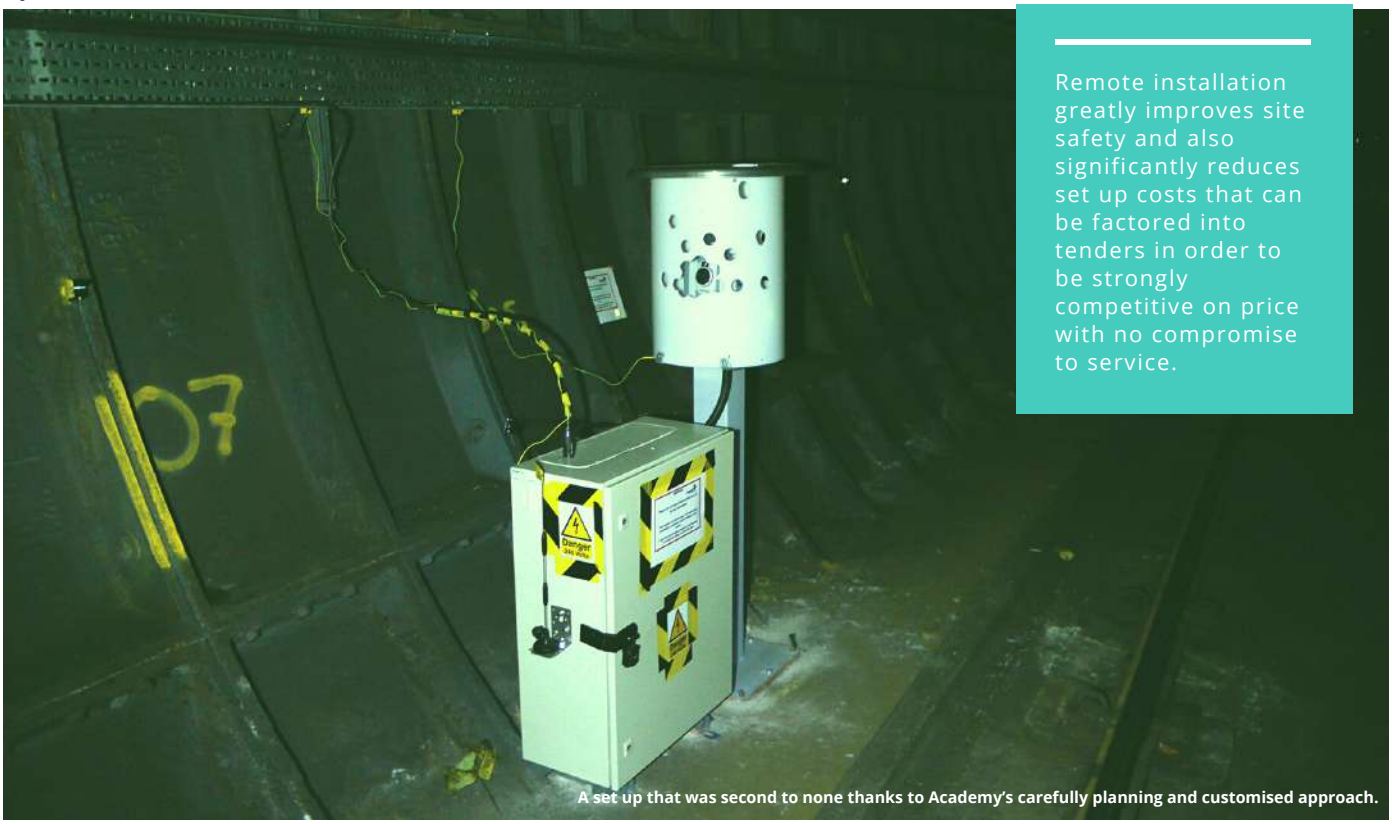
CUSTOMIZED AUTOMATED MONITORING SOLUTION SET UP FROM AFAR

A new level of automation provided via remote set-up to address safety concerns.

by Mark Anderson



A set up that was second to none thanks to Academy's carefully planning and customised approach.

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While development of the Newcastle city center continues as scheduled, there are many construction projects underway or already completed within the vicinity of underground sections of the English city's rapid transit system. These projects often require careful monitoring of sections of the rail network.

Unique Challenges to Overcome

When one of the construction projects was ready to begin in Newcastle's city center, Gateshead-based Academy Geomatics Ltd. was recommended to design and install an automated monitoring system for the metro tunnel that could be affected by the work overhead. A tailor-made solution was created to protect the in-service metro tunnel by addressing a unique set of challenges that included:

- Lack of access – the site was within a live metro tunnel, so could only be accessed for a short period of time during the night.
- Limited space – in previous locations within the metro tunnel, there had been insufficient room to install a total station so a laser scanning method was used on a weekly or bi-weekly basis.

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However Academy Geomatics advised the client that during critical phases of the job, such as piling, more frequent measurement would be required.

- Requirement for client assistance – the construction company undertaking the work would need guidance in both the system set up and understanding the automated results and long-term logistics for the site.

- Communications – if data was to be transmitted from the tunnel, robust transmission of this data would be imperative with a possible requirement for 280m of fiber optic cable run through a vent shaft.

- Need for additional sensors – the tunnel was a cast iron ring section, which means heat could trigger movement through expansion that would need to be recorded.

- COVID-19, cost and time – restricting the number of site visits to an absolute minimum would be beneficial to all involved especially with these visits restricted to nighttime.

Tailor-Made Solution

Responsible for finding a solution to the site's complex demands was Academy Geomatics Ltd. director, Mark Anderson. Having previously managed metro monitoring jobs, Mr. Anderson included a 3D laser scan of the affected tunnel in his initial investigation of the site. The scan revealed that through careful positioning, there would be enough room within the tunnel to place a total station and consequently, Mr. Anderson was able to suggest two potential solutions to the client: one involving the total station and an alternative method using tilt sensors. The client elected to use the total station method favoring the ability to generate absolute displacement values over the extra cost of using a total station.

As a long-term user of Trimble equipment supplied by KOREC, a Trimble supplier, Mr. Anderson used both his own knowledge and that of the KOREC monitoring team to create a tailor-made system that would suit all of the client's requirements and the dictates of the site. His final solution comprised a Trimble S7 1" Total Station, chosen for its reliability, a KOREC supplied Trimble Settop M1 total station controller, back up battery and charger, and Trimble 4D Control real-time monitoring software (T4D). T4D controls the measurement rounds, manages and analyzes the data and alerts, and additionally allows for extra sensors to be supported. In this case, a temperature probe was attached to the M1 box because temperature would be an important variable to monitor due to the possibility of expansion of the tunnel's cast iron ring sections.

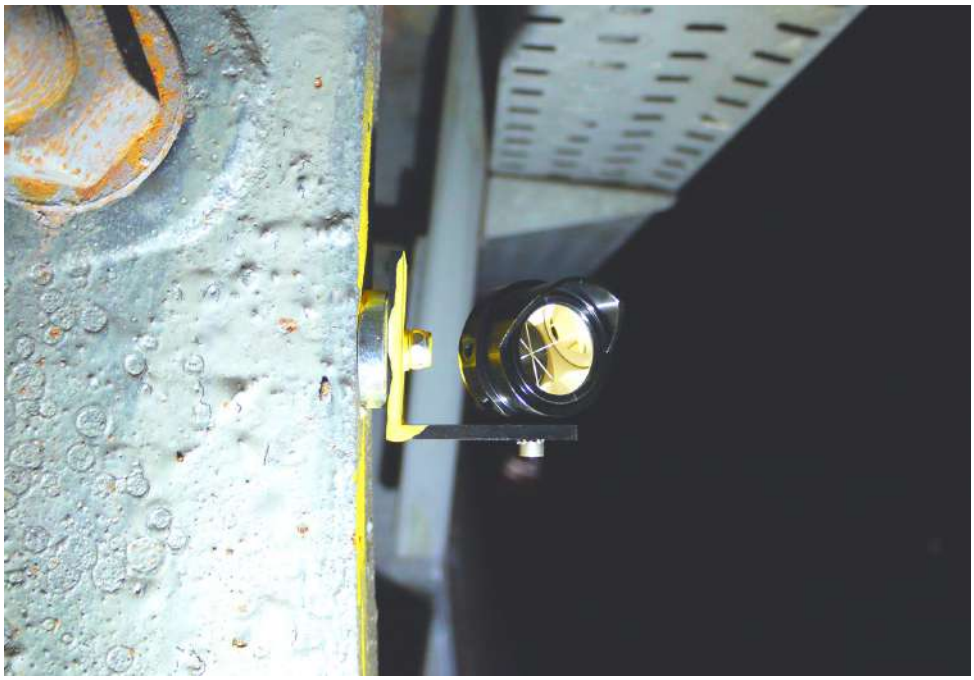

Figure 1: Information from a 3D laser scan was used for the best positioning of the 100 prisms.

Maximizing Space and Time

A walk over of the site revealed there was sufficient mobile phone coverage to ensure seamless communication simply by placing the relevant SIM card in the Settop M1 box. Meanwhile, power was provided to the instrument via 150m of armoured cable that was pulled and then installed in cable trays - one of the most problematic parts of the project that involved the Academy team crawling under platforms.

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With communications and power in place, Mr. Anderson addressed the limited access times and limited instrument area by using the 3D laser scan he had carried out during an earlier visit. The scans enabled him to plan the exact position he required for the instrument's installation, to design and order a customised casing that would protect it for the duration of the project, that it would fit within the restricted area and additionally ensure full line of site to the prisms. The scan was also used to model Academy's set up of 100 prisms, a number dictated by the extents of the site and the piling plan. The scan confirmed the prisms would not be placed too close together, they were all visible by the Trimble S7 and were a safe distance away from the tracks. By carefully

planning their locations in advance, Mr. Anderson could make best use of his limited time in the tunnel.

Automated Set up – Safe, Efficient and Cost-Effective

Over the course of one night, KOREC monitoring expert Julian Gray remotely configured the Trimble M1 Settop box, without the support of on-site staff, to get the monitoring system fully operational – all from the safety of his home office. Not only did this ensure the system was up and running almost immediately and was operational by the next nightshift, it also removed the need for access to the tunnel, additional travel expenses and the cost of having KOREC personnel on-site during the five night shifts. This was also the safest method possible during the pandemic.

Maximizing All the Benefits of Automated Reporting

The T4D software program was set up by Mr. Anderson to include automated alarms for any movement outside the predetermined tolerances along with automated reports, analysis charts, and custom and composite views. All the information and visuals were designed for clear and easy interpretation of the tunnel's behaviors by the client via T4D running on Academy's server through the web portal.

For Mr. Anderson, it was important that the client understood both the long term logistics of the site and how best to interpret the data. A project-specific guide was therefore created, which outlined how to use T4D by highlighting the various functions and best practices when viewing the data and also pointing out some of the better analysis charts to look at and the rationale behind them. Daily and weekly reports would also be issued automatically to interested parties via email. The automated alarms, if triggered, would report via email and SMS (text) to all relevant parties so site movement could be investigated in a timely manner.

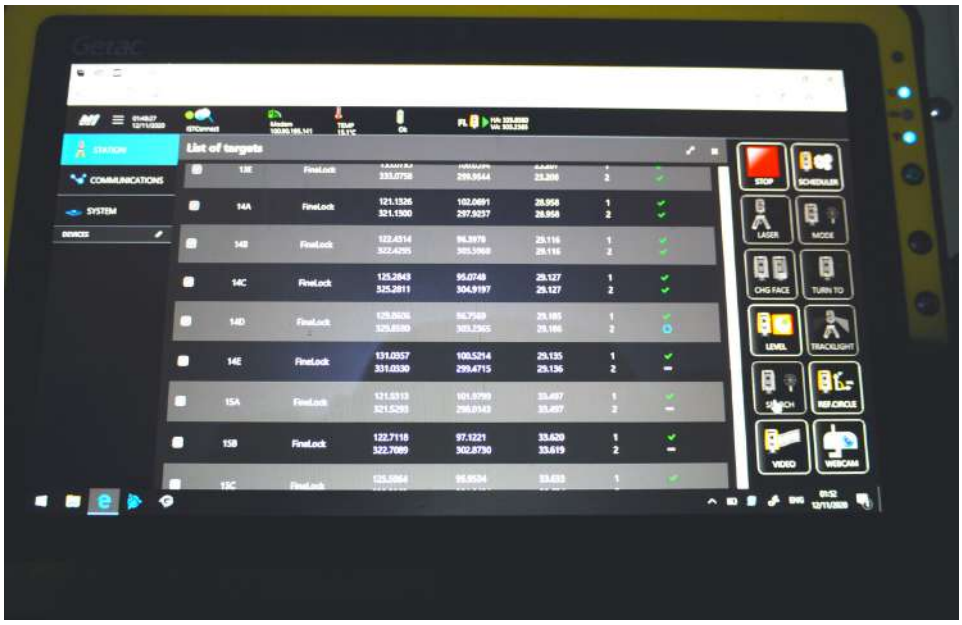

Figure 2: A project specific guide was created for the client to ensure best practices.

Mr. Anderson reported the system was up and running, and fully tested in preparation for before the beginning of the construction project. The system delivers unrelenting and constant monitoring (rounds every 30 minutes) with live data reassuring the client that their building activity is not unduly affecting the tunnel and therefore the safety of passengers. The system will deliver exactly what the client and Nexus (who provides, plans and promotes public transport in north east England) specified for this complex project.

Side Bar: Settop M1 – Communicating New Levels of Automation

The M1 total station controller has recently been relaunched with new software and is an extremely robust communication hub. When combined with Trimble 4D Control (T4D) software, the Settop M1 enhances the operation of a Trimble total station, combining the functionality of a field computer, device server, router and remote switch all into one device. This streamlines the number of components needed in the field and provides a level of remote installation unrivalled by any other system.

Remote installation greatly improves site safety and also significantly reduces set up costs that can be factored into tenders in order to be strongly competitive on price with no compromise to service. Additionally, KOREC's Julian Gray has developed software to feed total station raw data directly into 3rd party monitoring software as well as T4D making it a viable solution for all.

Figure 3: Key components - (Top) Trimble S7 Total Station and (Bottom) the Trimble Settop M1 controller.