

PROJECT SUMMARY

Project: General Motors Plant Expansion

Organization: Ghafari Associates
Location: Toledo, Ohio

Project Objective:

- General Motors is expanded its Toledo, Ohio transmission plant to produce a new Hydra-Matic 6L80 six speed, rear-wheel-drive automatic transmission for full-size SUVs and trucks.

Software Used: MicroStation®, Bentley Triforma, Bentley Architecture, Bentley Structural, Bentley Building Mechanical Systems, Bentley Building Electrical Systems, Design Series Piping and Raceways, Bentley CloudWorx, Bentley ProjectWise Application Server, Bentley ProjectWise Web Server

FAST FACTS

- 275,000 sq. ft. of facility renovation
- 475,000 sq. ft. of new construction
- Construction start -July 2006 , plant schedule -in production late 2008
- Duration of Project:
Approximately 12 months
- Produced highly coordinated construction documents for architectural, structural, and MEP systems
- Eliminated conventional 2D steel-order drawings- reviews were completed 400 percent faster, accelerating the steel order by 560 percent
- Overall project savings of 3 percent to 5 percent was achieved by reducing field interferences
- Used ProjectWise® to implement a 3D model-based review process which reduced detailing and review time to no more than two days per model-- considerably less than the five-to-10 day industry average

GHAFARI Associates Continually Refines BIM-Based Design And Construction

Using GM's Lean Construction Methodologies, GHAFARI Implements Innovative 3D-Enabled BIM Technology To Meet Aggressive Schedule

GHAFARI Associates is no stranger to model-based design. But a recent plant expansion for General Motors (GM) afforded the full-service engineering company the opportunity to push its expertise to new limits.

GM was expanding its Toledo, Ohio, transmission plant to produce a new automatic transmission for its full-size SUVs and trucks. The project included the renovation of 275,000 square feet of facility and the new construction of 475,000 square feet, a staggeringly large project by plant standards -- so big that GM considered new construction to avoid shutting down existing production lines. To minimize the expected break in production, GM implemented an aggressive schedule that called for construction to begin in July 2006 and end by late 2007.

Using GM's lean construction methods, the integrated and highly collaborative design-build team implemented innovative 3D-enabled Building Information Modeling (BIM) technology to design and deliver the project on schedule in October 2007. The Ghafari team also established new benchmarks for BIM-based design and document processing.

SUBSTANTIAL CHALLENGES

Plant expansion always comes with a few well-defined challenges. For example, because owner-operators typically expand plants and factories in phases over many years, and because temperature extremes and other factors can affect dimensions and geometry over time, accurate plans of existing plant conditions are hard to come by.

Further, conventional survey techniques don't capture complex plant environments very well. These factors make it difficult to design integrated facilities because plant expansions typically require months of onsite measurement. And, as clashes between new and existing structures are detected, design teams often have to modify drawings during construction.

This particular plant project had additional obstacles of its own. For example, the plant expansion hinged on a large steel order, which involved a lengthy review process between the design team and steel fabricators that would affect scheduling goals. Moreover, the distributed project team needed to tightly coordinate its efforts to perform document reviews and

updates in a timely manner. Given these very real challenges, the GHAFARI team knew that successful project completion would require their very best work and a new approach.

"We wanted to apply previous breakthrough results, best practices, and lessons learned to develop all facility systems and process installation using 3D BIM technology to the point where all systems were fully coordinated prior to construction," said Samir Emdanat, manager, advanced technology, GHAFARI. "Secondly, our team needed to access the most recent 3D BIM and construction documents from any location and at any time, regardless of origin.

"Our third challenge was to develop best-in-class methodologies to capture existing plant conditions by laser scan, and develop faster, less expensive, and more accurate processes to use scanning data during the design process. Lastly, we wanted to develop best-in-class practices for using 3D data in new facility construction and brownfield renovation."

NEW IDEAS AND NEW TECHNOLOGY

GHAFARI's plan incorporated the use of laser scans rather than conventional surveying techniques to create an accurate model of as-built conditions. By integrating the as-built model with new design work, the team could perform effective clash detection and interference checking virtually, greatly reducing construction time. But this process created another problem -- developing conventional models from scanned data is time consuming.

To stay on schedule, GHAFARI used:

- Bentley's data-processing software,
- Cloudworx, and
- MicroStation TriForma extension.

These tools were used to integrate scanned point-cloud data, rather than fully developed models, with conventionally developed 3D models of the new facilities. Using laser scanning and relatively unprocessed point clouds, the team accelerated the design, increased the accuracy, and avoided the pitfalls of conventional surveying techniques and time consuming existing-conditions modeling.

“Using the model in this way allowed construction to begin while keeping the majority of the plant operational.”

ABOUT BENTLEY

Bentley Systems, Incorporated is the global leader dedicated to providing comprehensive software solutions for sustaining infrastructure. Architects, engineers, constructors, and owner-operators are indispensable in improving our world and our quality of life; the company's mission is to improve the performance of their projects and of the assets they design, build, and operate. Bentley sustains the infrastructure professions by helping to leverage information technology, learning, best practices, and global collaboration – and by promoting careers devoted to this crucial work.

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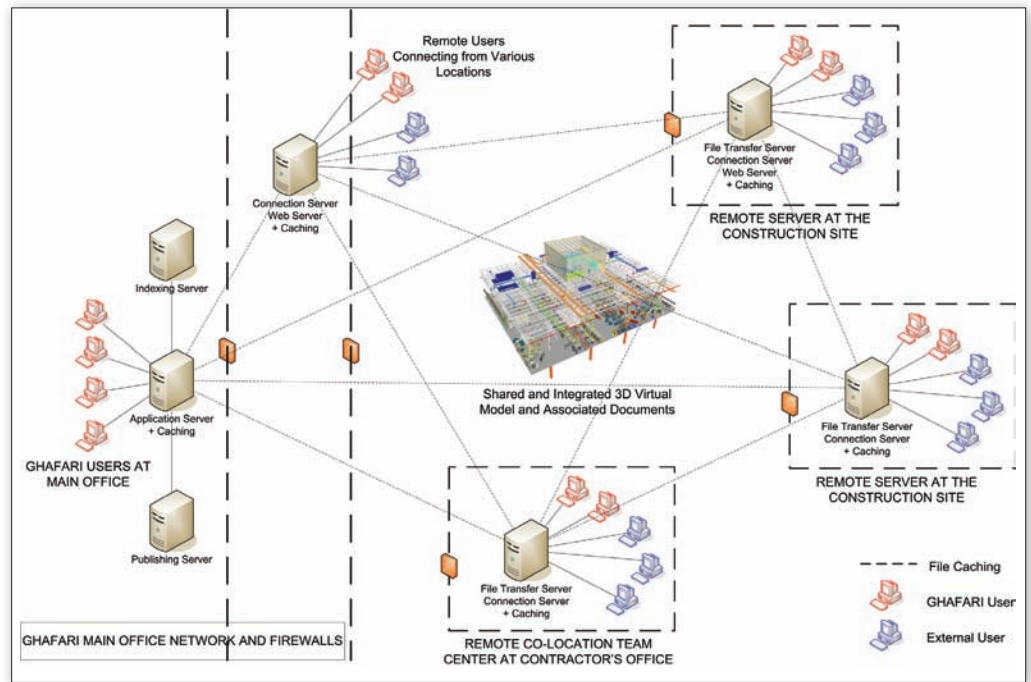
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Ghafari-ProjectWise Network Configuration

“The hybrid model was used to accelerate decision making and coordinate demolition sequences to avoid hours of delays,” said Emdanat. “Using the model in this way allowed construction to begin while keeping the majority of the plant operational.”

The GHAFARI team knew that in order to meet the aggressive construction schedule, it couldn't use a conventional 2D drawing and review process. Instead, it used Bentley's collaborative ProjectWise® software to implement a 3D model-based review process. For example, steel detailers submitted 3D models for review by the team in ProjectWise. This enabled the team to work with the proposed models, then annotate and approve the models before returning them to the steel detailers for incorporation into the final detailed models for the steel order. This workflow reduced detailing and review time to no more than two days per model – considerably less than the five-to-10 day industry average. Ultimately, the steel mill order was issued fewer than eight days before the start of construction, compared to an industry average of 10-14 weeks.

The same principle – working with a Building Information Model – was used as comprehensively as possible with all contractors, as well as internally, to reduce the use of 2D design documents and shorten the review process. Using 3D models instead of 2D construction documents to coordinate the mechanical, electrical, and plumbing systems saved hundreds of drafting hours.

TRIFORMA: AN IMPORTANT TEAM MEMBER

What about the team's workflow goals? According to Emdanat, there were four factors for this project's success – coordination, interoperability, scalability, and file sharing.

To facilitate coordination, the team selected TriForma® as the model creation and management platform. TriForma's interoperability with other CAD formats allowed the team to interact directly with all subcontractors, whether they used Bentley

products or not. Also, using Cloudworx to reference the point-cloud models in the TriForma 3D models allowed the team to ensure the newly designed systems would fit into complex existing constraints. This resulted in highly coordinated 3D models and associated installation documents. In addition, it significantly reduced field coordination problems.

Support for interoperability in RAM™ Structural System and TriForma meant the team could produce CIS/2 and SDNF steel exchange formats for the fabricator and import the steel fabricator's 3D models, saving weeks of 2D drafting.

TriForma also afforded scalability. Using TriForma, the team could work with individual steel models as well as the complex model that resulted from assembling the detailed steel models for the entire facility. For example, this helped the MEP team reference the models and produce fully detailed MEP systems. These models were used to develop detailed equipment and process layouts with the required connections.

The accelerated schedule required the design team and the subcontractors to work on project documents simultaneously. To manage this file-sharing process seamlessly, the team used the check-out/check-in functionality in ProjectWise to update files. This saved hundreds of hours of document management because all teams had access to the latest documentation.

Emdanat estimates that by eliminating conventional 2D steel-order drawings, reviews were completed 400 percent faster, accelerating the steel order by 560 percent. In addition, an overall project savings of 3 percent to 5 percent was achieved by reducing field interferences. Lastly, using ProjectWise to distribute the PDF files saved as much as \$100,000 in reproduction costs.

“Bentley's commitment to interoperable formats and scalable document management solutions has helped GHAFARI and the project team provide highly collaborative 3D-enabled projects using a leaner, more efficient workflow facilitated by a single shared dataset,” Emdanat said.