TAKING the WILD out of the Zoo

Redesigned and rebuilt for 21st-century mobility, Wisconsin's busiest interchange provides a reliable link that keeps motorists and consumer goods moving through Milwaukee

ORIGINALLY BUILT IN THE EARLY 1960S, the Zoo Interchange in Milwaukee, Wisconsin, emerged as a tangled mass of roadways where the current I-94, I-41, I-894 and US 45 freeways converge. The interchange was considered an engineering marvel 55 years ago, but as the city's population grew, it became clear the declining interchange wasn't up to the task of carrying 300,000 vehicles each day.

Its outdated design started to affect safety. Ramps coming in on the right and left with short distances to weave contributed to high crash rates.

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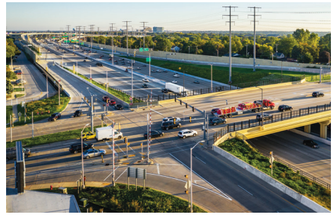
"The interchange design needed to be updated to improve safety and congestion and to achieve system reliability," said Bob Gutierrez, southeast freeways design chief for the Wisconsin Department of Transportation.

WisDOT selected Forward 45, HNTB's joint venture with CH2M and Kapur & Associates, as lead designer for a $1.7 billion program to rebuild the interchange. HNTB's role encompassed roadway, structural, environmental, traffic signal, traffic engineering and modeling, project management and intelligent transportation system design. HNTB also provided geotechnical analysis, construction inspection, traffic management planning, landscape architecture and public information services.

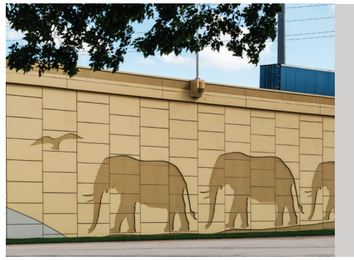
Open for business during construction

The massive, complex project included 4 miles of local arterial roads, 7 freeway miles, seven service interchanges, 60 bridges and six railroad structures that had to be constructed within the original interchange footprint. Adding to the challenge was the fact that the interchange provides entry points to the nearby Milwaukee County Zoo, Milwaukee Regional Medical Center, Wisconsin State Fairgrounds, a college, churches, neighborhoods and large employers. Maintaining access to the medical center, the region's only Level I trauma center where more than 17,000 employees work every day, was particularly crucial.

Having completed the Mitchell and Marquette interchange projects with WisDOT, HNTB was well versed in developing a sequencing plan that allowed reliable access to all neighboring sites throughout construction.



"Staging construction while keeping traffic moving was a challenge because of the Zoo Interchange's tight urban footprint," said Andy Kowske, HNTB project manager. "For the project to work, we pre-planned detailed crane placements and material-hauling access points within the interchange and combined that with strategic ramp closures to create space for the contractor. All jobs have challenges. Past experience taught us how to solve problems."



Project facts

- 7 freeway miles
- 4 miles of local arterial roads
- 7 service interchanges
- 60 bridges
- 6 railroad structures
- 100+ retaining walls
- Four-level core interchange
- 70+ traffic signal upgrades
- Millions of cubic yards of earthwork

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To maintain accessibility for freeway travelers and the nearby neighborhoods and businesses throughout construction, HNTB developed an innovative integrated corridor system with adaptive traffic signals. The system represented the nation's largest single deployment of adaptive traffic signals and WisDOT's first use of the sophisticated technology.

The Federal Highway Administration recognized the Zoo Interchange as an example of a successful mega project, citing its 3D engineered model and adaptive signal deployment, among other strategies, as industry best practices.

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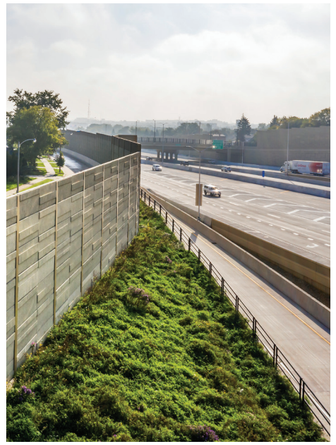
Early in the project, the team made significant improvements to arterial roads, so they could handle traffic that would be diverted during core interchange construction. HNTB also developed an integrated corridor system with adaptive traffic signals, digital message signs, traffic cameras and Bluetooth detectors.

Using Bluetooth origin-destination data, WisDOT posted information on freeway and arterial digital message signs, comparing freeway and arterial travel times to a common destination. The integrated corridor system represented the nation's largest single deployment of adaptive traffic signals and WisDOT's first use of the sophisticated technology.

"Deciding to implement the integrated corridor system was a leap of faith on WisDOT's part," Kowske said. "The DOT invested in developing the system without having built one previously. It moved traffic very effectively during construction, and the technology and equipment will be used on the Zoo Interchange well into the future."

Innovative firsts for WisDOT

Utility management was a recurring theme throughout the project. A major utility corridor, the Zoo Interchange was a minefield of potential schedule and budget overages. To ensure as few missteps as possible, HNTB and the joint venture partners designed the interchange using 3D surface modeling and clash detection software – a first for a WisDOT project. The investment helped reduce cost and schedule changes in the field and minimized change orders to 3 percent, below WisDOT's 5 percent goal.



Numerous underground utilities had to be relocated, including city water facilities, which the team moved using below-grade jacking pits to avoid affecting the freeway. The project also required relocating American Transmission Company's seven overhead high-voltage electric transmission lines and stringing more than 11 miles of new wire across six lanes of traffic.

"3D modeling helped us visualize constraints on crane travel, placement, reaching and lifting. Swinging huge girders under high-voltage lines and over existing and proposed roadways and bridges while minimizing traffic disruption was a complex puzzle," said Pat Cashin, HNTB lead structural engineer. "It is the most in-depth evaluation we've done to analyze how to build. In some locations, our plans called for temporary shoring solely to provide suitable crane placement."

Interchange design preserves monarch pedestrian trail

Every summer, as monarch butterflies migrate to their winter home in Mexico, thousands at a time roost overnight in oak tree groves adjacent to the Zoo Interchange.

"It was evident early in the interchange redesign process that the butterflies were important to the community," said Bob Gutierrez, southeast freeways design chief for the Wisconsin Department of Transportation. "Nearby residents didn't want the monarch pedestrian trail or oak tree groves affected by construction or by the end product. We embraced that perspective, making sure the footprint was light in the migration corridor."

The interchange design extended the trail under a new bridge that preserved the monarchs' habitat, and a pattern of butterflies adorns the bridge abutment. In the open trail area, WisDOT used a seed mix for vegetation that attracts the butterflies.

The Zoo Interchange's new flyover ramps rest on bridge columns supported by 60 drilled shafts, 8 and 10 feet in diameter and 60 to 100 feet deep. Although large-diameter drilled shafts are common in other states, they were new to Wisconsin.

"WisDOT asked us to provide dual foundation designs at locations where the footprint was sufficient to fit an alternate pile-supported footing," Cashin said. "The contractor chose drilled shafts, confirming our cost-comparison analysis. The shafts shrunk the footprint, could be built in half the time and reduced risk near underground utilities. The shaft drilling generated far less noise than pile driving would have, minimizing the impact to surrounding residences and businesses – particularly the zoo, where there was a concern vibrations and noise would affect the animals."

A load-testing program optimized the drilled shaft foundations, cutting the budget by $6 million and the schedule by two months. In addition, full-length testing tubes were dual purposed, allowing grout injection to the bottom of the shaft, which shortened shaft lengths by 20 percent, further reducing the project's price tag.

Communication with stakeholders

Contributing to the Zoo Interchange's success was early involvement with project stakeholders, including both the community near the site and the region-wide and statewide entities that rely on the interchange to move freight. WisDOT and HNTB met with municipalities, businesses and neighborhoods to make sure all stakeholders had a voice during design and construction.

"The attitude and spirit were that we would design what everyone felt was the right approach in this area," Kowske said. "Because of our work with the community, there were no surprises. Working closely with the medical center was a key part of our 'no-surprises' approach."

During design and construction, WisDOT stayed connected with the medical center, providing staff who were dedicated to communicating with patients, employees and emergency responders through social media and grassroots outreach.

"We told the medical center and all our stakeholders there would be some impact but that we would be open for business with viable alternate routes," Gutierrez said. "Our plan worked, and I give our stakeholders credit for preparing themselves and being flexible."

Responding to stakeholder feedback in the design process, the team included a state-of-the-art LED lighting system that reduced energy costs, bike lanes that connect to existing trails and retaining walls with reveals that provide aesthetic benefits for the surrounding communities.

An FHWA example project

The core of the Zoo Interchange opened fully, on time and under budget, in August 2018. Local businesses and neighborhoods remained accessible throughout construction. Previously bottlenecked traffic on southbound I-41, once the most-congested in Milwaukee, now flows freely in afternoon peak hours. During the first two months after the interchange opened, crashes already were down 45 percent and the interchange was handling 25 percent more traffic without congestion.

"The statewide impact of this crossroad – the largest and most heavily used in the state – provides benefits far beyond the localized region," Gutierrez said. "The improvements keep motorists and millions of dollars of consumer goods moving and provide a reliable link to our major attractions near the interchange and in the downtown area."

The Federal Highway Administration recognized the Zoo Interchange as an example of a successful mega project, citing its 3D engineered model and adaptive signal deployment, among other strategies, as innovative industry best practices. ■

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