

Faith Confirmed

By David R. Miller, Associate Editor

"In God we trust; everything else we check," is a wise, if somewhat cynical, phrase that can be applied to renovation work. Without as-built drawings, contractors are forced to make assumptions based on observation, measurement and knowledge of standard building practices of the time. Experienced builders may be able to make surprisingly accurate predictions, but it is still a wise practice to double-check.

GEM Industrial, one of the Rudolph/Libbe Companies, is using a new method of generating precise as-built drawings for existing structures, without spending countless hours gathering field measurements. Appropriately, this method for confirming contractor faith in estimates and predictions is being used for an extensive renovation of the Motherhouse, owned by the Sisters, Servants of the Immaculate Heart of Mary, in Monroe.

GEM Industrial is using laser mapping technology to route the new electrical systems it is installing and the mechanical piping being installed by project partner Monroe Plumbing & Heating Co. Even with the new technology, the skills of these contractors and construction manager, The Christman Company, will be tested, because the Motherhouse project is far from a typical renovation.

UNIQUE CHALLENGES

As with most renovation projects, the greatest challenge to overcome at the Motherhouse is the age of the building. The original wings of the Motherhouse were built during the Great Depression. The chapel was added in the 1940s and another wing in the 1950s. The 376,000-square-foot building will provide separate residential units for 241 sisters, plus

offices on the main and ground floors.

Special care is being taken to preserve decorative plaster on the 70-year-old, 18-inch walls and the brass, copper and Tiffany light fixtures, which are being reinstalled by GEM Industrial. The greatest challenge, however, lies inside the walls, where there are few air gaps that can accommodate new mechanical



GEM Industrial is filling the ceiling of the lower level of the Immaculate Heart of Mary Motherhouse with racking, piping and ductwork for the electrical and mechanical renovation of 240 residential units and offices. A geothermal heating and cooling system is being installed.

and electrical systems. Because the Sisters, Servants of the Immaculate Heart of Mary, wanted to create a sustainable design with every consideration given to recycling and protecting the environment, a lot of new mechanical piping will be placed into these narrow spaces along, with the wiring and data connections to equip the facility for the 21st century.



An artist's rendering of the Immaculate Heart of Mary Motherhouse's courtyard, in Monroe.

During the renovation, electricians will double the number of outlets and install a new substation. The entire electrical system is being removed and replaced, and the service size doubled to accommodate the health care requirements of the building. Every room is also being equipped with tele-data connections.

The existing heating system, where steam was transported from the powerhouse via underground tunnels, will be replaced with a geothermal HVAC system using 232 bore holes, each 450 feet deep, and a central chiller plant for air conditioning.

"As you go down into the surface of the Earth, the temperature becomes constant in the mid-50 degree range," said Ron Donnal, manager of sales and marketing for GEM Industrial. "Water in a closed-loop system will run through compressors and the circulating water will be used to transfer heat into the ground or extract heat from it for heating and cooling."

The system is augmented with a two conventional boilers to provide additional heat when necessary.

Two closed-loop pipe systems will be needed inside the building to heat and cool each residential unit. Since the building previously lacked a cooling system, the second supply-and-return loop is being fitted into spaces not designed to accommodate it, making it a difficult and tight fit for the new pipes.

A gray water system, believed to be the largest system in Michigan, also will compete for valuable space inside the walls at the Motherhouse. Water from toilets will drain into a standard sanitary system, where it ultimately will end up at a wastewater treatment facility. However, water from sinks, drinking fountains, bathtubs and showers will

drain into a gray water collection system and be filtered through a constructed wetland on the campus, where it will be treated and reused in the toilet system. Swales are being constructed in parking lots to manage and keep storm water and runoff out of municipal storm sewers. As a result, potable water usage will be cut by more than 50 percent, and 100 percent of storm water will be retained on site.

The Sisters are committed to the environment and are implementing the preservationist philosophy of using precious resources wisely and reverently, leaving as little imprint on the land as possible. With the creation of wet meadows, pedestrian pathways and prairies of native and indigenous plants, approximately 60 acres of the 280-acre campus is affected by the renovation.

LASER MAPPING

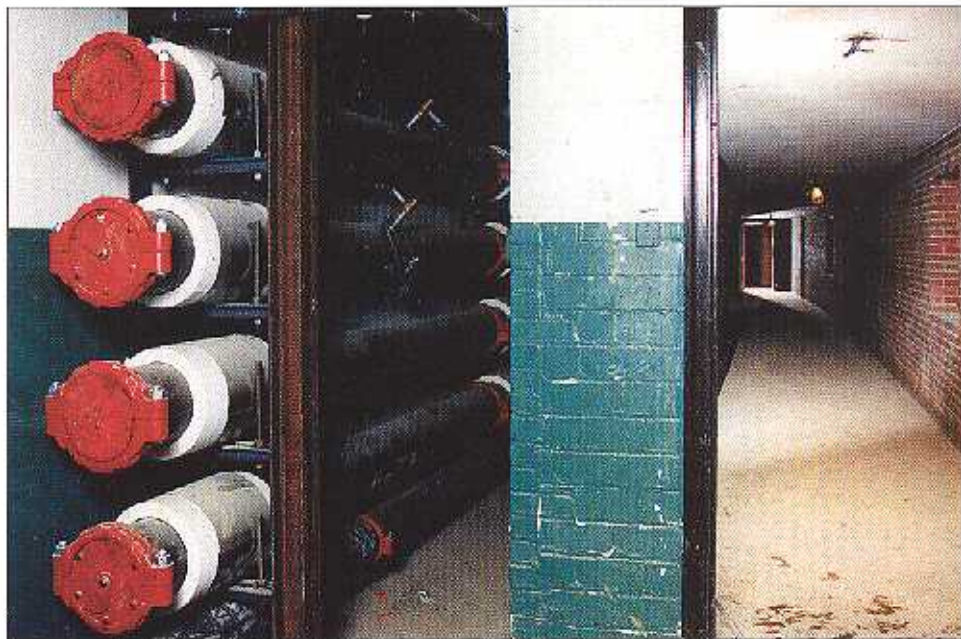
Given the unique nature of the mechanical systems at the Motherhouse, the vast quantity of time and materials should come as no surprise – 170,000 pounds of duct, 1,200 air diffusers, 490 fan coil units, 12 air handling units, six heat recovery units, 160,000 linear feet of piping 240,000 linear feet of geothermal piping and a minimum of 120,000 man-hours. All of which is in addition to fire protection, insulation and other work. Before this awesome task could even begin, a new tool was used to map precisely every inch of available space.

The mapping system works by sending laser pulses out into the space. When the pulses hit something solid, they are bounced back to a receiving unit. By sending the laser pulses out from multiple locations within a space, operators can analyze the returned pulses and generate a three-dimensional point cloud that accurately depicts the shapes and dimensions in the room.

"Rooms in a building like this might not be square or level," said Donnal. "Laser mapping shows us the conditions, as they exist, so that we can fit equipment and piping to suit the available space."

The system is accurate to within one-fourth of an inch at 330 feet and can gather 1,000 data points per second.

For a typical boiler room, a single scan would take approximately 10 min-



Laser mapping helped GEM Industrial plan how to run piping along a curved passage for a gray water recycling system that will reduce water consumption by more than 50 percent at the Immaculate Heart of Mary Motherhouse.

utes. Operators can increase the distance between each point to do scans more quickly, or can do an extremely accurate scan where points are generated every sixteenth of an inch. A considerable amount of information can be obtained from these point clouds in the field.

"When the system gets a return pulse, it measures the intensity of the object that was hit," said Brian Fleck, CAD engineer for GEM Industrial. "It creates different colors for different intensities. If something is metallic, it will have a higher intensity. Dark or softer objects will have a lower intensity."

GEM Industrial purchased its laser mapping system from Cyra Technologies, Inc., in San Ramon, California. The system includes the scanner, battery pack, computer, software and spherical targets. When placed in an area to be scanned, the spherical targets are a means of tying multiple scans together. At the Motherhouse, laser mapping detected several structural peculiarities that otherwise might have gone unnoticed or been very difficult to detect using the traditional field-measurement approach.

"The boiler room only has a 10-foot ceiling, but some of the columns are twisted about three-eighths of an inch," said Fleck. "There is no way that we

would have picked that up with field measurement."

Laser mapping had a direct impact on the design of supports, piping and duct work in the basement. For example, the supports that carry pipes below the ceiling in the basement level hang from uneven heights. Without laser mapping, each section would have to be measured to see which was lowest, so that a pipe system that would not further



The geothermal HVAC system being installed at the Immaculate Heart of Mary Motherhouse requires drilling 232 bore holes, each 450 feet deep, on the 280-acre campus in Monroe.

reduce the overhead space could be designed. With laser mapping, a system that preserves overhead space was much easier to create. The point clouds created by the system can be used in a variety of other ways.

GENERAL APPLICATIONS

Once scans are completed in the field, the data can be taken back to the office where system software can be used to create a three-dimensional model that can be exported into popular CAD programs including AutoCAD or Microstation. The program also compares gathered data against its internal library of standard construction components. When the CAD model is complete, it will show the specific type of steel beam, instead of simply its shape.

"It takes more time to turn the data into an AutoCAD model, but that gives us a realistic picture of what is here," said Fleck. "We can use the AutoCAD drawing for piping layouts, so we can fabricate pipe in the shop rather than on site."

Although it does take time to translate the raw data into an AutoCAD format, the system was still a timesaver at the Motherhouse.

"With about two days of scanning and



With laser mapping, GEM Industrial discovered that some of the support pillars in the lower level of the Immaculate Heart of Mary Motherhouse were twisted three-eighths of an inch. Laser mapping also made it easier to plan for the uneven heights, size and direction of joists.



GEM Industrial electricians are replacing old electrical panels, right foreground, with new electrical switches and a substation. The number of outlets in the Immaculate Heart of Mary Motherhouse is being doubled, and tele-data connections will be available in each residential room and office.

three weeks of modeling, we got data that would have taken us at least two months to do by hand, and it would not have been as accurate," said Fleck.

Because the system increases the speed and accuracy of field measuring, it has applications beyond renovation work. According to Fleck, a new version of the software recently was released to make the system much easier to use for surveying. The system also is of great value to road crews, because they can take accurate measurements without diverting traffic on existing roadways or endangering workers. And since the unit picks up data so rapidly, an occasional pedestrian or car crossing the scan area will not have an impact, unless a very fine scan is being done. This feature also allows the system to be used in

some industrial environments without stopping production. GEM Industrial is offering the service to engineering and architectural firms to develop existing, as-built drawings.

"GEM Industrial sees laser mapping as especially valuable in manufacturing facilities, power plants and refineries, where mapping can be done without affecting operations. All mapping can be done prior to a shutdown, saving time and money," said Donnal.

GEM Industrial could not have selected a better location than the Motherhouse to test the accuracy and usefulness of laser mapping technology and confirm field conditions for estimating and planning. After all, GEM Industrial has a long history of confirming the faith of customers and community. ☞

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