California’s Santa Rosa–based Cinquini & Passarino, Inc. (CPI) is known for its creative approach to tough surveying problems. Even so, the initial face-to-face encounter with the Petaluma Trestle—a 500-foot length of rotting piers in slimy river mud along the Petaluma River—gave CFO Tony Cinquini, PE, PLS, a moment’s pause. “My first thought was: ‘How are we going to do this?’ I sure didn’t want to go underneath there, so there was no way I was going to send a field crew with conventional survey equipment into the area.”

The assignment itself was straightforward: to provide a 3D AutoCAD model that would show the number and location of piles, pile caps and beams in the 1922-vintage railroad trestle, so the City of Petaluma could proceed with a funded rehabilitation project. Once safely restored for pedestrian (and perhaps even trolley) traffic, the trestle is expected to become the centerpiece of a vibrant commercial venue on the riverfront.

By Gail Garabedian
Executing the assignment, however, was anything but straightforward. CPI had to document the structure of a trestle that was inaccessible on the upland side due to existing construction. Using standard survey techniques would mean shooting 400 feet across the river into the shadowy underbelly of the structure, with clear life-safety issues for the crew. “You can’t set your survey equipment in the river,” says CPI President Jim Dickey, PLS. “And you can’t set your equipment under the trestle, because that’s just slimy, slippery mud. We had to come up with a creative way to survey this project.” CPI elected to use a 3D scanner to get the job done. “We used 3D scanning, because we were able to both save ourselves time and be much safer,” says Dickey.

OVER THE EDGE
Having decided on the technology, the next challenge was figuring out how to scan the approximately 120 paper checkerboard targets set along the length of the trestle. Given the accessibility challenges, the targets were taped or stapled to the structure opportunistically: from a small walkway behind the trestle, through a hole in the plywood decking, from a free-floating dock adjacent to the structure at high tide and, in some cases, by cautiously slogging through the mud down below. Says Dickey, “The first criterion in determining target location was whether it would be visible by the scanner. The second criterion was whether we could reach it.” For most of the targets, CPI’s Trimble FX™ 3D Scanner could be mounted on a rolling platform and operated from the dock. Of course, this presented its own set of issues, as the dock was subject to seven-foot tidal fluctuations; because each scan could be completed quickly, however (in about two minutes at low tide) the vertical movement of the dock had a negligible effect on the accuracy of

Erik Vonderscheer setting scanning targets under the trestle and inspecting the trestle for accessible locations.

Erik Vonderscheer and Jim Dickey, PLS discussing how to survey the trestle.
the data. The scanner was cantilevered slightly off the platform over the water to get as close to the trestle as possible, and the data was collected straight into a laptop.

The trickier part of the job was scanning the trestle section that lacked an adjacent dock. Here was another opportunity for creative problem-solving, and Dickey met the challenge by designing and personally fabricating an eight-foot steel bracket, making it possible to suspend the scanner from the top of the trestle. Although it was considered unsafe to work for any length of time underneath the trestle, there was sufficient platform stability above to permit this innovative approach.

“One of the known benefits of the FX is that it doesn’t care what position it’s in,” explains Dickey. So over the edge it went, bolted onto the bracket which, in turn, was hooked onto the old railroad track and steadied by ropes on either side. (While the scanner can be in any position, it needs to be motionless relative to its target; the combination of bracket and ropes kept the FX stable during scanning.) It was nerve-wracking at first, but once it became clear that the bolt would securely hold the 24-pound instrument, scanning proceeded without incident. Each of these scans took about 20-30 minutes, including the time to set up the scanner and measure to target points, because it was necessary to finesse the bracket assembly through metal cables on the walkway every time it was moved.

**REGISTERED AND VERIFIED**

Back in the office, the raw data—which had been collected quickly, over a two-day period—was entered into Trimble RealWorks® software. “We went into each individual scan to find the target centers, and then we used that data to register the scans together,” says Cinquini. “We actually had some cases where we couldn’t see a target well enough, or just couldn’t match it, so we ended up using some physical features in the environment.” For example, the team used one corner of the “T” in a “No Trespassing” sign as a target.

After registering the 60 scans together, the team added survey control data obtained with a Trimble S6 Total Station, importing the S6 data directly into RealWorks. “We had to ensure that the target numbers and XYZ coordinates were correct,” explains Cinquini. “Once you run your survey control data, it basically reassigns a coordinate value for the target, and that brings your whole project into the project coordinate system.” With the entire point cloud registered together, RealWorks was used to define the location of all the piers; a cross-section of those objects, created using the pipe tool in RealWorks, was then exported to AutoCAD. CPI was also able to model the water line, the storm drain and the existing concrete retaining wall under the trestle. In addition, CPI used RealWorks to create the contour lines of the river bottom, which was visible at low tide.

Even the conventional survey part of the project had its challenges. “We were able to get a couple of terrestrial shots here and there,” says Cinquini. “For example, the top of the trestle had rotted plywood on it. The City had actually fenced off the trestle so the public couldn’t walk on it, but we were able to put a rod down there and give ourselves a few spot checks.” All targets were shot as reflectorless measurements, using the Trimble S6.

This and similar data served to verify the accuracy of the scans. It is worth noting that the scanning data and total station data fit together well: The scanner measures the 3D relations between a number of points, and the total station does the same. By obtaining two sets of \(\Delta X\), \(\Delta Y\), \(\Delta Z\) coordinate differences between pairs of points (one set from the scanner, and one from the total station), CPI was able to compare the delta values directly and confirm that they were in close agreement.
A SUCCESSFUL AND SAFE PROJECT

The City of Petaluma’s engineering consultant didn’t specifically ask CPI to scan the trestle. “We chose scanning as our work method to provide the topographic survey to them,” says Cinquini. “They were looking for an AutoCAD drawing, and however we got there was up to us.”

The trestle project was a perfect opportunity to put this technology to the test. “We had kind of been dabbling with scanning, looking for the right application for it, and this project just seemed to be a natural fit,” he continues. “Knowing what needed to be done, and knowing that we needed to reach the unreachable, it seemed to be the only option. The fact that the Trimble FX Scanner can be used in any direction is a huge benefit. I don’t think we would have been able to get this job done with any other scanner on the market.”

The City was happy with the results of the project, which was completed in a timely manner and close to the estimated budget. “We were impressed with Cinquini & Passarino’s innovative approach to a challenging survey project,” says Bill Silva, senior project manager with GHD, an engineering, architecture and environmental consulting firm. “They took the initiative to use scanning technology, since conventional survey methods presented safety issues. We are very pleased with the results.”

Concludes Cinquini: “The client learned how many piles were there, more piles than they anticipated. They also have useful data on walls, pipelines, storm drain inverts and the silt level under the trestle. They got the information they were asking for, and we got the protection for our workers that we require.” The iconic railroad trestle is now ready for the next step in becoming a major revenue-generating destination in Petaluma.

Gail Garabedian is a freelance writer based in Northern California.