THE American Surveyor

A FOOT IN THE PAST… AN EYE TO THE FUTURE

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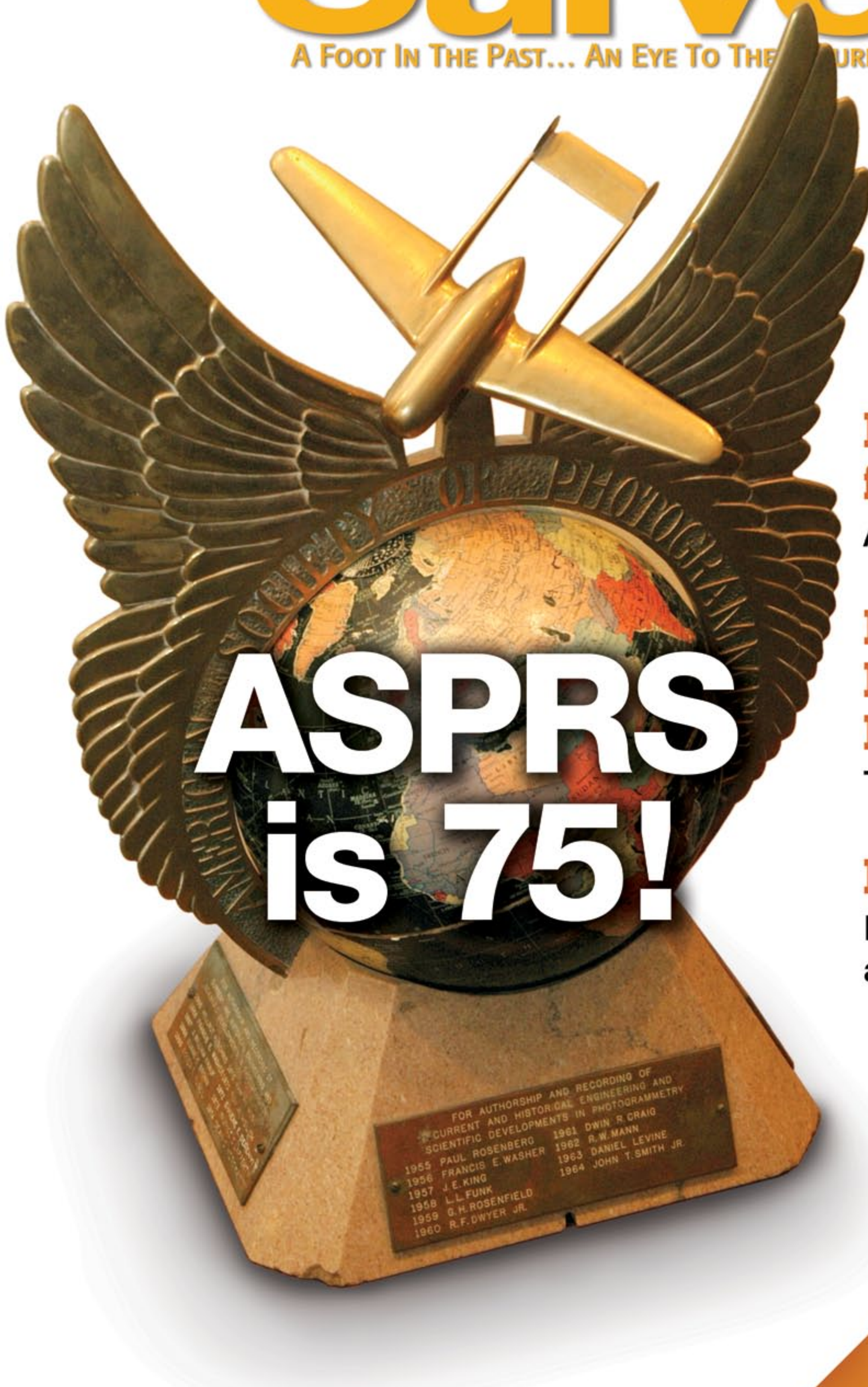

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RAPID-FIRE SURVEYING

When the Utah Department of Transportation (UDOT) set out to rebuild Interstate 15 south of Salt Lake City, the department needed accurate one-foot contour interval mapping and a digital terrain model (DTM). With accurate maps and models of the 20-mile stretch of freeway, designers could calculate precise earthmoving quantities. Those in turn would lower UDOT's risk of disputes over actual earth moved.

UDOT had an existing two-foot contour aerial map and a DTM, but they were not accurate enough. So Horrocks Engineers, the civil engineering design consultant on the project, turned to DEI Professional Services LLC, a 27-year civil engineering and land surveying firm, to do a new survey. One of the main reasons for selecting DEI is that the Phoenix-based firm has proprietary software that can analyze variations between accurate ground survey data and the existing DTM.

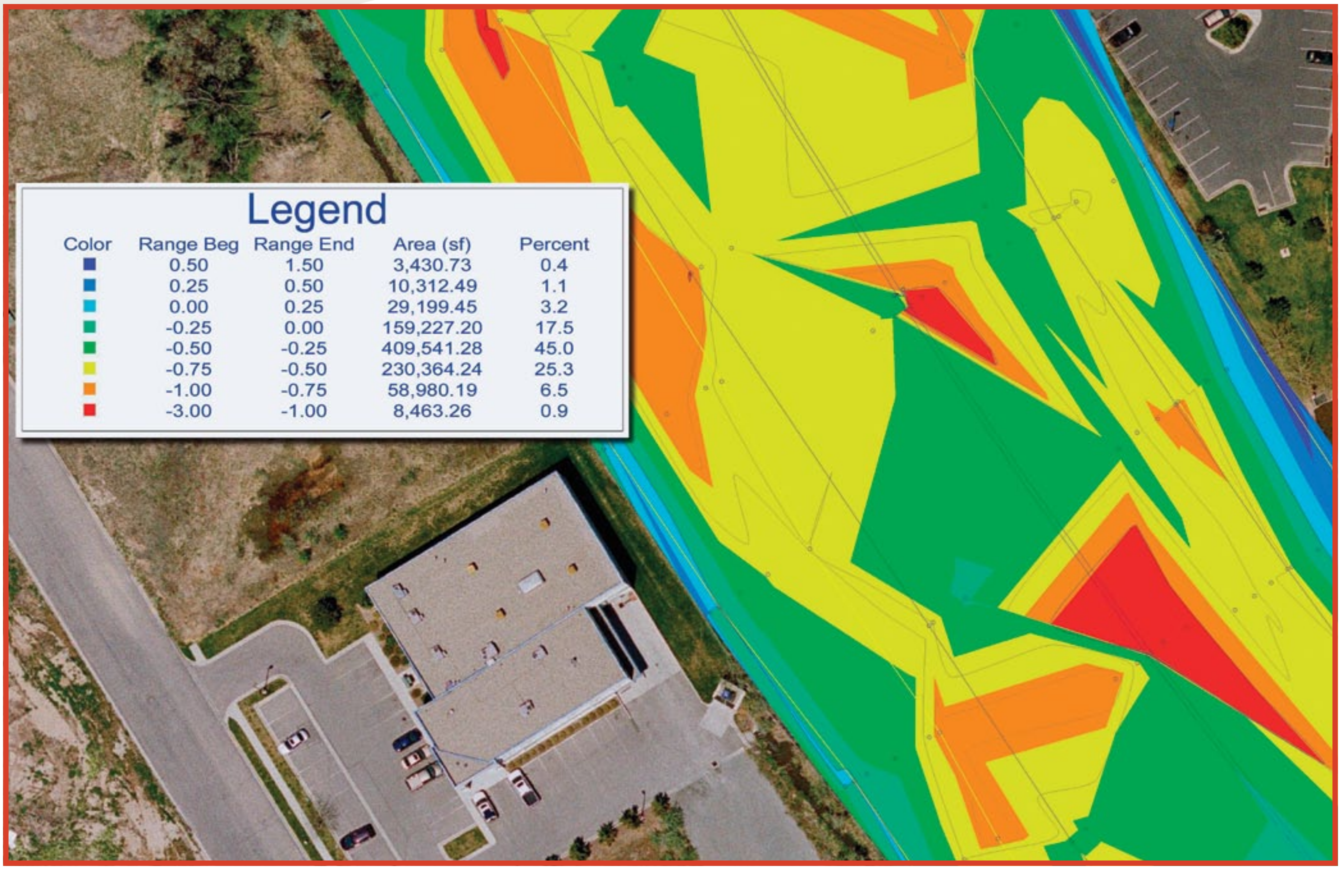
"Earlier mapping was done for environmental studies," says Greg Olson, a Horrocks principal. "Rather than taking the time to re-fly the freeway and map it that way, this gives us a quick way to supplement the original mapping with additional data and tighten up the original maps. The new digital terrain maps will be used to develop cross sections, earthmoving quantities and the like. The designers also use this data to set profiles and grades."

Called the I-15 CORE, this project is massive. It will eventually cover 43 miles. With a price tag of something close to $5 billion, it is the largest dollar-value project ever undertaken by the state (see sidebar).

>> By Jason R. Kack, LS

All photos by Luke Bingham, DEI

Dave Norman, a DEI survey crew leader, holds a Topcon FC-200 data collector for the robotic total station to collect a point.



DEI's proprietary software helps the firm analyze high and low areas along the I-15 CORE alignment. Red areas indicate where the original aerial map is too high; blue areas show where the original map is too low.

Robotic Total Stations

For Phase 1, DEI was assigned to survey the 20-mile stretch of I-15 with GPS technology and robotic total stations. As of last October, construction work was scheduled to begin in the spring of 2010, which allowed about a year for design–a very limited amount of time for such a large project.

Yet design work could not begin until DEI had completed the new contour maps and DTM. So the schedule permitted just eight weeks in late 2008 to complete the surveying, mapping and modeling work. DEI completed the 20 miles of surveying a few days ahead of schedule, but it wasn't easy. The eight-week schedule meant much of the surveying of the interstate had to be done at night, under traffic. We couldn't have done that work without the Topcon robots. They use a laser to track the receiver rod, so working in the dark was not a problem.

The survey presented three primary challenges: the size and time constraints of the job, the need to do much of the survey work at night, and the weather. Early snows presented somewhat of a problem, but the survey crews made up lost time by working on Sundays.

DEI began work in late September by checking 25 existing control points using Topcon GR-3 GPS equipment. Next we established 53 new control points on the primary corridor and

CORRIDOR FOR THE FUTURE

With a program budget of approximately $5 billion, the Interstate 15 Corridor Expansion project (I-15 CORE) south of Salt Lake City is the largest dollar-value project ever undertaken by the Utah Department of Transportation (UDOT).

The 43-mile expansion is part of an 840-mile route connecting San Diego, Calif., to Salt Lake City that was identified as one of six "Corridors of the Future" by the U.S. DOT in 2007. Construction was scheduled to begin in the spring of 2010. The project will involve rebuilding and expanding the capacity of I-15 to replace aging infrastructure and to meet the increasing traffic demand from Utah County, which is one of the fastest-growing counties in the nation. In 2010, the county's population is projected to be 560,000 residents; by 2030, that number is expected to exceed 907,000.

I-15 is a superhighway that carries up to five lanes of traffic both northbound and southbound. Along the northern portion of the 20 miles addressed in this article, UDOT will completely remove and replace the existing pavement and add two northbound and southbound lanes. On the south end, UDOT will add one southbound and one northbound lane. The I-15 CORE project also calls for rebuilding or modifying 11 freeway interchanges and replacing 55 aging bridges.

More than 7.5 miles on the south end of the I-15 CORE project, UDOT will add one southbound and one northbound lane.

Dave Norman back-sights a control point to set up his robotic total station.

110 new points on the supplemental areas such as interchanges and ramps. DEI also completed 18 miles of optical bench loops using Topcon optical levels.

Two Sections of Roadway

Because the existing pavement on the northern 12.5 miles being surveyed for the project will be completely removed and replaced, field measurements in that northern section did not need to be as accurate as in the southern section, where the existing roadway will be widened. To obtain the northern-section measurements, DEI used three field crews equipped with Topcon GPS systems, which are accurate to plus or minus 0.10 foot. DEI crews took elevations at 200-foot intervals on the pavement and at 100-foot intervals or less on the ground, depending on what the terrain dictated.

On the southern seven-and-a-half mile portion of freeway surveyed in Phase 1, designers and contractors must match the edge of the existing pavement with the new structure. To achieve the higher accuracies required for this part of the project, DEI used four crews equipped with Topcon robotic total stations (two 802a units and two of the new 9000-series units).

The crews set control points at 500-foot intervals along the edge of the pavement and placed two robotic total stations on each side. Each robot was set at 1,000-foot intervals and could shoot 500 feet to either side. That way, the robots leapfrogged each other as they moved down the pavement. The robotic elevations are accurate to within plus or minus 0.02 foot.

Everywhere we took a pavement shot with a robotic total station, we indicated flag elevations to the nearest hundredth of a foot at 50-foot intervals. The designers need our precise elevations to extend the cross-slope of the freeway. An additional crew with a Topcon GPS system gathered measurements from the soft surfaces in the dirt.

To survey 20 miles of freeway in eight weeks was quite an undertaking. We needed almost twice the people to shoot the seven-and-a-half-mile section with robotic total stations as we did in the northern section. Crews worked around the clock to gather the required measurements. DEI closed traffic lanes with reflective barrels at night. And safety crew members with flashing lights accompanied surveyors in the field to help ensure worker safety.

"On the Map"

In the office, DEI used its mapping capabilities to enhance the value of its survey data. We collected ground elevations and then dropped them onto the existing two-foot DTM. Then we used our proprietary software to go through the DTM and analyze the variations between the existing DTM and the actual field elevations.

In fact, DEI's software created a color-coded map that indicates the severity of those variations. The colors move through the spectrum. The red color shows where the DTM is too high, and on the other extreme, the blue color shows where the DTM is lowest. That gave us the ability to show UDOT how far off from the desired one-foot accuracy the existing map was.

Much of the surveying was done at night, under traffic, which required extra workers to protect the crews.

Using that ground data, we remediated the DTM to a one-foot level accuracy, and we produced a new one-foot contour interval DTM. The design engineers can use the new contour map and DTM for earthwork analysis, grading design, and drainage studies.

Supplemental Areas

In early October, DEI won a bid to survey 37 supplemental areas such as interchanges, ramps, underpasses and rivers. In those areas we were shooting complete detail at 50-foot intervals. We shot curbing, surface utilities, drainage structures, roadway signs, and traffic signals–total detail. For that work, DEI used Topcon robotic total stations for the hard points and Topcon RTK GR-3 units for the soft points such as natural ground and drainage ditches.

The hard points had to be within plus or minus two-hundredths of a foot. And the soft points only had to be within plus or minus one-tenth of a foot. For the supplemental areas, the deliverables were detailed drawings in Bentley MicroStation, which is the standard design software used by UDOT. Five crews worked the supplemental areas bringing the total number of crews on the project to 13.

Several factors contributed to the success of the project. Our staff made an unbelievable sacrifice. They basically dropped everything within five days' notice and moved to Utah. About 75 percent of our entire field staff moved to Utah for that eight-week span. Horrocks' management of the contract with UDOT and the support of the equipment dealers that supplied the Topcon instruments were also key. We couldn't have accomplished the project in the required time frame without any one of these three factors.

Editor's note: *In late November 2008, UDOT put the I-15 CORE project on hold due to budget concerns.*

Jason Kack is Principal and Survey Division Leader at DEI Professional Services LLC, in Phoenix, Arizona. He leads survey operations in all geographic areas of DEI including managing project managers in each office and remote facility. Jason has more than 20 years of surveying experience including extensive boundary, mapping and construction related survey projects.