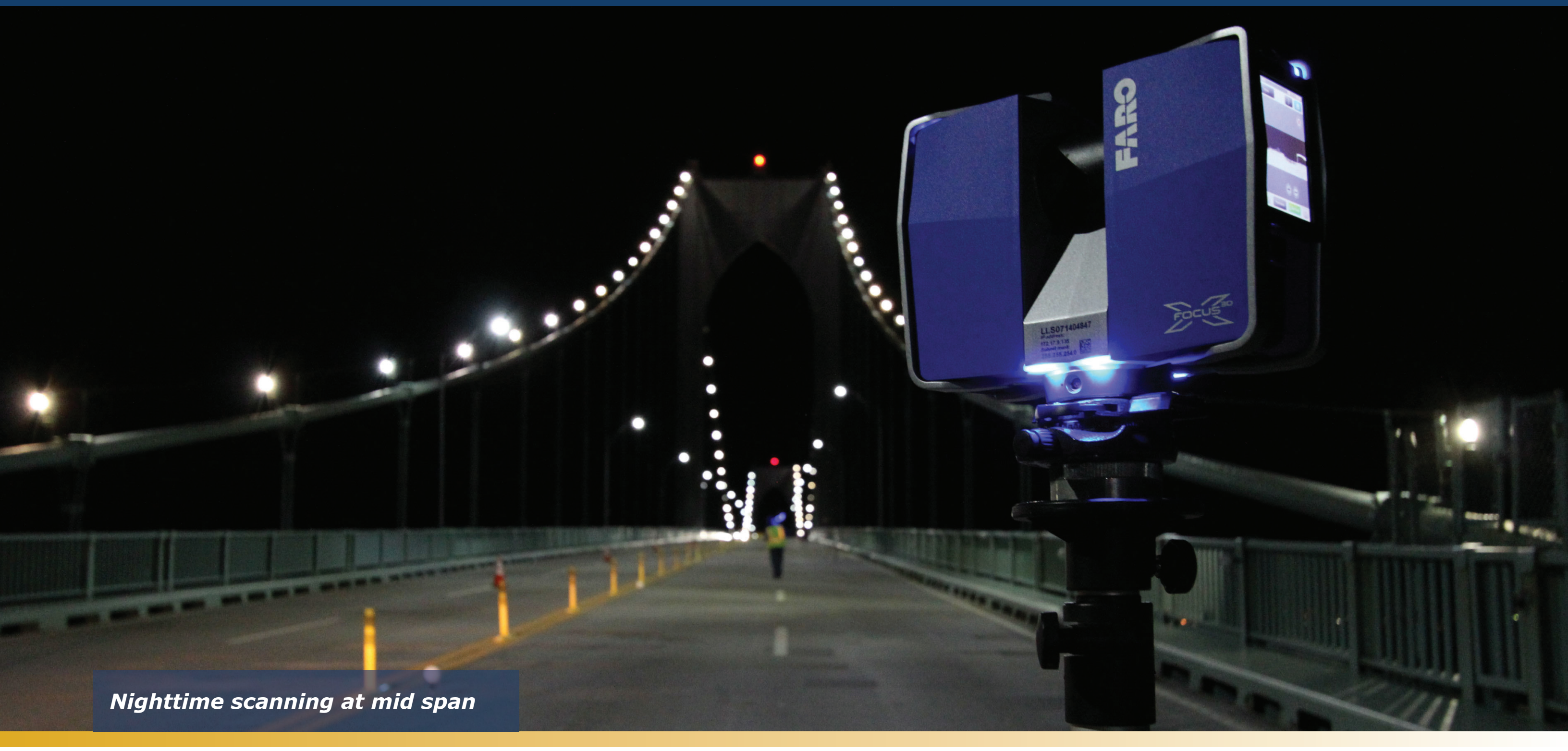
CASE STUDY



Nighttime scanning at mid span

Preserving Infrastructure with Point Clouds

JOHN SMITS, AIA The maintenance and repair of our country's infrastructure creates a need for an ongoing record of both completed and anticipated work items. 3D laser scanning's ability to quickly and accurately document existing conditions, yielding both visual and forensic information of surfaces, is becoming an important part of the workflow in developing infrastructure maintenance programs.

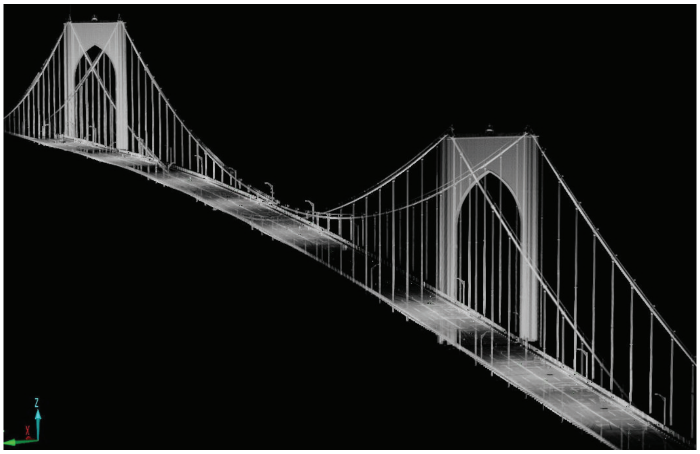
The Claiborne Pell Bridge connects Jamestown to Newport, RI. It is a suspension bridge, built in 1966, which covers a length of approximately 11,250 feet from abutment to abutment, with a suspension span of 1,608 feet. Bridges are especially susceptible to degradation over time. The salt air, constant traffic and daily expansion and contraction of the bridge's structural components all contribute to breakdown of the steel supports and road surface. Well planned maintenance and repair is critical to providing safe long term operation of the bridge.

Parsons Brinckerhoff was the original design firm for the bridge, and has been providing on going engineering services since its completion. While undergoing a structural maintenance program, the Rhode Island Turnpike and Bridge Authority (RITBA) inquired about the possibility of setting up a database that would catalog and identify all the main parts of the upper roadway, i.e. railings, scuppers, curbs, light poles, and most importantly, the numerous areas of patched asphalt concrete roadway. The ability to document the road surface within a cad environment would allow them to understand the percentages of roadway currently patched, the age of those patches, and where future monies might be required for new or replacement patches. It would also provide a base model of the bridge that the RITBA could add to over time, resulting in a real time model that updated modifications and repairs to the surface and structure.

Actus3D, a NY based laser scanning firm, was asked by Parsons Brinckerhoff to take a look at the bridge and offer some options for using 3D laser scanning to aid creation of such a database. The RITBA wanted to have a visual record of the entire 11,250 lf of roadway surface easily accessible by computer within their offices. The scan data was to be of high definition quality,

FARO, THE MEASURE OF SUCCESS and the FARO Logo are registered trademarks and trademarks of FARO Technologies, Inc. © 2014 FARO Technologies, Inc. All Rights Reserved. 04REF202-124.pdf Updated: 4/21/15

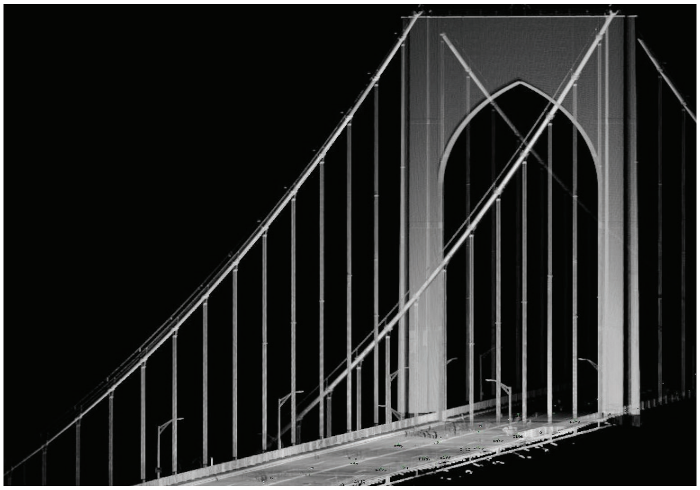
Preserving Infrastructure with Point Clouds



so that individual scans could serve as photographic references as well as measurable data within CAD. The final processed data would be required in a format that the Authority's own personnel could easily interpret and use for ongoing work. The data had to be scalable so that small segments of the roadway could be handled within the computer, eliminating the need to work with multiple data-heavy point cloud files too cumbersome for most computer systems. A deliverable of the roadway surface and the two adjacent sides of the bridge illustrating the railings, suspension cabling and towers was to be provided in CAD format. This CAD document would serve as the basis for indexing an excel database which would identify and clarify the various items delineated. The primary objective of this project was to document and draw the roadway with all patches and expansion joints displayed in place. A method of scanning that would yield adequate data for that objective was to be proven before approving the project.

Options of both mobile scanning and medium range terrestrial scanning were explored. Test scans were done off site to see the level of detail that could be expected from a road surface when scanned at night. The resultant data was also studied for its ease of use within CAD and ability to be manipulated within a viewer program application. Scans should also be able to be located and tagged to a roadway map, enabling a single scan to be brought up on the computer to be used for visual reference. After consideration of these and other factors, including speed of the scanner, station setup distances and targeting requirements, the decision was made to use a FARO Focus3D midrange scanner to scan the bridge. A test was conducted at the bridge within a lane shut down for maintenance. Scans were done at various levels of resolution and various distances apart. The results were shown to the RITBA, displayed within a viewer program that they would have access to at the completion of the project. The test data was also imported into CAD, so they could determine its suitability for producing a 2D CAD document that would be the basis for their final deliverable. Based on the test results, it was determined that scans set a distance of +/- 60′ (18m) at a resolution of 1/4 would yield a point cloud data return best suited for their needs.

The logistics of the project were then worked out. Access to the bridge was to be on weeknights only, from approximately 9:00PM to 4:30AM. With setup and breakdown, the team could anticipate a working scan time of approximately 6 hours. Use of a phase based scanner allowed us to gather significantly more scans within that time period than a time of flight scanner (given our spacing requirements). The bridge is four lanes, split with spaced traffic dividers in the center, creating a two lane roadway on each side. One side was shutdown for traffic, allowing a clear pathway for scanning. The plan called for the scanning team to start at the eastbound lane, and proceed scanning westward. Once that side was completed, the teams would then begin at the eastern end of the bridge and scan back on the westbound lane. Scans would be alternated on the west and eastbound sides, so final scan coverage of the bridge would have scans placed roughly 30′ apart. This provided an overlap of data from lane to lane, as well as providing clear scan data for each of the eastbound and westbound traffic lanes. The scanning team included a survey team from NY based Munoz Engineering. They used a Leica Scan Station for survey control, capturing existing bridge benchmarks and all scanning targets to allow a controlled geodetic alignment once all data was processed. Two scanning runs of 11,250 LF were to be completed within a timespan of ten working nights, over four lineal miles of road to

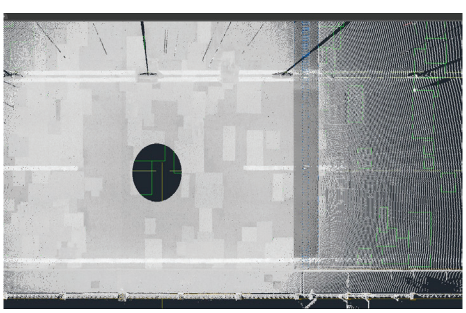


FARO, THE MEASURE OF SUCCESS and the FARO Logo are registered trademarks and trademarks of FARO Technologies, Inc. © 2014 FARO Technologies, Inc. All Rights Reserved. 04REF202-124.pdf Updated: 4/21/15

Preserving Infrastructure with Point Clouds

scan. Actual days on site ran longer. Weather was a factor, some nights were cancelled due to rain, and other nights scanning time cut short due to high winds and sporadic showers.

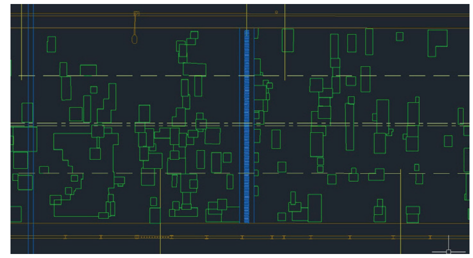
In order to insure a timely pace with the scanning, two FARO scanners were used for a portion of the project, allowing for additional coverage on the bridge within the limited nighttime scanning hours. A FARO Focus3D X 330 was used for a few days when scanning the center suspension section of the bridge. Its extended range allowed us to capture fine detail on the cables and towers. While the road surface data return was limited to a +/-60' distance due to the angle of inclination from the scanner, the towers and cabling were caught at distances of over 1200LF. This provided excellent data return on the cables and wiring, as multiple scans documented the items from various angles. While the use of an extra scanner yielded more lineal road coverage, it was far less than double that covered when using a single scanner. The survey scan station setups, locating of targets and the resetting targets between scans were all factors that limited the speed the team could move forward from scan to scan.



When completed, 380 scans were taken over a period of nine nights. Both FARO SCENE and Leica's Cyclone were used to process and align the data, with a final deliverable put together comprising all scans in FARO SCENE. SCENE LT, a viewer program, was given to the RIBTA along with the data. The scans were arranged into clusters for each individual nights work. All data was keyed to a scan location map that enables one to easily locate and view an individual scan for a specific area of the bridge.

The scan data was exported into Autodesk ReCap, setup in a file and folder system that mimicked the FARO SCENE data. This avoided any confusion when searching for a specific scan either in SCENE or in AutoCAD. The recap files were brought into AutoCAD, and used to create a plan view and elevations of the entire bridge. The data was used to locate light poles, expansion joints, manholes, scuppers, etc.; but most importantly the numerous areas of patches that were captured on the road surface. The point cloud data and CAD deliverables were given to both Parsons Brinckerhoff and RITBA for their use. Actus3D spent a few days in their offices training employees how to manipulate and utilize the data within the viewer program and CAD. A portion of the bridge's road surface on the CAD drawing was left for the RITBA employees to complete, which required them to import point cloud data and use it as a basis for drawing the road patches. This process enabled them to become proficient using point cloud data within CAD, as well as allowing them close familiarity with a cad file that will serve as the basis for ongoing maintenance programs at the bridge.

LIDAR has proven in this project to have value both as a data base for visual offsite reference, and as a basis for deriving large scale informative CAD files which illustrate the forensic findings of point cloud data while eliminating excessive data weight. The RITBA now has a well-documented, accurate computerized 3D data record of the bridge's condition at the time of the scan and a cad deliverable that documents the size and configuration of the road surface patches as



requested. This was all made possible by recent technical advances in phase based scanner capabilities and software, which provided highly detailed, accurate point cloud data that can be easily assimilated into a variety of computer programs.

LIDAR has proven in this project to have value both as a data base for visual offsite reference, and as a basis for deriving large scale informative CAD files which illustrate the forensic findings of point cloud data while eliminating excessive data weight. The RITBA now has a well-documented, accurate computerized 3D data record of the bridge's condition at the time of the scan and a cad deliverable that documents the size and configuration of the road surface patches as requested. This was all made possible by recent technical advances in phase based scanner capabilities and software, which provided highly detailed, accurate point cloud data that can be easily assimilated into a variety of computer programs.

About the Author

John Smits, AIA is a partner in an Architectural/Engineering firm and President of Actus3D, a laser scanning service and consulting company, both located in the NY metro area. He is a frequent lecturer to professional groups and oganizations on laser scanning technology, and author of various articles on scanning applications in the AEC industry.

FARO, THE MEASURE OF SUCCESS and the FARO Logo are registered trademarks and trademarks of FARO Technologies, Inc. © 2014 FARO Technologies, Inc. All Rights Reserved. 04REF202-124.pdf Updated: 4/21/15