SHORT STOPS

REDESIGNING A BUS STOP MAY SEEM SIMPLE, BUT ASSESSING ALL THE STOPS IN SWEDEN LOOKED LIKE AN OVERWHELMING TASK. **JOHN STENMARK** REPORTS ON AN APPROACH THAT HAS CUT THE FIELD WORK IN HALF

For the Swedish Road Administration (SRA), the effort to assess and update roadside bus stops seemed like a simple task. But with thousands of bus stops throughout the 450,000-sq-km country, the redevelopment effort threatened to become an overwhelming task.

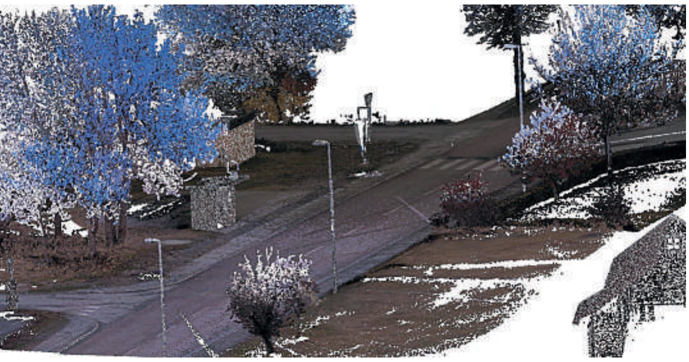
To design and implement improvements, SRA needed on-site field surveys to assess conditions at each location. But the scale of work posed serious issues for teams charged with collecting, managing and using the survey data.

To solve the challenges, a team of geospatial professionals has combined multiple technologies with customised workflows to collect, distribute and use the information. Their efforts have reduced field time by 50% and cut overall surveying costs by about 30%.

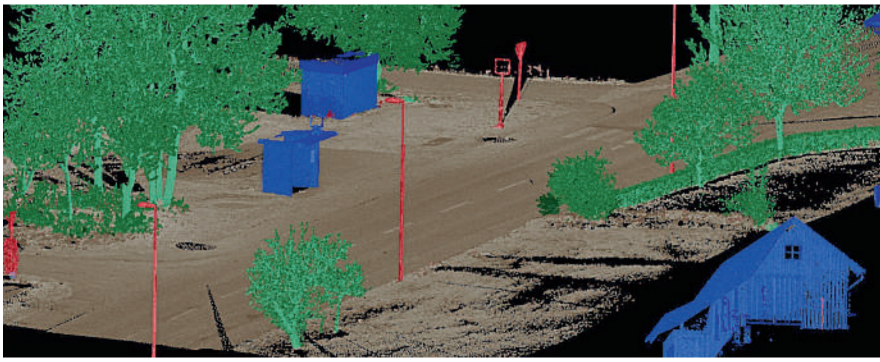
The initial work is taking place north of Stockholm in Uppsala county. Initiated last year, the three-year project involves reconstruction of stops at 100 locations in the county. With the simple title of "100 Bus Stops", the project will redesign and rebuild bus stops along two rural roads. The stops will be reconfigured to better serve blind and disabled passengers and improve traffic safety. For example, bus lay-bys are enlarged and some trees may be removed to improve sight lines for drivers and pedestrians. Other changes may include pavement marking, adjusting slopes and installing guardrails.

Bridget Coulter (left) and Annalena Hellström at work in the Swedish countryside. "There is no bad weather, only bad clothing," Hellström says

For the planning and design, SRA called on ÅF, a multinational engineering and design company. Founded in Sweden in 1895, ÅF has played a key role in Sweden's development as an industrial and socioeconomic powerhouse. Surveying and mapping manager Lennart Gimring says that ÅF has a long relationship with SRA on road and transport projects. The value of that relationship was apparent during project planning meetings where



Raw point cloud data produced by the SX10 and processed in Trimble Business Center (TBC) software. The ÅF team captured scans at each location



Processed scanning data highlights trees, structures and light poles. Simple colour-coding was applied in TBC

SRA's confidence in ÅF enabled Gimring to propose new approaches to data collection.

New approaches

After reviewing SRA's proposed methods for surveying the bus stops, Gimring suggested alternative techniques that would reduce field time and increase safety for the surveyors. For example, SRA had suggested using total stations for the work, including traversing between benchmarks. Instead of time-consuming traverses, Gimring pointed out that ÅF teams could use Sweden's national GNSS network to collect data at bus stops using total stations, scanning and GNSS. They named the technique RUFRIS (Real-Time Updated Free Station), which enables surveyors to establish precise georeferenced positions in areas where no control points or benchmarks exist.

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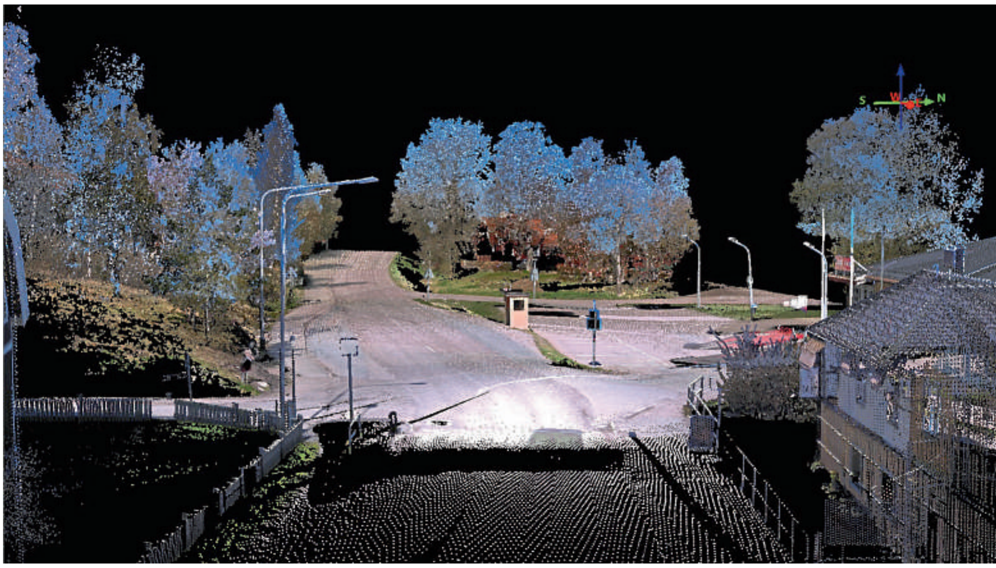


Scanning data output in LAS format is ready for viewing by stakeholders. Designers could work directly in the point cloud and make virtual "visits" to the site

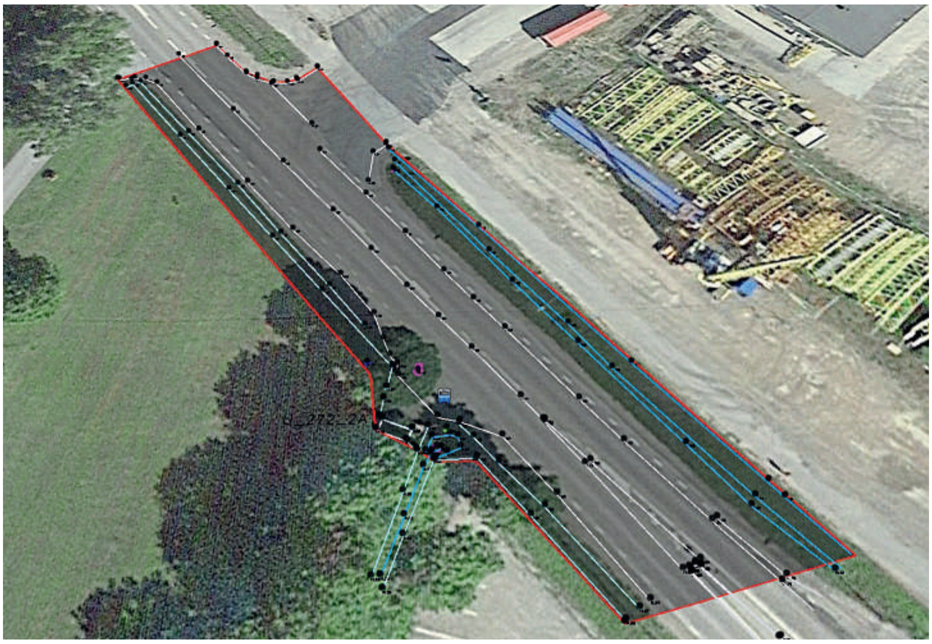
Gimring assigned the work to two engineers, Annalena Hellström and Bridget Coulter. "They were given a free hand to plan and execute the project," Gimring says. "My role was to convince the client that RUFRIS was the best approach."

With the green light from SRA, Hellström dug into the budget and planning. She used a simple project management tool that could be shared with stakeholders. To help with the planning, the bus stops were divided into groups of different priorities. The data was also converted into a KMZ file for use in Google Earth.

As the work covered a large area and was a long distance from their office, Hellström and Coulter needed to plan the fieldwork in detail. In addition to selecting driving routes, they planned their activities at each site.

"A quick look in Google Earth Street View was very helpful in this process," Hellström says. "In addition to getting ideas on where we could establish our instrument stations, we could also decide where to safely park our vehicle."

Hellström and Coulter used a Trimble R10 GNSS receiver and a Trimble SX10 Scanning Total Station to conduct the fieldwork. At each site, they first confirmed that they could work safely and stay clear of traffic. Next, they performed the RUFRIS procedure. Setting the SX10 in a suitable location, they used integrated surveying, in which GNSS receiver and prism target on a single pole occupy a point. With



Survey results from TBC as viewed in Google Earth. Accurate georeferencing enabled smooth transfer via KML files

the R10 connected to the SWEPOS real-time GNSS network, they obtained positions based on the national coordinate grid and vertical datum. At the same time, the SX10 measured to the point and added the data to the free station solution in Trimble Access software running on a Trimble Tablet controller.

A QUICK LOOK IN GOOGLE EARTH STREET VIEW WAS VERY HELPFUL

The RUFRIS technique allowed Hellström and Coulter to establish good geometry for the free stationing and enabled them to quickly orient the SX10 into the coordinate system. "The method was especially useful for us since no existing control points or benchmarks were available and high relative accuracy was required," Hellström says. "Because we were in the countryside, we had no problems working with SWEPOS and RTK. We had previously compared existing benchmarks against RUFRIS in other locations. Those comparisons demonstrated that surveying with RUFRIS was efficient and provided high accuracy."

Next, they split up the tasks, with Hellström using the R10 with a Trimble TSC3 controller to capture points for terrain modelling while Coulter worked independently using the SX10 as a robotic total station to collect details on pavement, structures and other features. In addition to capturing discrete point data, they used the SX10 to scan and photograph the entire site.

"Depending on conditions, we moved the SX10 three times at each location," Hellström says. "We also completed one to three full-dome scans as needed and captured panoramic photos."

Before leaving a site, the team established a benchmark point for use in subsequent visits (if needed) and construction.

An efficient path

When the team returned to the office, Coulter downloaded and processed GNSS and total station data in Trimble Business Center software (TBC). Because the SX10 automatically combines the multiple scans in the field, she needed only to import the resulting single point cloud into TBC. With all information captured in one georeferenced coordinate system, the different data types fit together seamlessly.

After completing quality checks, Coulter prepared files for delivery to ÅF's in-house engineering team. Output from TBC included drawing files for use in AutoCAD as well as LAS files for the point clouds.

Gimring says they coordinated with the engineering teams to help them use the full potential of the multi-sensor field data. In addition to assisting with processes to create digital terrain models from the field data, the surveyors also showed engineers how to work directly in the point cloud.

"By operating in the point cloud, we can bypass the work of modelling 3D objects," Gimring says. "People can make direct measurements and extract exactly what they need."

With the complete data in hand, the engineers then developed plans for updating the bus stops.

The value of the scanning data became most apparent during the engineering phase. "It saved a number of revisits," Hellström explains. "If the client wanted to add lines or objects, it's easily done from the point clouds. For example, the client wanted all big trees near the bus stops to be included, which was not in the original order. But it was possible to add the trees without returning to the site."

The finished designs were provided to SRA for construction. Design data from ÅF could

A bus stop in Uppsala County before and after updating. Safety improvements include wider lay-bys and improved pedestrian access. A new shelter and bicycle parking would be installed later


Annalena Hellström


Bridget Coulter

be viewed in Google Earth to aid stakeholders in visualising the planned upgrades. ÅF also exported information on benchmarks from TBC to Google Earth to provide ready access to control information at each site.

The approach developed by ÅF produced both immediate and long-term benefits. In addition to speeding the work at each site, the RUFRIS approach eliminated the need for traversing and levelling between existing benchmarks (if located) along with the associated issues for safety and guard vehicles.

Hellström notes that SRA was satisfied with the results and will promote the ÅF technique in future projects. Other safety benefits included the ability to capture points on the road from the point cloud instead of walking on the road. And reflectorless measurement enabled Hellström and Coulter to collect points on the road without being in or close to the traffic lanes.

The most important benefit came on the bottom line. "We were able to save time and money while working in a safe environment," Gimring says. "It's cutting costs without cutting corners."

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