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D-B IN 3-D

3-D Modeling Serves as the Backbone for a Technologically Complex Project with a 100-Year History

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Little technology was involved when Teresa Marzetti wanted to start a restaurant in Columbus, Ohio, in 1896. The Florence, Italy, immigrant just wanted to serve good food and did. The restaurant became one of the Midwest's premier four-star eateries and remained open until her death in 1972. The restaurant's showpiece was her signature Marzetti salad dressings, which now find themselves in restaurants and on dining room tables across the country. But just wanting "good food" — Marzetti's ultimate goal — isn't enough anymore. And it takes more than a factory above the kitchen, which is where Marzetti produced her dressings in the mid 1950s, to meet the demand.

The T. Marzetti Company's new award-winning salad dressing plant in Horse Cave, Ky., is a far cry from the 1950s. The project was driven by not only a design-build team, but one utilizing some of the most advanced techniques — particularly 3-D Building Information Modeling (BIM) — in the design-build delivery method. The result was a significant contribution to the success of a complex design-build project, which ensured accurate, cost-effective prefabrication, collision avoidance, higher installation quality, and an accelerated schedule that eliminated change orders.

The 220,000-square-foot, $50-million project was completed on budget, 25 days ahead of schedule, with no generated change orders and less than 2 percent overall owner-directed changes. Moreover, the first product run produced saleable product. Confirming the plant's design and operational effectiveness, the new facility received the highest scores ever awarded for quality, food safety, and facility design by Cook and Thurber, a respected independent food plant auditor. In addition, the plant received the coveted 2007 U.S. Food Plant of the Year Award by *Food Engineering* magazine, the annual award for America's best food plant project.

It was the first time in 50 years the 110-year-old specialty food company built a new plant to help meet increasing demand for its dressings, sauces, dips, spreads, and bakery products as well as better reach its customers.

Design-Build Selection

Marzetti's wanted a qualified design-builder with verifiable credentials in designing and building innovative and efficient food process facilities. As a result, Marzetti selected Shambaugh & Son, L.P., an EMCOR Company, as the single-source, prime design-builder of the new, state-of-the-art salad dressing facility. Shambaugh oversaw mechanical, electrical, process, fire protection, utilities, plant automation, tele-data, and security work with its own forces.

"Shambaugh was selected based on its technical expertise in the food processing/manufacturing industry and for its track record of completing work on time and on budget," said John Boylan, treasurer, Lancaster Colony, the parent company of T. Marzetti.

Design-build was attractive to Marzetti because it delivered the project sooner than other delivery methods, provided an earlier guaranteed maximum price within about 20 percent of design costs, eliminated one level of construction management fees, and reduced change-order risk. Moreover, 3-D modeling was successfully integrated into the delivery process.

A Powerful Tool

The use of 3-D BIM has been accepted in construction as a powerful tool to pull together design and construction disciplines making it a more efficient and streamlined process. This modeling fosters greater collaboration among members of the design and construction teams, allows a modular prefabricated construction approach, reduces field conflicts and change orders, accelerates the schedule, reduces rework and project costs, provides improved quality control, and yields greater installation productivity.

In fact, 3-D modeling was a key to the ultimate success of this project, in which Shambaugh used Bentley's AutoPLANT 3-D plant design tools. They allowed the customer to take a virtual flight through the plant from any angle or viewpoint before any construction began. The technology enabled the project team to fine-tune the design to enhance maintainability, accessibility, operability, ergonomics, and food safety throughout the project. It's collision-avoidance software prevented rework in prefabrication or construction.

The isometrics automatically generated by the 3-D model allowed the Fort Wayne, Ind., shop to prefabricate various pieces, which were shipped as complete skids or major prefabricated pieces and quickly assembled onsite, saving weeks of construction time. AutoPLANT's 3-D modeling design resulted in one in four project man-hours spent offsite, leading to modularization of as many sub-systems as possible.

Prefabricated systems included five complete process mix kitchens, cook kitchens, a boiler room, a chiller plant, and air compressor room piping, among many others. For example, a significant portion of the process ingredient piping was erected in 40-foot sections, eight to 10 pipes across, pre-insulated, delivered to the job site, and erected in hours.

3-D and Design-Build

Theoretically, 3-D BIM should yield the same benefits whether part of a design-build or design-bid-build project. However, in addition to the inherent savings associated with design-build, the owner realized additional savings when 3-D BIM is integrated into the design-build delivery method and the design-builder creates both the 3-D model and the associated isometrics.

When the designer and 3-D modeler are different, re-work is typically required.

Second, the isometrics are automatically generated as a by-product of the 3-D modeling process and require the addition of only some text and tags. When performed by the installing design-build contractor, the contractor makes cost-conscious decisions about where to cut the model, based on reducing installation costs and how many assemblies to build in the shop.

The result is often a reduction of the number of assemblies for the installing contractor, which reduces costs. For example, on another recent project, Shambaugh received some prefabrications based on a piping model, and these arrived in 50 different sections. If part of a design-build contract, the model would have been cut to fewer than 10 field assemblies. In addition, the materials would have been specified differently to further reduce installation costs. An A/E firm does not have the fabrication and material knowledge to make these types of decisions.

The biggest argument in favor of a design-builder performing 3-D modeling is the constructability advantage and single-source responsibility. For example, Shambaugh has installed systems modeled by many large EPC and A/E firms in which the fabricated pieces simply did not fit properly, and the owners incurred additional costs for the fabrication to be redone. Modeling and ISOs by the installing contractor puts responsibility for fit and constructability solely in his hands, reducing owner risk.

T. Marzetti's Recipe

Marzetti surveyed its own personnel about their vision for a "dream plant." During 12 weeks of early engineering, the owner and project team met six times and had numerous interactive design conference calls among separate disciplines. In November 2004 the final guaranteed maximum price (GMP) contained more than 62 value engineering options to further reduce project costs. Shambaugh began site work in December 2004.

Numerous challenges arose immediately, in particular, large sink-holes and karst geological formations at the site. Sensors identified underground anomalies in conjunction with micro-gravity studies to help design remedial subsurface soil stabilization measures. More than 4,000 yards of concrete were pumped via high pressure into underground water channels to consolidate loose soils and provided a highly stable building pad.

As site construction commenced, a 3-D virtual engineering model of the process and major utilities was developed utilizing AutoPLANT and Explorer. The software's fly-through feature was critical to the design of the process kitchens, tank farms, cook kitchen, and bulk rooms. It also helped in complex, congested areas, such as CIP rooms, bulk ingredient piping, CIP piping, fire sprinkler mains, luminaries, HVAC units with ductwork, and most important, the utility systems above process area ceilings, and boiler and chiller rooms.

The models allowed plant operators, installers, engineers, and maintenance team members to review, understand and critique the process and utility systems long before fabrication or construction began. The AutoPLANT Piping 3-D software also automatically generated 3-D isometrics for prefabrication.

The Right Sequence

The building pad had been brought up to grade by early April 2005, with sub-surface remediation complete, and foundations began in earnest. Steel erection then followed the installation of large food ingredient bulk storage tanks.

After completion of roof decking and lateral bracing of the processing building, installation of prefabricated piping racks began, which consisted of random lengths of pre-insulated stainless steel process piping with the required outlets, cross connections, meters and ingredient trees to serve the process area below.

As soon as interior block wall footings were poured, construction began on ceramic glazed concrete masonry unit walls to enclose utility and sub-processing areas. At the same time, floor drains were installed throughout the building, and the sloped concrete floor was poured. After the floors cured, processing equipment, storage tanks, pumps, mixers, and other equipment was delivered to the site to be set and anchored to the base concrete.

Utility systems were also constructed with high voltage power in-feed to high-voltage switchgear, transformers and distribution equipment. Air compressors, centrifugal chillers and steam boilers were delivered to the site and installed in utility rooms.

Prefabricated components arrived almost every day during this phase of the project to feed the aggressive schedule of the 100-plus workers at the site. Stainless steel platforms, handrails, and fiberglass decking sections arrived in a timely manner to connect with the tank farms and processing equipment throughout the project. Electrical crews were busy distributing power feeders throughout the plant to a variety of motor control centers to eventually power the process and heating ventilating equipment.

Once the floors were poured in, processing and the majority of pipe racks and other equipment were hung from the bar joist, the process ceiling was installed.

Weekly construction meetings helped overcome construction and design challenges throughout the course of the project, and the 3-D drawings gave field installers the perfect picture of the installation and eliminated many "how-to" questions.

The project represented the latest in technology and the future but also kept an eye on the past, taking the T. Marzetti company to the next level, with an award-winning facility and a complexity Teresa Marzetti probably never dreamed of. But it was all done with the same goal of simply producing "good food" that Marzetti established more than 100 years ago.

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