ABOUT THE PROJECT

Project Name: US-23 Flex Route, M-14 to M-36

Enter in the following category | check one:

- Studies, Research, and Consulting Engineering Services
- Building/Technology Systems
- Structural Systems
- Surveying and Mapping Technology
- Environmental
- Waste and Storm Water
- Water Resources
- Transportation
- Special Projects
- Energy
- Industrial and Manufacturing Processes and Facilities

Project Location
City: Ann Arbor
State: MI

Completion/Use Dates
Scheduled: November 25, 2017
Actual: November 25, 2017

Studies, Research, and Consulting Engineering Costs
Budgeted: $17,000,000
Actual: $18,000,000

Construction Costs
Total Project Budget: $4,175,059
Total Project Actual: $4,175,059

*Entrant’s Portion of Total Project Budget: $4,175,059
*Entrant’s Portion of Total Project Actual: $4,175,059

Check box if project was awarded through a QBS process.

*NOTE: The Entrant’s Portion of the Total Project Budget includes the design fees paid to the entrant for the services provided for this project.

ABOUT THE FIRM SUBMITTING THE PROJECT

Entering Firm: HNTB Michigan, Inc.

Firm Representative: Karianne Steffen, PE, PTOE

Address (no P.O. Box)
4900 Montrose, Ste. 200
Okemos, MI 48864

Phone (517) 333-3330
Email: ksteffen@hntb.com

I hereby authorize submission of this project into the American Council of Engineering Companies of Michigan 2018 Engineering and Surveying Excellence Awards competition.

Senior Executive/Principal: Eric Morris, PE
Title: Vice President
Signature: [Signature]
Date: 10/2/17

ABOUT THE OWNER(S) OF THE PROJECT (NOT PRIME CONSULTANT/CONTRACTOR)

Owner(s): Michigan Department of Transportation (MDOT)

I believe the work of the engineer meets the intended uses and expectations for the project and hereby grant permission to enter this project in the ACEC/M 2018 Engineering and Surveying Excellence Awards competition, and authorize publication of its outstanding features, unique aspects, or innovations. I confirm the project was substantially completed and ready for use between November 1, 2015 and October 31, 2017.

Owner Representative: Stephanie Palmer, PE
Title: Region Traffic Safety & Operations Eng.
Signature: [Signature]
Date: 9/21/17

A fee of $325 per entry for ACEC members ($1,200 for non-ACEC members) must be attached. Visit acecmi.org for an electronic version of this form and additional category guidelines.
September 21, 2017

American Council of Engineering Companies of Michigan (ACEC/M)
215 North Walnut Street
Lansing, MI 48933

Re: 2018 ACEC Michigan Engineering and Surveying Excellence Awards
(US-23 Flex Route, M-14 to M-36)

To ACEC/M Distinguished Judges:

It is my pleasure to submit this letter of support for the US-23 Flex Route, M-14 to M-36 project for the 2018 ACEC/M Awards program. HNTB Michigan Inc. served as the prime consultant, providing planning, design, and system management for the US-23 Flex Route, the state’s first Active Traffic Management (ATM) system.

The US-23 Flex Route uses several innovative ATM strategies: dynamic lane control, dynamic shoulder use, variable speed advisories, and queue warning. Dynamic shoulder use will allow MDOT to dynamically open the shoulder to traffic during certain times of the day to help alleviate congestion during peak hours and special events. This will be accomplished by utilizing gantries over the roadway with lane control signs that will designate whether the shoulder is open or closed. The Flex Route system will also be used to alert traffic to current roadway conditions and provide real-time advisory speeds to help reduce congestion-related crashes and secondary crashes related to incidents.

Although HNTB’s primary role was to provide the planning, design and system manager services for the Intelligent Transportation System (ITS) infrastructure, they also played a significant role in the overall coordination and successful delivery of the project. This included weekly coordination between HNTB and the ITS, road design and bridge design project managers. In addition, HNTB led the development of the ATM software and oversaw the systems engineering process to ensure the project was designed as planned and installed correctly in the field. Furthermore, HNTB assisted in MDOT’s public involvement efforts by creating traffic simulation of the Flex Route operation for inclusion in an MDOT public education video, as well as providing the design of the freeway signing for US-23.

MDOT is extremely satisfied with the services that were provided by HNTB and hereby grants permission to enter this project in the 2018 ACEC Michigan Engineering and Surveying Excellence Awards Competition and authorizes publication of any features or innovations. MDOT thanks you for your consideration of this the project for your prestigious award.

Sincerely,

[Signature]
Stephanie Palmer, P.E.
Project Manager
Michigan Department of Transportation
Role of the Entrant’s Firm in the Project

As part of Michigan's first active traffic management (ATM) project, US-23 Flex Route, HNTB Michigan, Inc. was the prime consultant and lead design firm for the planning, design, design assistance during construction, and system management of the intelligent transportation system (ITS). This project was packaged with several large road and bridge projects to construct the shoulder, drainage, and widened bridges to facilitate part-time shoulder use. HNTB was also the prime consultant for bridge design of 6 Mile Road, 8 Mile Road, and North Territorial Road, and the as-needed construction engineering and inspection (CEI) firm for roadway construction.

Role of Other Consultants Participating in the Project

Kimley-Horn, as a subconsultant to HNTB, provided systems engineering services.

PSI, as a subconsultant to HNTB, provided geotechnical engineering services.

Parsons, as a subconsultant to HNTB, provided software development services.

Brief Description

ATM is the ability to dynamically manage recurrent and non-recurrent congestion using technology and operational strategies. US-23 Flex Route uses several ATM strategies: dynamic lane control, dynamic shoulder use (also known as part-time shoulder use or hard shoulder running), variable speed advisories, and queue warning. Dynamic shoulder use allows driving on the shoulder during certain times of the day. US-23 Flex Route utilizes gantries over the roadway with lane control signs over each lane to indicate if the lane or shoulder is open to traffic. MDOT selected dynamic shoulder use due to peak directional traffic, crash history, and stop and go congestion. The deployed ATM strategies will provide additional capacity, improved incident response, speed harmonization, and advance notice to drivers of upcoming conditions. The US-23 Flex Route is between Brighton and Ann Arbor in MDOT's University Region. The corridor is approximately nine miles in length, from M-14 to M-36. US-23 has heavy peak directional traffic southbound in the morning and northbound in the afternoon.
ORIGINAL OR INNOVATIVE APPLICATION OF NEW OR EXISTING TECHNOLOGY

Using ITS to Actively Manage Traffic

Real-time data is being used to actively manage traffic to open the shoulder, harmonize speeds, warn drivers of conditions ahead, and respond to incidents. Dynamic Message Signs (DMS), Microwave Vehicle Detection Systems (MVDS), Closed Circuit Television (CCTV) cameras, and fiber optic cable are all being used on this project and are not new for MDOT; however, each device is being used in a new and innovative way. The DMS used are full color LED lane control signs above each lane to provide graphical information for drivers. MVDS provide speed and vehicle density for the software to analyze for variable speed advisories and if traffic conditions meet thresholds to open or close the shoulder lane. Cameras are being used to confirm a shoulder is clear of obstructions 24/7 and camera tours that link preset views together will be utilized to inspect the shoulder lane. The fiber optic cable plant is configured to provide redundancy along the corridor with Layer 3 Ethernet switches at each device location. For backhaul, two dedicated leased Ethernet Private Line Services at opposite ends of the corridor provide redundant links to the State of Michigan ITS Network, accessed from their Statewide Transportation Operations Center (STOC) in Lansing.

Public Information Video

A public information video was created for US-23 Flex Route to communicate what each graphical message means and how to drive the corridor. Several scenarios are shown, such as shoulder closed, shoulder open, and lane closed due to an incident. The video also includes a description of ATM, goals of the project, and a link to the project website.

Low Light Cameras

Since the corridor does not have continuous freeway lighting, a solution was needed to “see in the dark” to confirm the shoulder is clear of obstructions prior to opening. The MDOT ITS Program Office utilized their test bed to assess several low light camera options. Once the technology was confirmed to work, a special provision was written to be included in the project.

Software

Software to operate the ATM system was developed as part of the project. Software development included coordination with other MDOT regions that may utilize ATM strategies to make the software as
flexible, scalable, and user-friendly for US-23 as well as future ATM projects. The new module added into their existing Advanced Traffic Management System (ATMS) software package includes response plans to open the shoulder during peak periods and as-needed, an algorithm to analyze real-time data and propose advisory speeds to harmonize traffic flow, and logic for dynamic response plans to react to incidents that may require lane closures and/or shoulder opening. User acceptance testing and training was also needed to confirm software functionality and to prepare the operators at MDOT’s STOC.

Streamlined Maintenance
Remotely controlled power distribution units and hardened computers were included in ITS cabinets to decrease maintenance response time. MDOT’s ITS maintenance contractor can remotely access all ITS equipment on US-23 and troubleshoot any problems quickly, with the ability to power cycle devices without driving to the site and impeding traffic.

FUTURE VALUE TO THE ENGINEERING OR SURVEYING PROFESSION
Design Criteria
In conjunction with MDOT, industry experts, and peer states, many design criteria and standards for ATM corridors, such as pavement markings, static signing, guidelines for spacing of gantries near bridges and ramps, and dynamic lane control sign messages, were established throughout this project. MDOT is already moving forward with concept exploration on their second Flex Route project, which is utilizing many of the concepts and standards developed on US-23 Flex Route. Design coordination meetings included representatives from additional regions and business areas not part of the US-23 Flex Route to make sure the established design criteria would work for more projects than the immediate needs of US-23.

Standard Operating Procedures (SOP) and Quick Reference Guides (QRG)
SOP and QRG were developed to define procedures for Flex Route operators. The SOP include definitions, maps, graphics of what the system should look like, and procedures for each scenario an operator might encounter. Knowing that Flex Routes will be part of MDOT’s tools to address increasing congestion, the procedures cover operation of ATM strategies at a general level, with specifics to each corridor noted in the procedures. This way, the SOPs are flexible and scalable to additional deployments without having to rewrite the book.

The QRGs are concise step-by-step guides meant to be a quick aid that an operator can flip through as a reminder of the steps and expected outcomes of each procedure without having to reference the full SOP. They include tips and graphics from the ATM software to help guide operators through common processes, creating consistent operation and reliable messages.

SOCIAL, ECONOMIC AND SUSTAINABLE DESIGN CONSIDERATIONS
Travel Time Reliability and Safety
The main goals of the US-23 Flex Route project are travel time reliability and safety. Dynamic shoulder lanes are expected to reduce congestion during peak periods and special events, improve travel time reliability by providing consistent conditions, and reduce crashes by
providing speed advisories and advance notice of conditions ahead. The dynamic shoulder use strategy will provide an additional lane of traffic during the peak periods, special events, and unexpected congestion. The variable speed advisory and queue warning strategies will convey speeds to reduce stop and go conditions and messages, such as “stopped traffic/2 miles ahead.” Dynamic lane use combined with dynamic shoulder use will direct traffic safely around major incidents to improve traffic flow and safety of first responders.

Nobody likes being stuck in traffic and everyone wants to be safe when on the road. With more consistent traffic conditions, improved incident management during major incidents, and safer road maintenance, the benefits to society are numerous. Reliable travel times, less congestion, and safer roads are anticipated to lead to an economic boost through fuel savings, emissions reduction, people and freight on time, and improved safety.

Traffic Flow
The system was designed with lane control sign components in the cabinets protected with guardrails to minimize disruption to traffic when maintenance is needed. Most work can be completed to fix the lane control signs without closing a lane of traffic. This is for the safety of workers and to keep traffic flowing without disruption.

COMPLEXITY

Extensive Coordination
This project required extensive coordination of the road, drainage, bridge, and lighting plans prepared by MDOT; ITS, freeway signing, and bridge plans prepared by HNTB; and, signal plans, ramp extensions, and public involvement activities by other consultants. Because all of this was combined into a single bid package, it was essential that the plans, special provisions, and cost estimates be coordinated at a high level to avoid the possibility of contractor claims during construction due to inconsistencies in the contract documents. This coordination was achieved through a series of regularly scheduled coordination meetings, project consistency reviews, and use of MDOT ProjectWise for file sharing.

Expedited Construction Schedule
Due to an expedited schedule for construction, the design assistance during construction and system management part of the project was accelerated, including shop drawing reviews and acceptance testing. ITS projects require the contractor to submit shop drawings of equipment for approval by MDOT’s system manager. This project required all submittals in 30 days following award, which is significantly faster than standard ITS projects. Testing was also compressed with multiple testing on the same day: local testing, sign commissioning, and fiber optic testing requiring numerous qualified staff.

A new ATM software module analyzes real-time data to propose advisory speeds and plans to open the shoulder or react to incidents.
Testing
Testing all equipment was required to confirm functionality in the field as intended. Local device testing makes sure each device meets requirements, subsystem testing confirms each device can be communicated with, and final system testing verifies the whole system works together. Testing was complicated with vehicles traveling the corridor during construction with potentially confusing or conflicting messages needing to be posted on lane control signs. A system of dots was used to simulate final messages and “testing in progress” posted on DMS to continue testing during construction. This way when the roadway work is complete, the ATMS will already be tested and ready to use.

Software
In addition to developing the ATM module, the project team also needed to improve existing ATMS software functions for the ATM system to function properly. Examples include vehicle detection and camera tours. Detection data needed to be consistent and reliable for the algorithm to work correctly. Enhancement of the ATMS camera tour functions was required to allow pausing and restarting tours. This will allow operators to pause a tour while investigating any observed obstructions. Once ready, the operator can restart the tour from that point instead of having to replay the tour from the beginning. This software development complicated the typical testing and integration activities of an ITS project as the software build needed to progress from development servers to testing servers to production servers while at the same time not disrupting daily operations of MDOT’s extensive statewide ITS network.

Gantry Details
A standard MDOT truss was selected as the gantry to attach the lane control signs over each lane of traffic. This required power and communications cabling to go up the vertical member of the truss and across the truss box to each lane control sign. Aesthetics of the gantry were considered while designing the mounting details for power and communications. Special details were also required to mount the low light camera to the truss for viewing the median shoulder and MVDS bracket arm to detect traffic speeds and occupancy of all lanes for each direction.

EXCEEDING OWNER/CLIENT NEEDS
HNTB provided a quality project, within budget, and met the expedited schedule, exceeding MDOT’s needs. It proved to be a success for all parties involved and is serving as an example of collaboration, partnership, and technical excellence. The project team has been asked to speak about US-23 Flex Route by many different states, agencies, and professional organizations.
Photo 1: US-23 Flex Route is Michigan’s first Active Traffic Management (ATM) corridor. The system dynamically manages recurrent and non-recurrent congestion using technology and operational strategies. US-23 Flex Route uses several ATM strategies: dynamic lane control, dynamic shoulder use, variable speed advisories, and queue warning. US-23 uses gantries over the roadway and lane control signs over each lane to indicate if the lane or shoulder is open to traffic.

Photo 2: ITS equipment is being used, including dynamic message signs (DMS), microwave vehicle detection system (MVDS), CCTV cameras, and fiber optic cable, in a new and innovative way to communicate to drivers with lane control signs, variable speed advisories, and queue warning.

Photo 3: Low light cameras were used for the first time in Michigan on US-23 Flex Route. The low light cameras can “see in the dark” to confirm the shoulder is clear of obstructions prior to opening.

Photo 4: Gantry details were developed to attach lane control signs over each lane of traffic, power and communications conduit, low light camera, and MVDS bracket arm on a standard MDOT truss while keeping aesthetics in mind.

Photo 5: During testing, a system of dots was used to simulate final messages and “testing in progress” posted on dynamic message signs to continue testing during construction without potentially confusing or conflicting messages on lane control signs.

Photo 6: A new ATM software module was needed to develop a process and response plans to open the shoulder during peak periods, an algorithm to analyze real-time data and propose advisory speeds to harmonize traffic flow, and logic for dynamic response plans to react to incidents that may require lane closures and/or shoulder opening.
As part of Michigan’s first active traffic management (ATM) project, US-23 Flex Route, HNTB Michigan, Inc. was the prime consultant and lead design firm for the planning, design, and system management of the intelligent transportation system (ITS). ATM is the ability to dynamically manage recurrent and non-recurrent congestion using technology and operational strategies. This project was packaged with several large road and bridge projects to construct the shoulder, drainage, and widened bridges to facilitate part-time shoulder use. The ATM will provide additional capacity, improved incident response, speed harmonization, and advance notice to drivers of upcoming conditions.
Firm Name: HNTB Michigan, Inc.

Project Title: US-23 Flex Route, M-14 to M-36

As part of Michigan’s first active traffic management (ATM) project, US-23 Flex Route, HNTB led the planning, design, and system management of the intelligent transportation system (ITS). The ATM will provide additional capacity during peak periods, improved incident response, speed harmonization, and advance notice to drivers of upcoming conditions.
Award Information

Project Name: US-23 Flex Route, M-14 to M-36

Owner Name: Michigan Department of Transportation (MDOT)

Firm Name: HNTB Michigan, Inc.
US-23 FLEX ROUTE, M-14 TO M-36
UNIVERSITY REGION, MI

US-23 Flex Route is Michigan’s first Active Traffic Management (ATM) corridor. The system dynamically manages recurrent and non-recurrent congestion using technology and operational strategies. US-23 Flex Route uses several ATM strategies: dynamic lane control, dynamic shoulder use, variable speed advisories, and queue warning. US-23 uses gantries over the roadway and lane control signs over each lane to indicate if the lane or shoulder is open to traffic.

ITS equipment is being used in a new and innovative way to communicate to drivers with lane control signs, variable speed advisories, and queue warning.

Low light cameras were used for the first time in Michigan on US-23 Flex Route. The cameras can “see in the dark” to confirm the shoulder is clear of obstructions prior to opening.

Gantry details, such as power and communications conduit, low light camera, and MDOT bracket arm on a standard MDOT truss were developed keeping aesthetics in mind.

During testing, “testing in progress” was posted on dynamic message signs to enable testing during construction while avoiding confusing messages on lane control signs.

A new ATM software module analyzes real-time data and proposes advisory speeds to harmonize traffic flow, and plans to react to incidents that may require lane closure or shoulder opening.

Owner Name: Michigan Department of Transportation, MI
Firm Name: HNTB Michigan, Inc., MI