

# Surveying Technology: 3-D Laser Scanning

Delivering real-time examples and virtual illustrations.

By Bryan A. Merritt

In today's world, accuracy, speed, and cost-effectiveness are key qualities that clients look for in a service provider. We are constantly seeking ways to do more in less time and using the latest technological advancements to take us there. However, in the engineering and surveying world, some project sites can be difficult to access for various reasons, including their historical significance, limited access, hazardous surroundings, etc. Until now our design and survey professionals have had to face these limitations, often putting themselves at risk and increasing project costs due to repeat visits to the site for additional data collection. Enter 3-D laser scanning, an ultra-precise system that analyzes an object and captures data accurately, quickly, and safely. A 3-D laser scan produces a precise "field condition" documentation of the physical space, like taking a snapshot in time that can be referred to and analyzed at any point in the future, in the comfort of your

own office on your own computer.

"3-D scanning provides an option to create a safe working environment for our employees to successfully complete assignments in a timely and efficient manner," says Richard E. Stees, PLS, Vice President and Transportation Core Business Leader at Erdman Anthony ([www.erdmananthony.com](http://www.erdmananthony.com)). There are many benefits to 3-D laser scanning, and it is revolutionizing the engineering and surveying world. Erdman Anthony has used this new technology on a variety of projects, and it has proven advantageous to both the firm and its clients.

3-D laser scanning, also known as Light Detection and Ranging (LIDAR), provides highly concentrated 3-D data points of existing site features. Together the data points are referred to as "point clouds." By using a laser pulse to measure directly to an object, physical contact with that object is not necessary. Thus, 3-D laser scanning makes field data collection safer and less intrusive on the daily operations of a site or facility.

For example, the need to access busy highways, overhead utilities, or active machinery is eliminated. Also, because of the enormous amount of data collected, 3-D laser scanning can reduce site investigation from weeks to hours, saving time, which

results in project cost savings to the client.

The 3-D laser scanner itself has two components: a digital camera and a laser. First, the operator takes a picture with the digital camera, then marks the area to be scanned. Next, the laser scanner rotates robotically to capture data at an incredible speed of up to 4,000 points per second or more. This rapidly reduces data collection time while also increasing the level of detail in the data gathered. Once the points are accumulated, the data is merged and produces a raw image. This raw image is then migrated into 3-D visualization software and design tools, which gives engineers and surveyors greater design power and capabilities and will allow clients to visualize before construction what the finished product will look like.

To summarize, the benefits of laser scanning include highly detailed 3-D data, safer and less intrusive field operations, enhanced design capabilities, reduced site investigation time, and access to areas not normally accessible. Because the scanner collects such a high level of detail, if the client requests additional data from a site, it has already been collected as part of the overall point cloud, and thus a return trip to the field is not necessary, providing an opportunity to reduce project costs.

The benefits of the 3-D visualization software are that it allows items to be placed and designed once; clients to visualize the end product before construction; greatly eliminates interferences and reduces construction rework; allows models to be used in construction by the trades; allows models to be easily used by the owner during design, for review, and after design as a building or



Digital "point cloud" of entire President's House excavation site.



**3D laser scanner in operation at lower section of historic steps.**

plant model; makes material management reports quick and easy to generate; and provides data utilized by other analysis or applications.

## Projects

Erdman Anthony has already successfully used this technology on several projects. For example, this Fourth of July, for the first time in history, a large-scale excavation was taking place on the site of a four-story mansion once lived in by George Washington and John Adams in Philadelphia. The former structure was also the executive headquarters until the White House was finished in 1800. Visitors were able to watch the excavation from an observation deck above. Erdman Anthony was hired by the National Park Service to collect data on the site using this 3-D laser scanning technology. The excavation continued until August 1, 2007, at which point it was scheduled to be closed. Because 3-D laser scanning was used, the site is forever preserved in digital form, and the data can be accessed at any time in the future for further study. A memorial will be built on top of the site that will include any artifacts that were found, the 3-D laser image, and other pictures/information on the former mansion.

Erdman Anthony utilized this technology on the Genesee River Falls located in Castile, NY. Letchworth State Park, renowned as the “Grand Canyon of the East,” is one of the most scenically magnificent areas in the eastern U.S. The Genesee River that roars through the gorge is 17 miles of river, flows over three major waterfalls between cliffs (as

high as 600 feet in some places), and is surrounded by lush forests. The park comprises 14,350 acres of scenic beauty and awesome magnificence, along with 26 individually designated, marked, and maintained trails, totaling 67.2 miles. Letchworth State Park is a hiker’s Mecca. Following a busy summer of campers and hikers visiting the park, the New York State Office of Parks, Recreation and Historic Preservation and the Genesee Region park staff conducted an inspection. As a result, they determined that parts of the trail may have presented a safety concern due to erosion over time. The client contracted Erdman Anthony to help evaluate design options and collect detailed topography of the trail. This topographic survey included stone walls and a walkway that was built by the Civilian Conservation Corps, immediately adjacent and above the 107-ft high Genesee River Falls. These areas had been classified as safety hazards, thus Erdman Anthony combined conventional survey methods with 3-D laser scanning to document the existing conditions of the eroding rock face located at the base of the falls. Mapping the gorge walls accurately was of key importance to avoid any possibility of future disaster, and given the tremendous accuracy of 3-D

laser scanning, the team was confident they could produce a quality survey. Laser imaging showed that the River Falls overlook was hanging over the gorge by ten feet; the rocks that had previously supported the overlook had eroded away. If any of the remaining support rocks gave way, the overlook and its inhabitants could fall into the river below. Because the team utilized this latest technology, the surveyors were kept safe and the project was completed under budget and within an accelerated time frame. This project won the Platinum Award for Engineering Excellence given by the American Council of Engineering Companies of New York.


The New York State Department of Transportation (NYSDOT), Region 8 approached Erdman Anthony for assistance with mapping pavement profiles and cross-sections on a busy portion of Route 17 in Orange County. The NYSDOT is designing the improvements necessary to upgrade Route 17 to Interstate Highway specifications. With an average traffic volume of over 2,000 vehicles per hour, the NYSDOT was looking for a surveying solution that minimized intrusion on traffic. Erdman Anthony recommended 3-D laser scanning and presented a plan that also



**“Black hole” undercut of Middle Falls.**



*View of President's House excavation site on day of scanning. Three targets were set to capture the entire excavation area.*

relied on conventional control surveying to meet NYSDOT standards and procedures for land surveying. Erdman Anthony's laser scanner was set up at 28 locations along the Route 17 highway shoulder. Each setup averaged about two hours, which included scanning at least 60 linear meters of pavement per setup and locating targets with known coordinates tied to the project horizontal and vertical datums. This survey method provided the NYSDOT with an accurate Digital Terrain Model of the pavement on an accelerated schedule, and eliminated the need for any survey personnel to enter the travel lanes. 

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