Survey technology for rail infrastructure is gradually relocating. Increasing automation is helping to remove survey personnel from the tracks. Data collection is moving from dedicated vehicles to passenger trains, working at faster speeds and with less disruption. New line speed train-mounted technologies are being introduced that will revolutionise the way that data and asset information is collected on the railway.

And further change is on the cards. Network Rail is currently consulting with suppliers on new methods to improve future procurement of asset data, with an emphasis on health and safety, quality and efficiency. Offering multiple benefits to the rail engineer, survey automation is certain to play a central role. It ticks the all-important safety box by reducing the risks (and costs) associated with people working on or near the line as well as avoiding the disruption of track possessions. It also provides the potential to acquire more data more cost-effectively for use in the latest design software.

Additionally, output from automated surveys is sufficiently repeatable to indicate change over time, and sufficiently comprehensive to guide maintenance and renewal planning. Limited capacity on the network is fuelling demand for automation that can work on scheduled passenger and maintenance vehicles rather than dedicated trains to relieve an already congested system.

Track geometry
New developments in track geometry measurement are already solving this problem. The RILA system, developed by Fugro RailData in the Netherlands and recently adopted by Network Rail, measures the absolute position of the track in three dimensions at accuracy levels that support design whilst simultaneously capturing georeferenced forward facing video.

Crucially, RILA can be quickly and easily attached to any regular passenger train, taking measurements at normal operating speeds without expensive modifications to trains or changes in schedules or additional train-paths. Data collection is not just safer, but easier to plan and much more cost-effective.

This ease of use makes it possible to measure a large network as often as necessary without loss of track availability for train operators. The acquired data can be used as track survey data for (alignment) design, BIM-modelling, the calculation of track quality parameters, as well as vehicle behaviour and comfort parameters.

The system is connected to the train by a specifically-designed coupler adaptor in less than two minutes at any terminus station. It supplies absolute track position, gauge and cant at line speed with data collected in a fraction of the time of conventional ground based surveys. Track profiles are collected using an integrated laser and imaging system that computes position and orientation from on-board GPS and inertial measurement systems. The system is currently cleared to operate at 100mph and at this speed will yield profiles at 1cm intervals with an absolute accuracy of ±10mm (plan) and ±15mm (height) and relative accuracies of 5mm over a 200 metre distance. Individual profiles have a relative accuracy of <1mm.

Additionally, the system captures simultaneous forward facing video during collection that can be used as a desktop tool for asset management and condition inspection.

With a high absolute accuracy, RILA is readily meeting the specifications of an increasing number of European rail operators. Network Rail is the latest, having approved the system for a range of engineering design applications. Acceptance followed stringent testing on a Colas Class 47 locomotive and then using the BSI coupler for Northern Rail Class 150, 156 and 142 passenger services.
Imaging powers

Since modular systems such as Fugro RailData’s RILA are so easy to deploy, they empower designers and asset managers by providing a suite of robust, reliable measurement information that would have previously been beyond the boundaries of most project budgets or programmes.

RILA information is being used by designers working on electrification and route upgrades and is also proving attractive to High Output track renewal teams for optimising design and checking the finished product. Whilst capable of impressive productivity, state-of-the-art track renewal machines are expensive to run, requiring a sizeable labour force and mostly constrained to short overnight possessions. Any delays caused by quality issues, for example, take a heavy toll on budgets, programme time and ultimately customer service.

Innovation to deliver safety, accuracy and efficiency

Achieving high quality track installation and rail bed maintenance requires high accuracy and rapid verification of track geometry.

The Trimble GEDO Vorsys is a premeasurement system for tamper machines which provides that high level of accuracy required by the railway industry with operational speed and flexibility.

Imetrum Video Gauge is a non-contact precision measurement video monitoring system ideal for when you need to accurately measure dynamic deflection at a distance with real-time feedback, and under train loading, all with sub mm accuracy.

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Pre-renewal, RILA can be used to screen for any anomalies or stability issues with the existing track that can be addressed during reconstruction. Post-renewal, it can deliver high accuracy data for all-important quality assurance - to check that any pre-existing issues with the trackbed or geometry have been resolved, and to troubleshoot any non-alignment or non-conformities.

Another area that can benefit is the pre-procurement survey, such as passing clearance analysis for introduction of new rolling stock. RILA data can be used to ‘model’ the kinematic window and spatial footprint of trains through curves, taking into consideration the associated track geometry as well as checking clearances with structures and other potential obstructions within the existing track environment.

Screening like this is now increasingly viable while also becoming indispensable in managing the risks of major investments, in fleet as well as track assets.

For an even more expansive view of the entire rail corridor while still onboard, Fugro has developed a complementary system, RAIL-MAP. This can be mounted to the front or back of any buffered locomotive or train, offering similar logistical as well as data quality benefits to RILA. It incorporates twin 360° laser scanners and a panoramic imaging system to supply ultra-high-density LiDAR point cloud data of the route.

The position of the point cloud data can be referenced using the highly accurate RILA track position data, providing an overall level of accuracy and precision not normally possible with conventional mobile mapping platforms.

Sub-surface surveying

Ground penetrating radar (GPR) technology provides a different but complementary view of track infrastructure. Imaging the subsurface to about a metre below the rails, GPR scanning is becoming a routine element in the asset data collection mix and the technology is getting quicker and more modular for use on a wide range of locomotives.

While it might not yet work at the speeds of RILA, it is certainly getting personnel off the lines, reducing track possession and ramping up productivity.

The picture provided by GPR allows asset managers to visualise the uniformity of ballast and foundation layers, highlighting places where further investigation or intervention may be needed. Users have found they can reduce the number of trial holes or window samples needed to characterise trackbed quality by targeting test locations from the GPR report. They have been able to pinpoint fouled ballast and hollow pockets where soft ground has been displaced with deep ballast and have been able to relate track geometry or ride quality issues to conditions in or below the ballast layer. GPR can also help map buried services and obstructions to ballast renewal or construction.

Today’s train-mounted GPR systems routinely collect hundreds of kilometres of data per day using multi-channel systems that typically scan three positions along the track using different frequency antennas to capture information from different depth windows.

Whilst the geophysical landscape has changed significantly in the last five years, it is likely to change more in the next five. The new generation of array-based GPR systems with many more antennae makes it possible to build a 3D image of the entire trackbed. The increased data density offers many benefits, such as the possibility to detect smaller targets including buried services and debris that could foul track renewal machinery.
As the value inputs and financial returns of survey data become more evident in rail asset management, so there is even greater appetite to integrate both acquisition and reporting to harness the ‘bigger picture’ for greater control of resources. In response, specialists with wider geoscience capabilities like Fugro are extending data catchment far beyond the ballast and track boundaries. With the addition of aerial imaging and remote sensing, as well as the latest 3D geophysical investigations, they are mapping and interrogating the wider rail corridor, above and below. Additional data-streams – on everything from ground strength and slope stability to the structural health of tunnels and bridges - can now be pooled for better decision-making across the asset life-cycle.

Remote imaging and measurement technology has enabled a step change in topographical mapping – with a growing range of outputs delivered more safely and cost effectively and generally without any ‘boots on the ground’. Aerial imaging enables detailed digital mapping of topography, albeit to a lower accuracy and resolution than RAIL-MAP, whether as a discrete ‘one-off’ survey or on a repeated basis to detect landscape change. Information can be used to spot slope movement, encroachment of vegetation, flood patterns and even details as subtle as a tilt in a tree angle - all possible precursors to change that could pose risks to the rail corridor. Another key use is mapping inventory – overhead gantries, signalling systems, trackside assets, bridges, culverts – which is essential for planning infrastructure upgrades and for general network management.

The UK rail network contains some of the oldest and most intensively-utilised routes in the world. Asset managers face a perfect storm of pressures to grow capacity, save money and reduce risk. The inevitable outcome is demand for a constant supply of accurate, reliable data that can be acquired without delaying trains; it is clear that the survey industry is responding with a range of technologies that look set to improve decision-making and consign many of the dedicated survey trains to the sidings.

Trevor Burton and Mark Thomas are business development managers with Fugro.

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**Bigger picture**

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