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## Project Summary

### Organization:

Foth Infrastructure & Environment, LLC

### Solution:

Roads

### Location:

Johnston, Iowa, United States

### Project Objective:

- Widen and reconstruct nearly 1.5 miles of NW 62nd Avenue in Johnston, Iowa, to manage travel demand through 2032.
- Secure two Revitalize Iowa's Sound Economy grants totaling USD 6.38 million in state funding.
- Design and construct a series of four multi-lane roundabouts to improve safety, increase travel speeds, and reduce travel time and fuel consumption.

### Products used:

Bentley OnSite, Bentley View™, CulvertMaster, FlowMaster, GEOPAK Civil Engineering Suite, LEAP Bridge, MicroStation, StormCAD

## Fast Facts

- Foth's 12-member team designed and sent the project out for bid in just six weeks.
- A Bentley SELECT subscription provided easy access to the product portfolio, helping with workload balancing.
- Foth maximized the benefits of product interoperability by using GEOPAK in conjunction with other civil software.
- An automated process used 3D roadway design models to detail over 1,000 geometric and staking callouts.

## ROI

- Innovative plan preparation trimmed 24 days from the schedule, saving USD 23,100.
- The low bid of USD 7 million was 20 percent below the estimate and 0.2 percent lower than the next lowest bid.

# Bentley Civil Software Powers Foth's Design of First Multi-lane Roundabouts in Iowa

Foth's Innovative Practices Leverage GEOPAK Civil Engineering Suite to Deliver Plans in Just Six Weeks

## Headquarters Expansion Fuels Traffic

The City of Johnston, Iowa retained Foth Infrastructure & Environment, LLC, to secure funding for widening and reconstructing nearly 1.5 miles of NW 62nd Avenue where DuPont Pioneer's world headquarters is expanding. The initiative led to design and construction of a series of four multi-lane roundabouts—the first in the state—to address challenging traffic conditions. Three key areas of innovation enabled Foth to design and deliver the USD 7 million fast-track project on schedule: interoperability of Bentley products, automation of plan preparation, and customization of inspection reporting.

Foth Senior Technology Manager Blaine Buenger said, "By combining Bentley solutions with Foth's exceptional technical staff and innovative spirit, we delivered the project to the client on time, on budget, and with advanced, sustainable electronic deliverables."

## Fast-track Schedule Drives Design

In early 2010, DuPont Pioneer announced to city and state officials that two campus expansions would create 638 new jobs, contributing to a significant increase in traffic on NW 62nd Avenue. Foth led a collaborative effort among the City of Johnston, the Johnston Economic Development Company, and DuPont Pioneer to complete two Revitalize Iowa's Sound Economy grants and secure USD 6.38 million in state funding for improving the corridor.

Given the existing traffic characteristics and imminent congestion, Foth saw an opportunity to implement a non-traditional intersection solution. Multi-lane roundabouts improve traffic flow, reduce delays, and promote pedestrian safety while presenting a smaller carbon footprint. Because this type of roundabout was new to Iowa, Foth was challenged to demonstrate the benefits to stakeholders. MicroStation® was used extensively to prepare conceptual drawings and preliminary geometric layouts. These illustrations assisted with educating city staff, city councilmen, and key stakeholders about the benefits of the proposed solution.

Once approved, the project was put on a fast-track schedule, making it imperative for Foth's multi-discipline 12-member team to engage in collaborative design using optimal tools.

The firm's Bentley SELECT® subscription benefited the geographically dispersed team by giving members easy access to Bentley's product portfolio. Flexible licensing and Bentley LEARN® training helped with workload balancing.

Bentley software streamlined design and automated repetitive tasks, facilitating a Lean Project Delivery approach that enabled Foth to meet the aggressive deadline. Typically, a project of this magnitude would take a design team of that size more than 16 weeks to finish. Foth's team completed the design and sent the project to bid in just six weeks.

## Interoperability Produces Master Model

GEOPAK Civil Engineering Suite offered a flexible suite of integrated tools for surveying and design of roads, sites, drainage networks, and storm and sanitary sewer systems. Foth maximized the benefits of Bentley product interoperability by using GEOPAK in conjunction with other civil software to take on the challenging scope of work. In addition to multiple multi-lane roundabouts, the corridor featured a two-lane bridge, box-culvert underpass, recreational trail, and stream realignment.

GEOPAK site design tools were used to model the roundabouts, bridge berms, and stream realignment. GEOPAK's Corridor Modeler was used to model the roadway in between roundabouts, which involved the design of pavement widening and full reconstruction, as well as recreational trails. Foth used GEOPAK's data acquisition tools to import the models and create a 3D master model of the entire project. The master model was ultimately used to cut cross sections and serve as a reference during plan preparation.

In areas where the storm sewer network had to be retrofitted, GEOPAK drainage tools allowed the designers to lay out the existing network, then place additional nodes and pipes relative to the new alignment. This drainage model was exported into StormCAD® for advanced network modeling, and then imported back into GEOPAK for final plan preparation.

*“Foth successfully and efficiently designed a complex, multi-disciplined transportation project by taking advantage of the interoperability among Bentley’s wide portfolio of engineering solutions.”*

— Blaine Buenger,  
Senior Technology Manager,  
Foth Infrastructure &  
Environment, LLC

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## **Flood Protection, Pedestrian Safety Priorities**

Foth used FlowMaster® and CulvertMaster® to perform the extensive hydraulic analyses required for correction of Beaver Creek’s course at the site where a two-lane bridge accommodated vehicular and pedestrian traffic. The channel was realigned, and the creek banks were reinforced to protect the new roadway embankment. The roadway was also raised above the creek’s 100-year flood elevation to ensure it would be passable during seasonal flooding. GEOPAK’s Roadway Designer generated the cross sections, which were imported into the U.S. Army Corps of Engineers Hydrologic Engineering Center’s River Analysis System software. LEAP® Bridge was used for the concrete bridge design.

Pedestrian safety was another major design concern, since the project corridor passed through DuPont Pioneer’s campus. Each leg of each roundabout contained pedestrian ramps that were modeled in GEOPAK site design tools to ensure compliance with the Americans with Disabilities Act and Public Right-of-Way Accessibility Guidelines. A 12-by-8 foot reinforced concrete box culvert was designed as an underpass allowing pedestrian traffic to cross safely under NW 62nd Avenue.

## **Automating Plan Preparation**

Laying out the roundabouts and pedestrian crossings required a staggering number of geometric and staking details. The design team devised an efficient process for detailing plan sheets using the 3D roadway design models. A Visual Basic routine automated the assignment of proposed elevations to coordinate geometry points. GEOPAK’s Roadway Designer advanced plan preparation tools were used to automatically label the IDs of the points by selection sets, rather than individually. Once the ID labels were placed, GEOPAK automatically generated tables containing location information.

Design of the roundabouts was also influenced by the requirement to maintain two-way traffic flow during all stages of construction. A fire station and 50 percent of the community’s schools are located on the east end of the project corridor, which is one of only two corridors connecting the city across Beaver Creek. Foth used alternate surfaces within GEOPAK’s Corridor Modeler to piece together the construction stages. The 3D surface model was also used to create a 3D rendering of the project.

The ability of Bentley software to convert to and from numerous file formats allowed design data to be passed along to other internal specialty applications; subconsultants and vendors using other design platforms; utility company databases; surveyor staking applications; and contractor machine-control grading applications. Making files accessible in users’ preferred formats eliminated errors that can occur during data transfer.

## **Customized Inspection Reporting**

Surfaces, alignments, and drawings were imported into Bentley OnSite for use during construction inspection. Foth developed a custom application that exported Bentley OnSite XML output to a central database. Inspectors had access to this data on rugged tablet PCs with survey-grade GPS capabilities, enabling the creation of real-time, as-built construction records.

By extracting data from electronic diary entries and bid item inspections, Foth was able to automatically populate three unique inspection reports. One, the Daily Inspection Report, contained several fields from the Bentley OnSite diary entry and had the capability to detect all bid items inspected during the same day. These bid items were pulled by name, along with quantity and location information, to populate a final report. Upon project delivery, the as-built data was converted into GIS format for the owner’s use in long-term maintenance.

## **Measurable Returns on Innovation**

Innovations in plan preparation shaved a total of 24 days from the project schedule, according to Foth’s estimates. The design team streamlined the process by merging the 3D models built in various GEOPAK modules to create one 3D master model. With the master model to use as a reference during plan preparation, this methodology saved an estimated 120 hours valued at USD 13,200 and cut 14 days from the project schedule. Plan sheet detailing took up to 60 percent less time, thanks to the automated workflow used to detail more than 1,000 geometric and staking callouts on the plan sheets. When final design revisions were made, it took minutes to update the plan sheets rather than the hours spent identifying which points had changed and updating them individually.

Foth estimated that automating this process saved about 90 hours of manual drafting valued at USD 9,000 and cut 10 days from the project schedule. It also reduced errors on the final plan sheets and, subsequently, during construction stakeout.

When the bidding time was shortened to 10 days, Foth was able to create a solid plan set and released electronic data to all contractors and subcontractors. Bentley software was used to create data in various file formats requested by contractors, including non-native formats such as DWG, XML, and TTM. The availability of electronic plan sets reduced the risk to contractors and made their bids more competitive. Of the eight bids submitted, six were within 3.7 percent of each other. Coming in 20 percent below the engineer’s estimate, the low bid of USD 7 million was just 0.2 percent lower than the next lowest bid.

Finally, Foth’s innovative approach to onsite inspection reporting saved an estimated 10 hours per week valued at USD 57,200 over the 52-week construction contract. Based on Bentley OnSite, the automated reporting process replaced handwritten diary entries, manual as-built measurements and calculations, and manual data entry on final inspection reports. Now all diaries and quantities are stored in a database, adding value for the owner after project completion.

Construction on NW 62nd Avenue began on Sept. 19, 2011, and was officially completed on Nov. 26, 2012. Transportation studies suggest that the multiple, multi-lane roundabouts will result in a 90 percent reduction in traffic fatalities, 76 percent reduction in injuries, and 35 percent reduction in crashes. In addition to improved safety, the design will save USD 1,500 per day in travel time value and an estimated USD 3,600 per day in fuel consumption. Foth’s innovative engineering, powered by Bentley’s flexible toolset, delivered an efficient design that will have a lasting impact on the community and the environment.