Designed by legendary engineer Othmar Ammann in 1931 and selected as the most beautiful steel bridge opened that year, the Bayonne Bridge has been an icon of the New York/New Jersey area for nearly a century. At one time the longest steel arch bridge in the world, it threatened to restrict trade to the Eastern Seaboard’s busiest ports, Newark and Elizabeth, New Jersey.

With the expansion of the Panama Canal and introduction of new “Panamax” shipping vessels—too large to fit under the bridge’s previous 151-foot navigational clearance—the Port Authority of New York & New Jersey and the HDR/PB team sought to “raise the bridge” to a 215-foot clearance.

As of Milestone 1 completion, the structure is no longer a barrier to port entry. With the roadway raised, Panamax ships up to 18,000 twenty-foot equivalent units (TEU, a standard cargo container size) can safely pass under the bridge.

On September 7, 2017, the CMA CGM Theodore Roosevelt marked a new era for shipping. With a capacity of 14,414 TEUs, it became the largest ship to enter an East Coast port.
Uniqueness and Innovation

Constructing a new roadway overtop an existing one, within the same arch structure, was an unprecedented task—one never previously attempted. Additionally, because the Bayonne is one of only four bridges connecting New Jersey to Staten Island and carries nearly 3.5 million vehicles annually, closing the bridge was not an option.

Keeping both bridge and shipping traffic open throughout construction was only possible through an audacious, complex construction sequence to raise the roadway—a worldwide first.

This truly an engineering marvel. Engineers have compared it to performing open heart surgery while the patient runs a marathon.

Chris Christie, New Jersey Governor

The process involved deconstructing the existing roadway from its dual-lane 40-foot width to a single-lane 25-foot width, then installing transfer girders to allow each lower floor beam to remain stable and supported. From there, the existing hanger was disconnected and new ones were hung from the arch to a new floor beam directly above the open roadway. A second hanger was installed from the lower portion of the new floor beam to the existing floor beam below, allowing the transfer girder to be removed. After completing this process 28 times, construction moved to the upper roadway, where new stringers were placed and a roadway deck was poured. Upon completion, traffic was moved to the upper roadway, and the lower deck was removed—clearing passage for larger ships and completing Milestone 1.

The project reverses the idea that old structures must be demolished to facilitate economic growth. In fact, the team kept the design and historical significance of the Bayonne Bridge while extending its useful life by another 100 years. It also proves that old bridges can be rehabilitated economically and efficiently. At Milestone 1 completion, the project is expected to cost half as much as a new bridge and shorten the timeline by seven years.

With additional weight on the structure, the team added more than 4,000 tons of steel plates to strengthen the bridge, accommodate higher wind loads and allow future light rail. Certified by Purdue University's Bowen Laboratory, the plates increased the strength of short and slender composite columns by 100 and 60 percent, respectively. The reinforcement also brought the bridge into compliance with American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) standards.

Unique for their staggering height, the 160-foot-tall approach piers are typically used to traverse canyons; the only bridge with taller piers is the Chesapeake Bay Bridge in Maryland. The new piers were also designed to resemble the original 1930s piers, with beautiful curved arches.

Social, Economic and Sustainable Development

SAFER, EASIER TO ACCESS BRIDGE

In the early 1930s, when Othmar Ammann designed his only steel arch bridge, there were significantly fewer road design considerations and no seismic requirements.

As a result of the project, the roadway is being widened from four 10-foot lanes with no median divider or shoulders to four 12-foot lanes with a concrete median barrier to prevent crossover crashes and 5-foot shoulders. An expanded 12-foot shared-use path spans the entire structure and allows pedestrians and cyclists to cross the bridge. The team continued Ammann's original design, which included rail transit, by allowing for future light rail expansion to Staten Island. The bridge also now meets New York's seismic requirements.
The Port Authority recognized the fact that its structures must not only be useful, but they must also conform to the aesthetic sense. This was one of the motives for the selection of an arch spanning the entire river in one graceful curve.

Othmar Ammann, at the bridge grand opening in 1931.

LARGER SHIPS, MORE CONTAINERS, PORT EXPANSION
The busiest port on the Eastern Seaboard is about to get bigger. In preparation for the bridge raising and arrival of bigger ships, the ports spent nearly $2 billion on upgrades, in addition to the $3 billion the Port Authority and federal government spent on dredging and rail access. Already handling 30 percent of all Eastern Seaboard traffic, the port is expecting to grow 6 percent per year for the next 20 years, made possible by raising the Bayonne Bridge.

Prior to the raising of the roadway, the ports were unable to receive 62 percent of the world’s TEU capacity. With more than $200 billion passing through in 2013 and the port supporting more than 280,000 jobs, it was clear a solution must be found.

PROJECT ECONOMIC IMPACT
The project has provided nearly 1,500 jobs per year throughout construction—an estimated $380 million in wages and $1.6 billion in economic impact for the region. Further, it is estimated to have long-term national economic developmental benefits of more than $3 billion.

By removing half the approach span pier, the project will also allow development, parks and waterfront access. The Port Authority has granted $2 million toward rehabilitation of the surrounding area, and preliminary discussions have begun for a park underneath the approaches. By improving air, light and viewing conditions, redevelopment of the historically underutilized area is now an opportunity.

PROTECTING THE ENVIRONMENT AND WILDLIFE
Although more cargo containers will pass through the port, the larger ships will reduce the quantity of vessels in comparison to if the project was not completed. Without raising the roadway, the port was limited to receiving ships carrying less than 10,000 TEUs. It was estimated that with the air draft restriction lifted, 7 percent fewer ships would arrive in 2020 and 19 percent less in 2035—cutting 11.6 million tons of emissions.

Listed as an impaired waterway, the previous roadway discharged untreated stormwater directly into the Kill Van Kull. Drainage improvements eliminated the direct stormwater discharges by collecting the water and routing it for treatment—removing 80 percent of suspended solids and 40 percent of pollutants.

The Kill and the bridge itself are also possible breeding locations for more than 70 bird species, including the state-listed endangered Peregrine Falcon, which nests on the bridge. As such, the team, with NYSDEC, NYCDPE and NDEP wildlife biologists, made significant efforts to protect fowl habitats during construction.

BETTER EMERGENCY RESPONSE AND EVACUATION ROUTES FOR STATEN ISLAND
With large portions of Staten Island and Bayonne at risk for flooding and storm surge from hurricanes, the Bayonne Bridge provides a critical evacuation route during inclement weather. The upgraded bridge, with wider, safer lanes and raised approaches, will provide additional assurance for residents during storms that they are able to evacuate. Additionally, with emergency operations managed out of Staten Island and lane reductions during construction, the team built a second emergency operations post in New Jersey to reduce incident response times.

The project also includes fully automated tolling by removing the Bayonne toll plaza, along with a fire suppression system, new mechanical and electrical buildings on each shoreline, aesthetic lighting, security enhancements and a bridge health monitoring system.
Complexity
Because reconstructing a bridge within a bridge had never been attempted, the most challenging aspect of the project was deciding if it could be done. Only through innovation and sheer will, the project will be remembered as one of the most bold engineering feats of the 21st century.

In the 1930s, Ammann did not have to compete with the encroached New York and New Jersey cityscape present today. Homes lie less than 20 feet from the worksite, and to avoid displacing residents or taking additional right-of-way, the team worked only within the existing right-of-way.

Seeking opportunities to streamline the project wherever possible to accelerate the schedule, the team altered their pier-design approach. Originally, they designed half of the southbound pier to be constructed concurrently with the northbound pier, allowing the 160-foot-tall piers to be braced at the midpoint. However, the construction of half the southbound substructure would have taken a significant amount of time. By bracing the northbound piers with a pipe strut, the southbound piers and substructure could be completed later, then braced against the northbound structure, at which time the pipe strut could be removed. This innovative effort saved two years of construction time.

The project required an unprecedented amount of mandated archaeological, traffic, wildlife, soil, pollution and economic reports. The environmental assessment considered input from more than 300 organizations. Fifty-five agencies and more than 50 Native American tribes were consulted, requiring 47 to avoid similar oversights that occurred on other New York bridges.

Once considered impossible, completing Milestone 1 on the Bayonne Bridge renews optimism for what innovative engineering can achieve. With the completed cost of retrofitting the Bayonne at half the estimated cost of a new bridge, residents and stakeholders rest assured that they restored a historic landmark to support transit and economic needs for the next 100 years.

Selected as one of the first infrastructure projects expedited by President Obama’s We Can’t Wait initiative, Milestone 1 was complete six months ahead of a revised schedule.

I.M. Pie, the architect who redesigned the Louvre, stated the challenge of altering famous structures was, ‘How do we make history live and still point the way to the future?’ The designers of the Bayonne Bridge reconstruction have shown how.

Frederick Gottemoeller, Renowned Bridge Architect
Executive Summary

Built in 1931, the Bayonne Bridge has been an icon in the New York/New Jersey area for nearly a century. At one time the longest steel arch bridge in the world, it now threatens to cut off trade in the Eastern Seaboard's busiest ports, Newark and Elizabeth, New Jersey.

With the expansion of the Panama Canal and introduction of new “Panamax” shipping vessels — too large to fit under the old bridge's 151-foot navigational clearance — the Port Authority of New York & New Jersey and the HDR/PB design team sought to raise the bridge by 64 feet — allowing the new supersized vessels to pass underneath. As of Milestone 1 completion, the structure is no longer a barrier to port entry, and Panamax ships can safely pass under the bridge.

Constructing the new bridge overtop the existing arch roadway without closing it to traffic was seen as an audacious task—one never previously attempted and only possible through a complex construction sequence. Additionally, because the Bayonne Bridge is one of only four bridges connecting New Jersey to Staten Island — and prior to construction, carried nearly 3.5 million vehicles per year—closing the bridge was not an option. Further, with 280,000 jobs and more than $200 billion in goods flowing through the ports, the team could not impact the navigable waterway.

As a result of the project, the roadway is being widened from four 10-foot lanes with no median divider or shoulders to four 12-foot lanes with a concrete median barrier and 5-foot shoulders. An expanded 12-foot shared-use path will span the entire structure and allow pedestrian and bike traffic to cross the bridge. Approach ramps now include acceleration and deceleration lanes, which provide additional safety measures to traffic entering or exiting the highway. The project team also paid homage to the original historical design, which included rail transit, by allowing for a future light rail expansion to Staten Island. The new structure also includes a new electrical design, fire suppression system, mechanical and electrical buildings, aesthetic lighting, security enhancements, health monitoring system and fully electronic tolling.

Because of staging and maintenance of traffic throughout the project, the existing and raised roadway will be in place simultaneously. To accommodate vehicular access through the arch at the raised roadway and to support this temporary double-deck condition, more than 4,000 tons of steel strengthening plates were added to the arch structure. The strengthened steel also brought the bridge into conformance with American Association of State Highway and Transportation Officials (AASHTO) standards.

The narrow construction site presented another construction challenge. With residential homes less than 20 feet from the worksite, the design team located approach piers within the existing right-of-way to not only avoid property annexation, but also limit environmental impacts.

When complete, the historic Bayonne Bridge will be safer and provide opportunities for future development—while no longer being a barrier to the busiest ports on the Eastern Seaboard thriving.