



Martin Drake
power plant fire

Photo Courtesy of KOAA News

AFTER THE FIRE

How Colorado Springs Utilities used Laser Scanning Technology to Help Assess Power Plant Damage

History

Located at the base of Pikes Peak on the front range of the Colorado Rockies, [Colorado Springs Utilities](#) is the fourth largest, four-service utility company in the United States. Originally developed as a municipal water and wastewater system, Colorado Springs Utilities

added electric and natural gas utilities in 1924, when the citizens of Colorado Springs voted to approve the city acquire what was then privately owned systems. Today, its service areas include the City of Colorado Springs, Manitou Springs, and many of the surrounding suburban residential areas. The military installations of Fort

Carson Army Base, Peterson Air Force Base (AFB), and the United States Air Force Academy receive water, electric service, and gas. Peterson AFB also receives wastewater treatment services. Colorado Springs Utilities serves a population of approximately 380,000, which includes more than 150,000 homes and businesses.

BY GARY **RUST**, RICK **BREWSTER** & TIM **THOMAS**

Martin Drake Power Plant

The Martin Drake Power Plant provides nearly one-third of the Colorado Springs Utilities power year-round and has been in operation for more than 80 years. The plant has been well maintained over the years to operate efficiently and reliably within regulatory requirements. As base load power generation, the plant runs 24 hours a day, 7 days a week. The three power generating units within the plant have achieved continuous runs exceeding 100 days several times in recent years, which is an industry benchmark of excellence. As a result, the Martin Drake Power Plant provides the lowest cost electricity of Colorado Springs Utilities entire generation portfolio.

On May 5, 2014, a fire broke out at the Martin Drake Power Plant during the performance of routine maintenance activities. The fire caused at least 22,000 customers to lose power for a period of time and led to a voluntary evacuation of a three block area around the plant. It took 20 fire units, 80 firefighters, and 20 support personnel to contain the blaze.

Once the building was deemed safe to enter, Colorado Springs Utilities immediately began work on the process of restoration. Getting the plant restored and back on line as quickly and safely as possible was of prime concern.

The Need for Information

As a starting point to the restoration, consulting engineers needed to have a good “viewpoint” of the plant as it existed after the fire. Acquiring new data with respect to the plant’s current condition, and then comparing that information to pre-fire information in the form of paper as-built drawings, would provide a perspective on the amount of restoration that needed to

take place, the timeframe for completing the work, and for producing a cost estimate for the restoration.

Consulting engineers began discussions with Utilities personnel about creating a 3-dimensional model of the plant as it existed after the fire. At that point, staff from the Colorado Springs Utilities Land Base Services (LBS) team was called to assist with this process. Since early 2010, CSU staff surveyors have utilized 3D laser scanning to document and model existing conditions at numerous CSU sites; supporting maintenance and upgrade activities for the organization’s infrastructure. Laser scanning for 3D modeling is a rapidly evolving tool at Colorado Springs Utilities that allows field survey personnel to safely and remotely collect massive amounts of spatial data in real world environments.

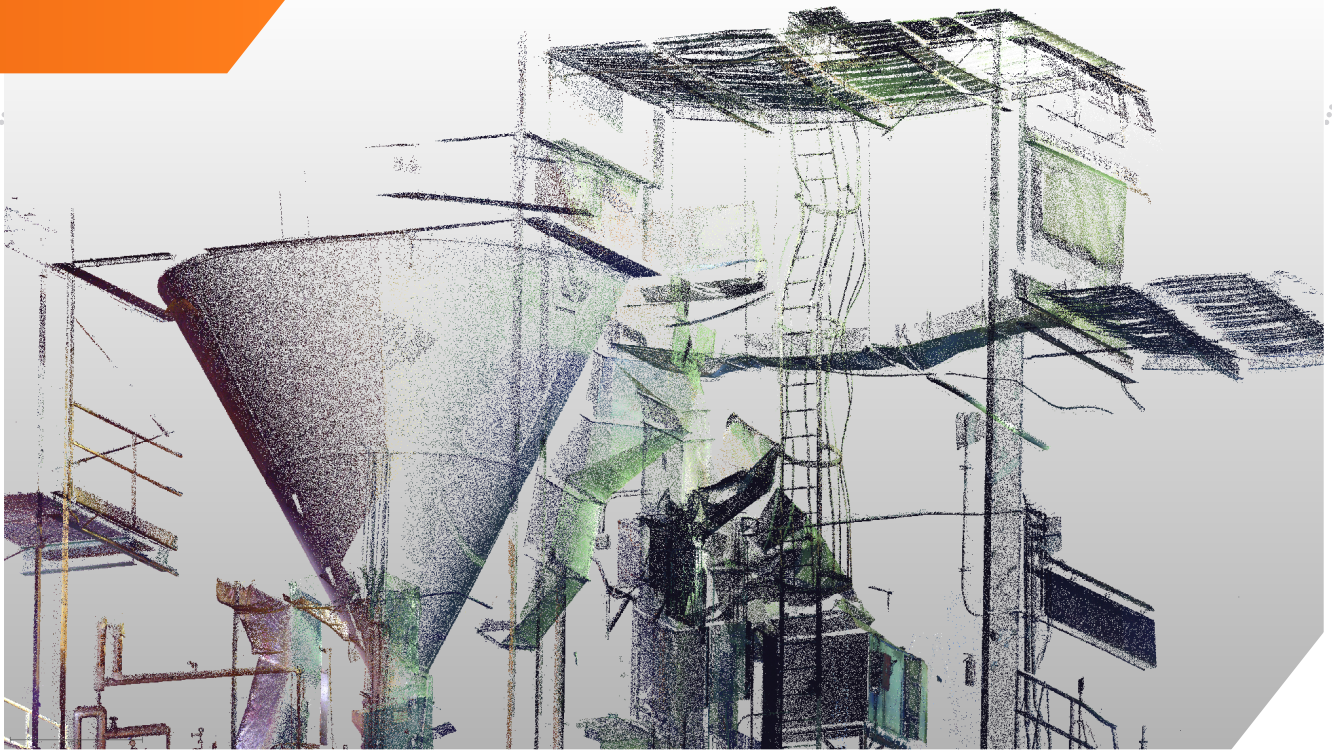
Many of the projects that LBS has undertaken have included engineering support for electric substations, wastewater processes, development of detailed topography, reservoir/tank volumes, conducting equipment inventories, parts fabrication, construction documentation and the emerging use of Building Information Modeling (BIM). BIM can be thought of as a holistic “3D GIS” which can follow the lifecycle of a building, project, or any piece of infrastructure. For Colorado Springs Utilities, a BIM used for design and engineering can also be used as a

digital blueprint during construction and finally, it can be passed on to facility managers and operators as “reality augmentation” for enterprise O&M and data management. It was decided that these same types of processes could be put to good use in helping to create a 3D model of the Martin Drake plant.

The LBS team would use a Faro Focus scanner which can capture a scene at up to one million points per second as it surveys the plant. These points, each with a precise position (X, Y, and Z) would comprise a single “point cloud”. Multiple scenes would then be stitched together



Faro Focus scanner



Point cloud showing structural steel damage

using common targets. The dense point cloud would be viewed by itself for measurement and analysis or, geometry solids would be fitted to the points to simplify viewing and data storage.

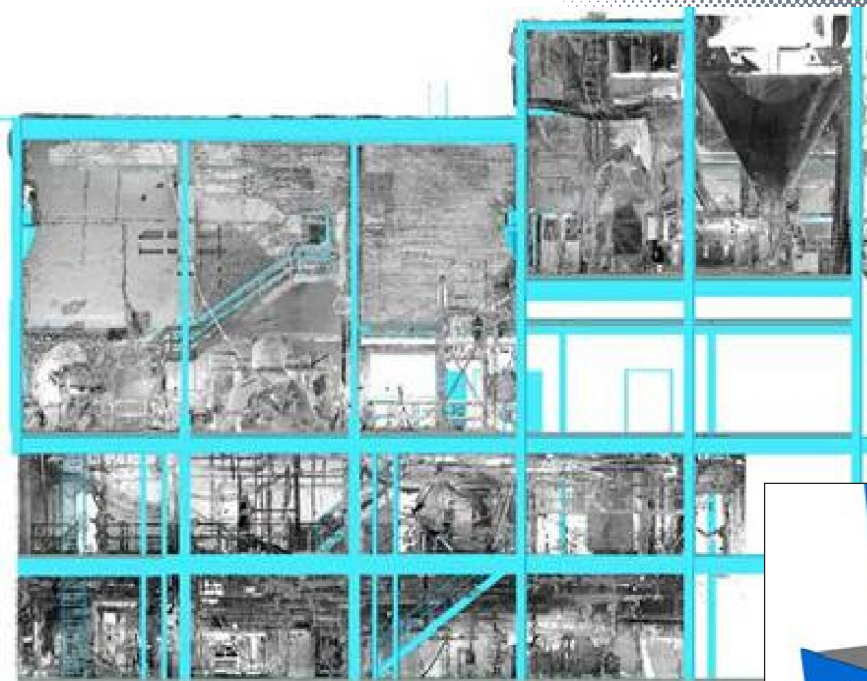
The Project

Consulting engineers wanted to assess the area around each power generating unit (as they had the most potential structural damage), and routinely requested laser scan data for this type of work. By having this technology in-house, a team of Colorado Springs Utilities surveyors captured the field scan data resulting in a cost savings to the project of approximately \$35,000 over the cost of hiring an outside contractor. Point clouds were acquired through the four levels of Unit 5 (basement, mezzanine, turbine deck, and de-aeration deck) and combined into one comprehensive cloud. Targets established by a highly accurate conventional survey and visible in the clouds were used to merge the clouds spatially relative to each other.

The actual work consisted of two phases: The first to establish survey control and the second was the actual laser scanning operation. The purpose of survey control was to provide a horizontal and vertical framework supporting the scanning data. This was accomplished by generating horizontal and vertical coordinates on control points throughout the work area. For this control survey, a Leica TS-15 Robotic Total Station system was used. The system included the total station which is a one second theodolite with an onboard distance meter. The instrument has a laser plummet and has a Bluetooth connection to a data collector. The total station specifications included a one (1) second angular accuracy both horizontally and vertically with a distance measurement accuracy of $1\text{mm} + 1.5\text{ppm}$. The data collector stored all of the measurement data, increasing efficiency and reducing the likelihood of transcription errors. Once the field work was completed, the data was provided to

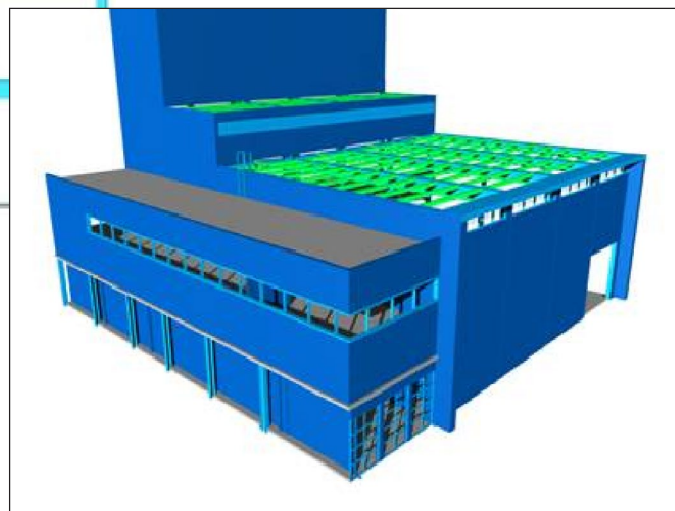
the scanner operator for incorporation into the Trimble Real Works least squares adjustment software.

The laser scan survey required a good deal of ingenuity, patience and pre-planning. The project area was undergoing cleaning and renovation. There were numerous consultants and cleaning crews working in the area. The fire had destroyed the electrical system making lighting of the scanning subject area an ongoing challenge. In total, more than 20 billion points and hundreds of photos across 80 scan stations were acquired, totaling nearly 1 TB of data. The point clouds were filtered, consisting of spatial and redundancy checks as well as spatial filtering at 1/16 of an inch. A smart filter was also applied to further reduce the size of the point cloud. The resultant data set was roughly 1 billion points or approximately 100 gigabytes. A subsequent field check of the point cloud was performed to determine the overall accuracy of control and laser scan surveys. Twenty well-distributed



Left: Point Cloud used as a reference during structural modeling

Below: 3D Model of Martin Drake power plant



points inside the project area from the basement to the roof were measured and compared against the point cloud. A total of 190 3D vector measurements were considered which resulted in a standard deviation of 0.025 feet.

After providing the data to the engineering consultants, they used the point cloud data to measure steel deformation, identify structures not present in paper as-built drawings (such as platforms/stairways), and to model piping networks. From this information, accurate models were developed as part of the complete restoration plan.

Conclusion

As with all of Colorado Springs Utilities scanning projects, the benefits are revolutionary and tangible. Analysis and measurement is done in “virtual scenes” from which detailed and dimensionally precise models are created. Initial capture of comprehensive data reduces site visits and provides a clear picture for remote designers. As a result, decision-makers now have access to a large amount of highly accurate spatial data allowing for more rapid and precise decisions to be made.

As an industry, many utilities and other engineering disciplines are adopting 3D standards. The Colorado Springs

Utilities survey team continues to integrate these technologies and demonstrate the benefits of facility models during the design, build, and operation lifecycle.

With the implementation of the **Southern Delivery System**, the Survey Team is using scanning methods at the construction of a water treatment plant to collect information for electrical conduit in form-work before massive concrete pours. The result is a spatially accurate record of where the conduits are located and will be used in the future as a tool to avoid critical and/or dangerous systems during drilling and installation of equipment on concrete flooring.

By associating QR Codes of individual pieces of equipment or building spaces with scanned data, users can use a tablet or phone to immediately access point clouds, associated models, and tabular data relating to that item. The ability to “see behind the walls” has become a reality.

As our LBS staff likes to say: We live in a 3D world—technology allows us to model it as such! ■

Gary Rust, PLS—Mr. Rust has over thirty years of experience in geospatial technologies. Mr. Rust has a B.A. in Geography from the University of Colorado at Denver and is a Colorado Registered Professional Land Surveyor. Having been with Colorado Springs Utilities since 2007, Mr. Rust developed and implemented new 3D laser scanning processes and procedures to the organization and is also researching Building Information Modeling functionality.

Rick Brewster PLS, CFedS, PMP—Mr. Brewster has nearly four decades of surveying, mapping and GIS experience half of which has been with Colorado Springs Utilities. He has been a Professional Land Surveyor in Colorado since 1992. In 2006 he obtained his Project Management Professional Credential (PMP) and in 2011 he obtained his Certified Federal Surveyor credential (CFedS).

Tim Thomas, CMS, GISP—Mr. Thomas currently manages the GIS and Land Based Services staff at Colorado Springs Utilities and has more than 32 years of experience in the GIS, mapping, and utility industry. He holds a B.S. degree in Geology from the University of Southern Colorado and holds active certifications as a Certified Mapping Scientist (ASPRS) and GIS Professional (GISCI).