ceramic tile mural by Brooklyn artist Cheryl Monar add warmth to the lobby. The building section looking west.

The new five-story, 97,000-square-foot addition contains classrooms, cafeterias, a gymnasium, and instructional and health space, helping to disperse the school's 2,000 students and serving as an important community hub and social services provider. "One of the things that was pretty compelling about the project is that this part of Queens is in dire need of school seats," says Murphy. The elementary school was one of the worst and most visible victims of overcrowding—a result of the closure, demolition, and consolidation in the 1970s of nearly 100 public schools in New York City as the population dropped and the city's finances tanked. When enrollment began to climb again in the 1990s, the school construction budget couldn't keep up. When Murphy's team began its design process, P.S. 19 had been using dilapidated 20-year-old classroom trailers located on the former playground to accommodate the diverse student body.

In order to speed up construction of the new building, MBB chose a precast panelized facade clad in brick. Canted windows appear to match the scale and fenestration pattern of the 1923 building with the addition of exaggerated precast concrete frames. One of the biggest challenges of the project, according to Geoff Smith, an associate with structural engineer Silman, was the connection of the precast facade panels to the structure—the engineers had planned for them to hang column to column, bracing back to the slabs. But due to a mix-up with the manufacturer, the panels had to be braced back to the steel structure. "So the steel had to be reanalyzed for torsional [stress]," says Smith. In addition, the structure had to be oversized to support the weight of the panels' brick cladding.

But perhaps the most challenging constraint was the fact that the north elevation of the new building is adjacent to the elevated, rumbling 7 subway line along Roosevelt Avenue. This made erecting the steel structure a laborious process, says Murphy, requiring flagmen provided by MTA and specialized staging. "They had to have [steel members] on the street, ready to go up, but in between when trains were running," he adds. A robust acoustical treatment of northern elevation included a baffle wall and STC-rated windows, allowing students to see, but not hear, the passing trains. Murphy and his team then placed the most active programs to the north, such as the cafeterias, stairs, and open-air play roof. "One of the things that the teachers and staff were so delighted with is that we were able to make the noise go away," says Murphy.

The cafeteria in the old school building was cramped and poorly planned, so part of the brief for P.S. 19's addition was two generous, column-free dining rooms. The architects placed these on the

ground floor, adding a band of glazing that creates a friendlier and storefront-like interface with the busy neighborhood. A playground on the roof of the northernmost cafeteria has a steel frame enclosed with steel mesh. This area required the design team to perform vibration analysis because it cantilevers from the building below.

Three oversized steel stairs—on either end of the new building as well as in its center—were another major design element, helping to choreograph the 2,000 students through three lunch periods. "We ended up having to make the connection to the new building through a stair in the old building," says Murphy. "That switchover had to be done in a weekend. The new stair in the new building could be used right away as we decommissioned the stair in the old building."

Murphy's team brought warmth and cheer to the addition with pops of color for orientation, wood ceilings in the lobby and corridors, and wood-clad seating niches in hallways for studying and socializing. A bright mosaic mural in the lobby depicts nearby Flushing Meadows Corona Park, the site of the 1939 and 1964 World's Fairs.

Together, the two buildings feel like a cohesive whole, and give students, teachers, and staff the space they need and deserve after decades of neglect. The massing, scale, and materiality of the addition are a pleasing foil for the 1923 school building. "We showed deference to the old building, but we tried to make the new building express today's values and technology," says Murphy.

P.S. 19 MARINO P. JEANTET SCHOOL

Location: **9802 Roosevelt Ave, Corona, NY**
Client: **NYC School Construction Authority**, *New York, NY*
Architects: **MBB Architects**, *New York, NY*
Structural Engineer: **Silman**, *New York, NY*
MEP Engineer: **Loring Consulting Engineers, Inc.**, *New York, NY*
Construction Manager: **Citnalta Construction**, *Bohemia, NY*
Structural Steel Erector: **JC Steel Corp.**, *Bohemia, NY*
Miscellaneous Iron Fabriactor and Erector: **Jordan Construction Product Corp.**, *Huntington, NY*
Architectural Metal Fabricator and Erector: **Transcontinental Contract**, *Newark, NJ*
Curtain Wall Erector: **JC Steel Corp.**, *Bohemia, NY*
Metal Deck Erector: **JC Steel Corp.**, *Bohemia, NY*


A gymnasium on the second floor allows for an enclosed playground underneath.

WINNER AND FINALISTS ANNOUNCED FOR *METALS IN CONSTRUCTION* MAGAZINE 2020 DESIGN CHALLENGE TO GIVE AN AGING OFFICE TOWER A NEW IDENTITY

Winning Team:
SECOND SKIN

WilkinsonEyre: Giles Martin, Melissa Clinch, Laurence Walter, Felix Exton-Smith, Andrea Botti, Philip Dennis, Lee Paterson
Eckersley O'Callaghan: Damian Rogan, Simon Pierce, Carmelo Guido Galante, Teni Ladipo, Matthew Tee, Rafailia Ampla
Josef Gartner GmbH: Timo Buehlmeier, Bernhard Rudolf, Roberto Bicchiarelli, David Ehnle, Frank Kuesters
MRG Studio: Clare Flawn-Thomas, Jennifer Mui, Jose Rosa
Level Infrastructure: Byron Stigge, Ryan Laber

On March 6, *Metals in Construction* magazine and the Ornamental Metal Institute of New York named the winner and five finalists for its 2020 Design Challenge at the TimesCenter in New York City. The "Transform a Facade" competition challenged architects and engineers to submit their vision for transforming the facade of one of Manhattan's 60-year-old buildings to reduce carbon emissions and address the city's Green New Deal.

The *Metals in Construction* magazine 2020 Design Challenge was conceived because of an urgent need for facade retrofit solutions in New York City. Seventy-five percent of the city's high-rise office buildings are more than a half a century old. Most will still be standing in 2030, a milestone year on New York's road-map to carbon neutrality. Since buildings alone account for more than 80 percent of the city's carbon footprint, equipping as many as possible with energy-efficient features is essential to reducing carbon emissions.

The ideas competition sought to upgrade an aging, energy-inefficient high-rise office building in order to comply with NYC's Green New Deal goals and render it more desirable space for companies competing for highly skilled employees in today's labor market. The site chosen for the challenge was 63 Madison Avenue, a 15-story New York City office high-rise constructed in 1962. Its age makes it typical of the office buildings that populate Manhattan's NoMad district, many of which are mandated to reduce carbon emissions by 2030 to comply with the city's new building emissions standards, known as the Climate Mobilization Act (CMA). The CMA's emissions targets are stringent: to comply, 63 Madison must cut its emissions in half by 2030.

The magazine awarded a $15,000 grand prize to the design judged best at achieving the goals of increasing light into the interior and affording tenants greater visual access to the outdoors while significantly reducing carbon emissions in accordance with the city's targets. Titled "Second Skin," the winning proposal was submitted by a team with members from WilkinsonEyre, Eckersley O'Callaghan, Josef Gartner GmbH, MRG Studio, and Level Infrastructure.

"We were drawn to this exciting competition initially due to its sustainable credentials," says Giles Martin, Project Director, WilkinsonEyre. "Rather than imagining a shiny new facade system, it genuinely seeks to solve a very real problem; many of New York's buildings won't meet the 2030 targets, but how to retrofit a solution without redeveloping the whole building? With our partners Eckersley O'Callaghan and Gartner we have developed 'Second Skin,' a loose-fit system that can be applied to any number of the city's existing buildings. Giving it a new image and new function for today's market. After all, the greenest building is one that exists already."

This year's winner was chosen from a field of 31 qualifying entries. The panel of six jurors who awarded the prize include experts in office architecture and facade design and engineering: Gabrielle Brainard, AIA, LEED AP, CHPC, Architect, Building Envelope Consultant, Educator; Margaret Cavenagh, AIA, LEED AP, Studio Gang; Enrica Oliva, M.Sc. Struct. Eng., Werner Sobek New York; John Pachuta, AIA, Heintges; Mic Patterson, PhD, LEED AP+, Facade Tectonics Institute; and Stephen Selkowitz, Lawrence Berkeley National Laboratory.

The grand prize was awarded at a half-day conference at the TimesCenter in New York City on March 6, 2020. The competition was sponsored by the Ornamental Metal Institute of New York.

The *Metals in Construction* magazine 2021 Design Challenge will be sponsored by the Steel Institute of New York with the goal of addressing structural steel challenges in New York City. The full competition brief will be released in Fall 2020.

Finalist Teams:

ACTIVE AND ADAPTIVE

Lars Anders, *CEO, Managing Partner, Priedemann Facade Experts*
Paul-Rouven Denz, *Head of R&D, Priedemann Facade-Lab*
Puttakhun Vongsingha, *Project Manager R&D, Priedemann Facade-Lab*
Steve Muchowski, *General Manager, Business Development USA, Priedemann Facade-Lab*
Simon Phillips, *Senior Project Manager, Business Development USA, Priedemann*

BLURRING SCALES

Ayman Wagdy Mohamed Ibrahim, *BSc, MSc, PhD, Lecturer & Researcher (QUT, UQ, CARRS-Q)*
Haitham Salah Ali Mahmoud *BSc, Chief design officer (YBA architects)*
Mostafa Aladdin *BSc, freelancer architect*
Waleed Gamal Eldin Mohamad Lotfy, BSc, Design Director (Mimar, Egypt)

TRANSFORMED SIMPLICITY

Schorn
Kevin Schorn
Liam Martin
Nader Wallerich
Laura-India Garinois
Keely Brittles (graphic design)

HIDDEN IN PLAIN SIGHT

Skidmore, Owings & Merrill
Chris Cooper, *FAIA LEED AP, Partner*
Yasemin Kologlu, *RIBA, LEED AP BD+C, Director*
Emily Mottolese, *AIA, LEED AP BD+C, Director*
Frank Mahan, *AIA, Associate Director*
Van Kluytenaar, *Designer*
Ivy Wang, *AIA, LEED AP, Designer*
Yunhwan Jung, *Designer*

Atelier Ten
Nico Kienzl, *Director*
Joseph Guida, *Design Staff*
Rohan Kohli, *Graphic Designer*
Devanshi Dadia, *Senior Designer*

Werner Sobek
Michele Andaloro, *Project Manager*
James Richardson, *Associate*
Andrea Riva, *Engineer*

ATMOSPHERIC VEIL

READ Architecture Design
Firm Principal: Côme Menage
Lead Architect: Pooja Annamaneni
Team members: Rui Chen, Marceau Guerin, Kraken Studio

Winners and finalists in attendance at the 2019 Design Challenge awards ceremony.

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

Steel Institute of New York

Robert Samela, Chairman
A.C. Associates
Lyndhurst, NJ

Jake Bidosky
Keystone Management
Associates, LLC
Mountainville, NY

Terry Flynn
Tutor Perini Corporation
New Rochelle, NY

Stephen Isaacson
SRI Consultants LLC
Califon, NJ

Robert Weiss
A.J. McNulty & Co. Inc.
Maspeth, NY

William Matre
Skanska Koch, Inc.
Carteret, NJ

Rich Lucas
RJL Consultants Inc.
Farmingdale, NY

Peter Maglicic
Kiewit Infrastructure, Co.
Woodcliff Lake, NJ

David Pisacrita
Metropolitan Walters, LLC
New York, NY

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

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Christopher Walsh
Recording Secretary and
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Edwin Christian
President and Business Manager

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International Association of Bridge, Structural Ironworkers & Riggers
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Steel Institute of New York

Ornamental Metal Institute of New York

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W&W Glass Systems, Inc.
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Skyline Steel Corp.
Brooklyn, NY

The labor to erect the architectural and ornamental metal on projects featured in this publication was provided by the following labor union:

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Architectural and Ornamental Ironworkers
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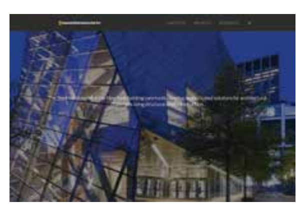

www.ominy.org
Ornamental Metal Institute of New York

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

270 Madison Ave., Suite 301
New York, NY 10016
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The institutes are a registered provider of the American institute of Architects Continuing education system (AIA/CES).

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METALS IN CONSTRUCTION

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