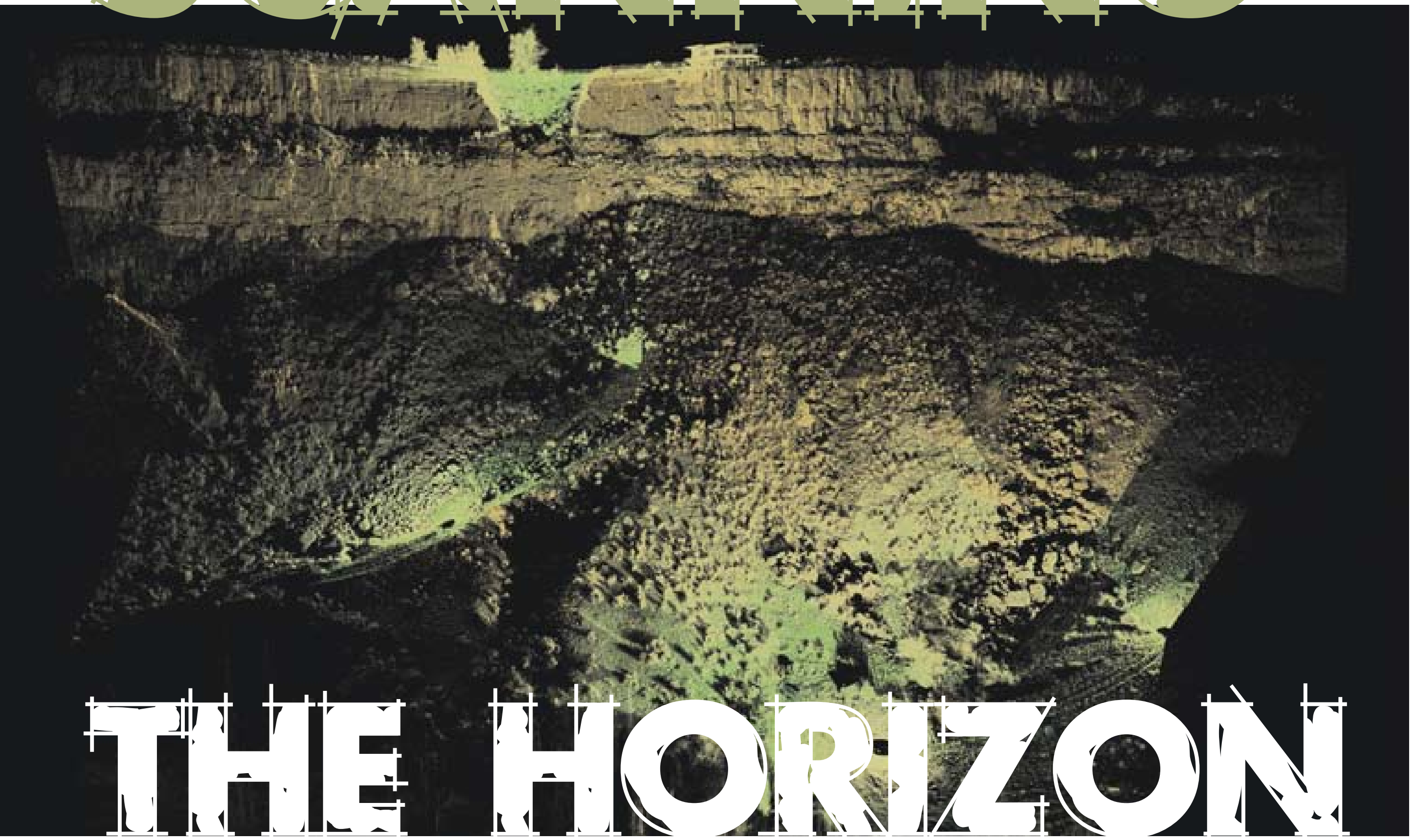
SCANNING THE HORIZON



Above: A ScanStation 2 point cloud from Sunrise's first scanning project—a 400-foot-high cliff face for a sewer-line redesign. Christensen says the design specs of the project, coupled with the steep vertical change of the slope, made laser scanning the tool of choice over conventional survey tools.

Laser scanning technology is providing new business opportunities for Sunrise Engineering.

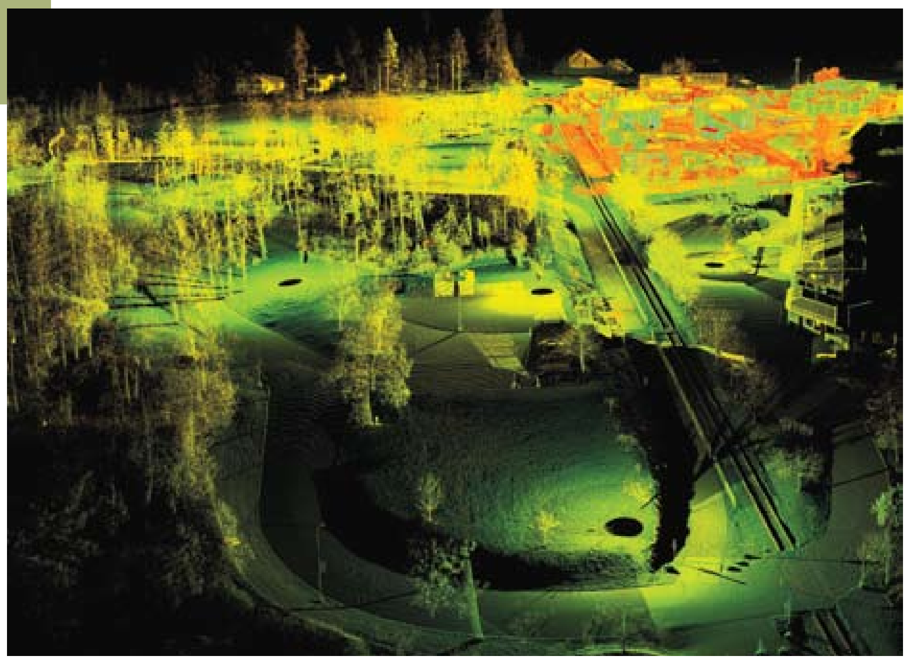
BY MARY JO WAGNER

There's something to be said for casual conversations with clients. Sunrise Engineering, for one, could say quite a bit. In fact, the company owes much of its ability to build a buoyant and diverse laser scanning business to the seemingly idle chitchat.

The 30-year-old engineering and consulting firm based in Fillmore, Utah, purchased its first scanner in February 2008. Within eight months, the company's project bookings nearly exceeded the cost of its initial investment in the technology, according to Burton Christensen, PLS, Utah Survey Division manager. "We haven't conducted any significant marketing pushes with the technology," he says. "Most of the scanning [projects] we've done are with existing clients who have an automatic fit for the technology. And often, these projects started by just a casual conversation and the clients saw the application benefit of laser scanning within their organization. So it's been selling itself."

Apart from the commendable speed with which Sunrise has built a healthy new business, particularly amid today's unhealthy financial climate, the company is also an atypical user of scanning technology in several other ways. It jumped into laser scanning by buying a scanner outright rather than renting the technology first. It did not have an existing backlog of scanning projects before acquiring the instrument. And a major portion of its initial customer base for the technology has been a group reputed to be the hardest sell for 3D imaging–mechanical contractors–who have found that scanning provides them with the accuracy they need to prefabricate components. Such accuracy can save them significant field-modification costs related to

Right: A close-up point cloud of the vertical cliff face complete with the existing sewer trunk line. The field crew scanned from seven different positions from the base to the very edge of the cliff creating a 3D view of the cliff, the area above the cliff, the talus slope at the base of the cliff and the alignment to the road beneath. Below: A combined ScanStation 2 and phase-based point cloud of the Coeur d'Alene Wastewater Treatment Plant showing the plant's exterior topography on the left and the plant's interior (within its fenced perimeter) in the upper right. The more-coarse exterior coverage is from the ScanStation 2, and the dense interior scans are from the phase-based scanner.



pier support, budgeted crane time, pipe modifications or volume changes for specialty grout materials, he says.

Indeed, within less than two years of buying a scanner, Christensen has succeeded in cementing the business case for Sunrise to the point that the scanner has become both the company's go-to instrument for a variety of topographical, as-built and engineering design projects as well as the technological platform to pursue projects for which they ordinarily wouldn't be selected. And, thanks to the firm's diverse client base, Christensen and his survey teams have had the chance to test the viability of the 3D scanner for unusual applications. Such projects have not only created unexpected business development opportunities for Sunrise but also have enabled the firm to break new ground in the wider laser scanning application market.

The Missing Tool

With six locations across the western United States, Sunrise specializes in implementing and completing public works projects. The company offers a full range of engineering and surveying services, including site inspections, geotechnical engineering, GIS services, detailed design, modeling, topographic mapping and construction layout. To manage such a varied offering, survey personnel have become very adept at applying the right survey tools for the job along with the right techniques. Christensen, however, believed that laser scanning was an important missing tool that they could use to augment their traditional survey and engineering services to existing clients as well as build a better, more-diversified future for the company. "A significant selling point for [laser scanning] is that you can integrate it into your daily operations to both secure new business and to increase revenue without increasing staff because you can complete jobs more quickly with the technology," he says.

He was equally certain that Sunrise's first scanner should be the ScanStation 2 from Leica Geosystems. "The Leica ScanStation 2 allows us to gather unprecedented levels of data at exceptionally fast rates," he says. "For example, a good surveyor will feel like he [or she] has made excellent use of his time if he collects 1,000 or more points in a typical day of surveying with GPS or robotic techniques. The ScanStation 2 can collect up to 50,000 points in a single second. Dollar for dollar, conventional surveying can't compete with that speed and data density. And we can pass those efficiency and productivity savings on to our clients."

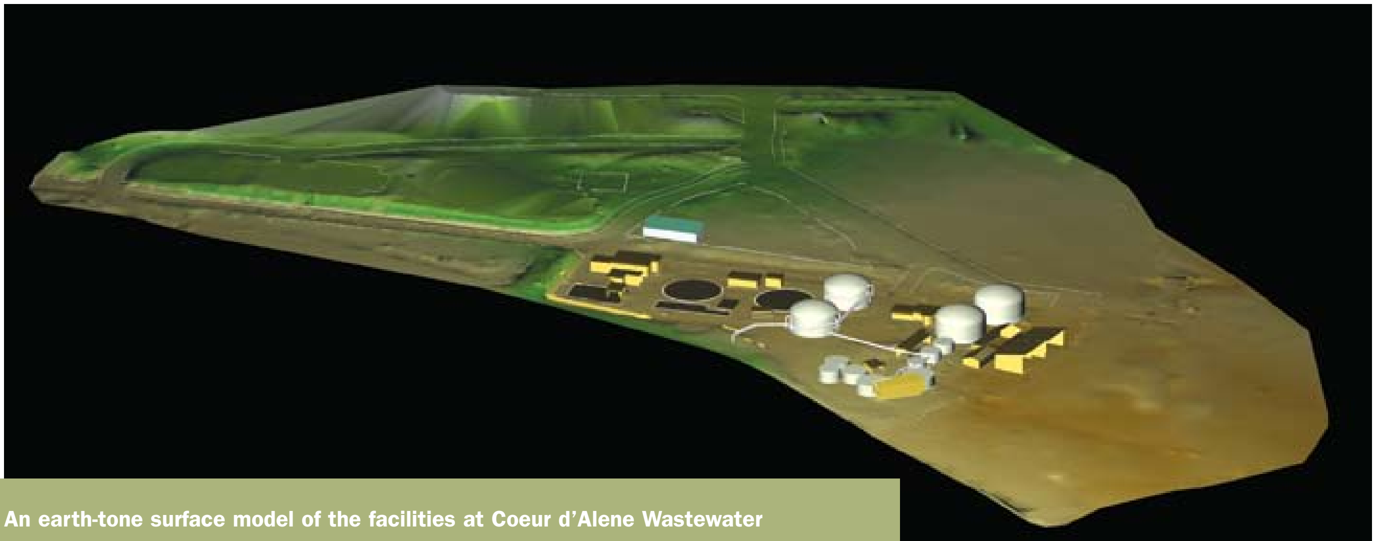
A View to a Cliff

By March 2008, within one month of receiving the scanner, Christensen qualified those value statements with the company's first scanning opportunity–an engineering design project for a new sewer outfall in Twin Falls, Idaho. At issue for this project was that the existing sewer line was mounted vertically to a 400-foot-high cliff face and the new line needed to be set within the cliff. Sunrise engineers needed to design a vertical route for a directional bore to accurately drill a new path for the replacement outfall.

Christensen says the design specs of the project, coupled with the steep vertical change of the slope, made laser scanning preferable to conventional survey tools. “We needed to know how far away from the edge of the cliff we would want to start the directional bore and the angle the bore needed to maintain to ensure it emerged below the junction of the cliff base and the top of the talus slope at an elevation that would maintain the appropriate amount of ground cover,” he explains. “The challenge in surveying this with a total station is that the amount of detail we would gather would be far less and we were shooting from a long distance—up to 800 feet. That makes depth perception really difficult. With scanning, we would have nearly total coverage of the cliff face, talus slope and topography at the top.”

After arriving onsite, Christensen and a colleague first used RTK-GPS to measure to three existing bench marks to match the city’s vertical datum that had been combined with corrected horizontal positions to control the scan data. Within 10 hours, they had scanned from seven different positions from the base to the very edge of the cliff creating a 3D view of the cliff, the area above the cliff, the talus slope at the base of the cliff and the alignment to the road beneath. A combination of three Leica HDS tilt-and-turn targets and three natural targets were used to align the scans.

From that scan data, they created a surface model of the old sewer trunk line, which was visibly anchored to the vertical portion of the cliff, and a detailed digital terrain model of the cliff and surrounding topography for their engineering colleagues to use as a base model to design the directional bore path. “Since this was our first scanning project as well as the first scanning project for the client, we scanned at a scan density that was much more in-depth than what was really needed,” Christensen says. “But since it is so easy to collect that level of detail, it was definitely worth the effort.”



An earth-tone surface model of the facilities at Coeur d’Alene Wastewater Treatment Plant. Sunrise collected more than 200 scans of the plant using both time-of-flight and phase-based scanning.

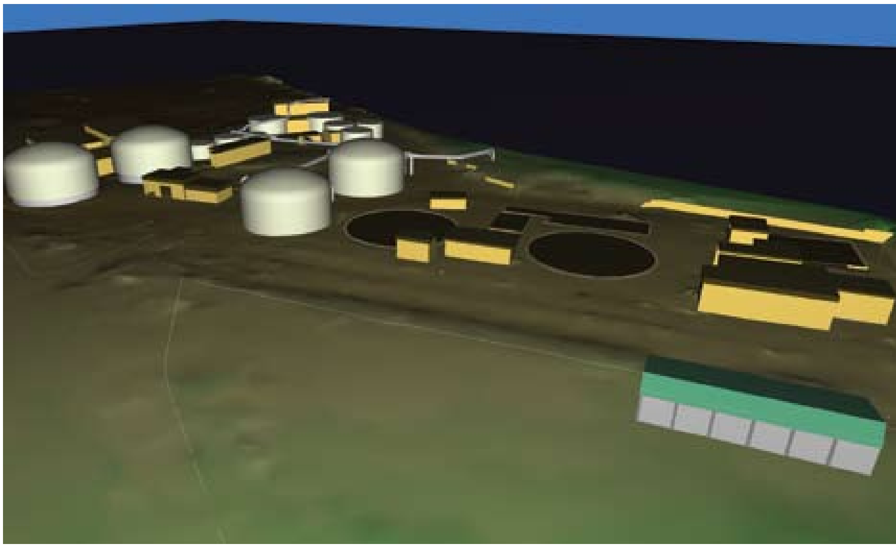
More Than a Reality Check

Another proof-of-concept opportunity came one month later when industrial engineering and contracting company Brahma Group Inc. (BGI) needed Sunrise’s survey services to confirm that the vessels it was installing at an oil refinery were plumb. The company’s managers initially requested a robotic total station crew. However, Christensen proposed to conduct the as-built survey with a robotic technique and, at no additional equipment charge, a scan with the Leica ScanStation 2. “Though the project manager had never used laser scanning before, I knew that he would like the 3D product, so I agreed to scan the site at my hourly survey rate, which is less than the robotic crew rate,” Christensen says. “After I showed them the initial scan, they only wanted to use laser scanning for any subsequent surveys at the refinery.”

In viewing the laser scan data, what struck the managers of BGI the most was how effective the technology could be as a project management tool for visually documenting and tracking construction progress. “They went from wanting a simple ‘reality check’ on plumb to understanding that they could acquire a detailed 3D image of their construction components—from the small pipeline joint to an entire storage cylinder—while at the same time creating a real-time map and timeline of their work progress,” Christensen says. “That not only helps them adequately monitor and understand the effort involved in certain projects, it also provides an accurate account of their progress to their clients, as well.”

Recognizing the benefits of such a comprehensive, historical record of their installations and fieldwork progress, BGI commissioned Christensen to scan newly installed elements at three- to four-week intervals to create a construction-progress timeline. Over a five month period, he acquired six scans totaling 420 million data points, each of which he processed and integrated into a seamless 3D model using Leica Geosystems’ HDS Cyclone software.

According to Christensen, the members of the management team were so quick



A close-up of the wastewater treatment plant surface model, complete with river and sky. Using the scanner for select interior data acquisition resulted in exceptional point cloud coverage of all exterior building features and the ground.

to visualize the benefits of such a holistic before, during and after "snapshot" of a worksite that, within a few minutes, they began listing a number of other construction projects where laser scanning would be a valuable asset.

Waste Not, Want Not

Providing that same "snapshot" into the future and allowing clients to connect the technological benefits of laser scanning to particular projects was exactly how Sunrise won another substantial scanning project, this time with engineering company HDR Inc.

Christensen conducted what he calls a watch and learn demonstration of laser scanning to about 30 project managers at HDR. By the end of the presentation, several managers had identified a specific wastewater-expansion project that would be a good fit for laser scanning. Soon after, Christensen was dispatched to the City of Coeur d'Alene Wastewater Treatment Plant (CAWTP) to collect more than 200 scans of the facility.

Operational since 1939, the CAWTP is embarking on a nine-year plan to upgrade its wastewater treatment facility at a cost of about $72 million to comply with the more-stringent water-quality standards that are anticipated. HDR is the lead design company for the expansion project, which involves several upgrades and the building of new facilities and associated support systems.

To help prepare for the new design, upgrades and construction, HDR needed an accurate ground surface model of the plant's interior topography (within its fenced perimeter) as well as the surrounding area to accommodate expansion beyond the plant's existing footprint.

With such an extensive scanning assignment, Christensen opted to use both phase-based and time-of-flight imaging technologies–a growing trend for high-volume laser scanning projects. "The phase-based scanner can collect 500,000 data points per second–it can take a full 360 by 270 scan in less than three and a half minutes," Christensen explains. "With that speed, we could acquire better coverage of the plant interior with a high-density point scan to ensure the client would have all the data they needed the first time. With the higher accuracy and exponentially better range of the ScanStation, we would then have the range to move farther away from the structures for better line of sight to roof features and also provide independent, dual-axis compensated measurements for the phase-based registration values."

To supplement the Leica ScanStation 2, Christensen rented a Z+F (Zoller & Fröhlich) 5306 phase-based scanner–an instrument very similar to Leica's HDS 6000 tool–as a primary source of 3D imaging for the CAWTP's interior perimeter. Another two-person crew used the Leica ScanStation 2 to survey the outside of the plant.

For the survey outside the fence, Christensen and his colleague set nine 6-inch spherical targets and Leica HDS tilt-and-turn targets on fixed-height rods on either bipods or tripods and located them at known points along the fence line. They then used static and RTK-GPS techniques to capture those positions to independently validate the positional accuracy of the exterior scan data and also seed the scan control with coordinates that tie to NAD 83/NAVD 88 datums. In two days, the team collected 22 3D scans of the plant's fenced boundary, the surrounding surface topography and features as well as exterior buildings visible from outside the plant's perimeter.

While the exterior field team was working, a second crew affixed about 300 self-adhesive black-and-white targets to a variety of objects such as buildings and light posts within the plant's perimeter to help align the Z+F scanner. By having a two-person crew, one person could stay close to the scanner while the other focused on identifying the next suitable scan location along with its available targets and the number of common targets to register adjacent scans.

On the first day of scanning, Christensen's crew collected 100 scans covering the majority of the interior-plant features needed. On the second day, they completed the phase-based portion of the project by acquiring 60 more scans.

Though the phase-based scanner provided a dense data set for modeling and design very quickly, there was still a critical level of detail missing–the roof features of the buildings. Christensen says acquiring point clouds of distant building roof features would have been difficult to do sufficiently with the Z+F 5306 because of its line-of-sight range limitations. Without the needed range from the ground, surveyors would have had to scan from rooftops or lifts, putting their safety at risk. In order to safely and accurately collect the visible roof features needed as well as to provide an extra layer of data redundancy on the majority of the black-and-white targets, the crew brought the Leica ScanStation 2 inside the plant to collect another 16 high-resolution scans.

Christensen says using the scanner for select interior data acquisition resulted in exceptional point cloud coverage of all

Sunrise used the ScanStation 2 to scan newly installed elements at an oil refinery and color-coded them to create a construction-progress timeline. Christensen acquired six scans totaling 420 million data points, each of which were processed and integrated into a seamless 3D model using Leica Geosystems' HDS Cyclone software.

exterior building features and the ground and provided peace of mind in knowing that the registered values could be independently verified by the additional scan data. "With the ScanStation, we were able to scan the roofs on 29 structures from the ground, save one scan location that was on a staircase platform," Christensen says. "The instrument's dual-axis compensator enabled us to scan the targets similar to how we would with a total station but with much greater confidence. Instead of collecting one shot at the apparent center of the target with a total station, we get thousands of positions so you visually see the whole target. That additional data redundancy not only serves to provide independent corroboration of the scan accuracy, it offers a much more data rich product for the client to use in designing the plant's future expansion."

Once the laser scanning was complete, Christensen and colleagues post processed the data by taking the point clouds from the phase-based scanner and the Leica ScanStation and registering them together using common scans. From the common point cloud data set, they created model features that were accurate in some cases to .005 foot–including building foundations and visible roof features, large piping (more than 6 inches in diameter) and the ground surface. In addition to the raw point cloud data and the 3D models, Christensen also provided HDR with Leica TruView images that encompassed nearly 200 individual scan locations as well as still photographs of various scanned features. "If the client had done this with conventional techniques, it would have taken several weeks to simply get a skeleton of the information we provided with HDS [technology]. And it would have cost much more," Christensen says. "Laser scanning was definitely the right technique for this project."

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