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INSIGHT: A MODERN DATA-DRIVEN APPROACH TO RAILWAY ASSET MANAGEMENT

KNOWLEDGE 200 TRACK

WHAT IS INSIGHT?

Insight is a modern computer application designed, built and patented by Network Rail (NR) to increase the data available about railway assets. This article will focus on the Track assets though Insight also contains data related to Signalling assets. Overhead Electrical equipment and Civils data is also starting to be included with Critical Rail Temperature and Stress Free Temperature intended to be added early in 2026.

WHAT DATA DOES IT USE AND WHERE DOES IT COME FROM?

The principal source of track related data comes from measurement trains. Measurement trains run over the vast majority of the railway network at intervals usually between monthly and six monthly depending on track category and speed of the line. The data these trains collect is used by NR Track Maintenance to identify track defects that require intervention.

The trains provide data from sensors relating to track geometry and visible defects using Plain Line Pattern Recognition (PLPR). Track geometry defects include twists, non-standard gauge, dips where rails join together, poor top, poor alignment and cyclic top which is where rail level dips on a wavelength that causes a build-up of energy in train suspension causing this wavelength to then propagate further over time. PLPR will identify missing rail clips, broken sleepers, visible rail defects and voiding or slurried beds.

Track geometry defects have historically been managed in a system called Track Integrated Geometry Engineers' Reports (TIGER) which is linked to Ellipse (the work management system used by NR Maintenance) and PLPR has been managed on PDF documents downloaded from the Patrol Coverage Tool (PCT). Insight improves upon both of these systems in different ways.

TRACK GEOMETRY DEFECTS - LIFECYCLE AND PREDICTIONS

Insight's advantage over TIGER is that historic track data for a defect can be quickly and easily accessed as shown in **Figure 1**.

The reason it is able to do this is because, where TIGER identifies any defect found as a new defect, Insight will check a detected defect's location against previous runs and if a defect of the same type has been previously detected there it will assign this as an updated occurrence of that defect. This is called persistence logic. This has been difficult to automate in the past because the accuracy of mileage from the measurement train is sometimes not precise enough; Insight makes it possible by comparing the new trace to previous runs to improve the relative accuracy. Defects often go through a lifecycle from Pre-Alert to Alert Level (AL) then to an actionable Intervention Level (IL). A defect number is assigned to a defect at its first occurrence in this life cycle and keeps the same value until it is closed within Insight.

Because historic data points for a defect are readily accessible within Insight, predictions are made for a defect for when it will become an

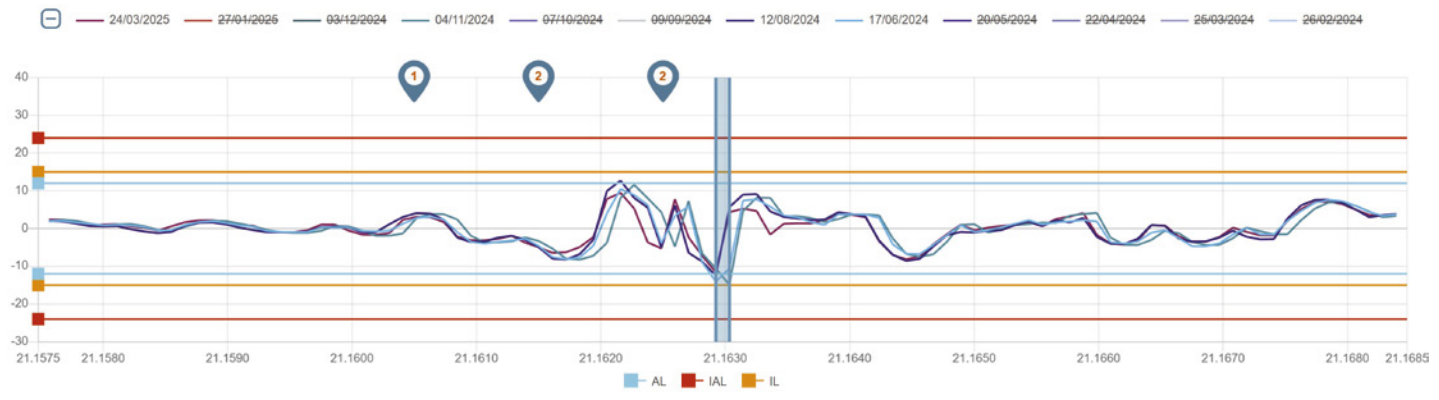

Figure 1: This shows the most recent recorded data and historic data for comparison. The lines show thresholds for defect severities with different timescales for rectification. Map pins show numbers of other nearby defects.

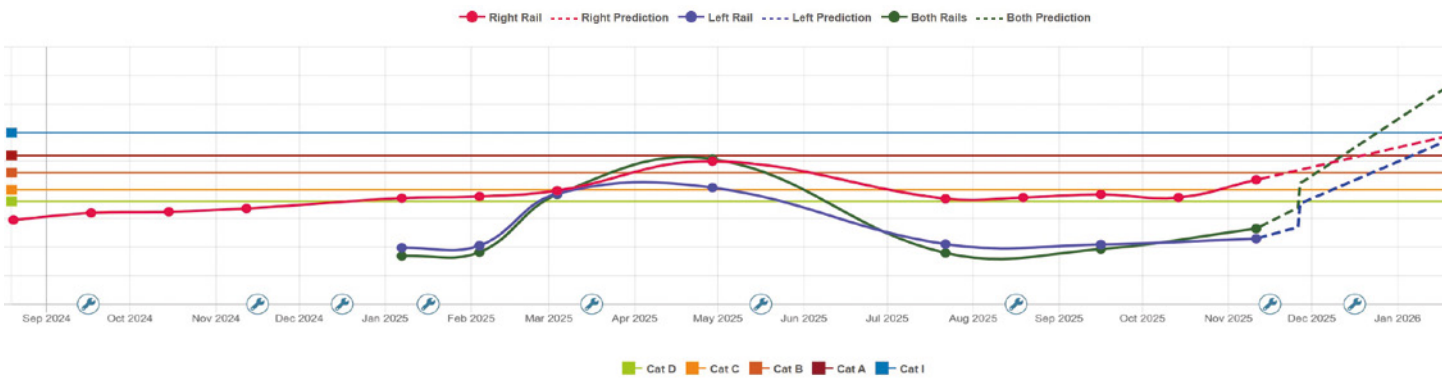

Figure 2: This shows the trace over time for a CT fault. The dotted lines show predictions; these are often stepped for CT faults as small changes lead to sudden defect development. Spanners show historic and planned interventions based upon work orders in Ellipse.

SEVERITY	RBM	ALERT	INTERVENTION	IMMEDIATE	RISK SCORE	REOCCURRENCE
IL	N/A	17/03/2025	17/03/2025		89.7	8
IL	N/A	03/12/2024	03/12/2024		121.6	7
IL	N/A	09/12/2024	09/12/2024	N/A	120.5	7

Figure 3: Three defects with the date each of them became IL defects. The reoccurence count shows how many times each defect has been closed and then been found again – the high number in these cases suggests normal maintenance intervention alone is not capable of fixing these defects.

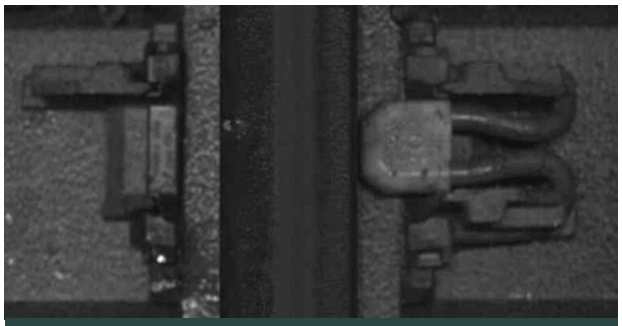

Figure 4: A missing fast clip along with a broken housing.

IL, as shown in **Figure 2** for cyclic top (CT) faults. These predictions are based on relatively simple linear regression models but there is potential to enhance these to consider various factors such as seasonal variations or even to reflect upon previous events and use weather forecasts to predict where intervention may be required following a severe weather event.

ELLIPSE INTEGRATION – INSIGHT AS A DEFECT MANAGEMENT TOOL

Insight went live in June 2022 but was limited to use as an analysis tool rather than a defect management tool. This changed in April 2024 when Ellipse Integration meant work orders could be created within Insight and added to the Ellipse workbank. These work orders then can be sent directly to the handheld tablets that the Maintenance teams use on site so defect details can be checked on site and the work order can be closed. The work order closure can be seen in Insight and the defect can be closed as rectified completing the defect lifecycle.

Insight is also able to identify, as shown in **Figure 3**, if the defect has occurred previously (Reoccurrence) within the last 450 days at a location which can help to make the case for a defect that has become "baked into" the track and may require a tamper, stoneblower or even a renewal to fix an underlying condition.

PLPR

Managing PLPR defects on PDF documents involves manual comparison with the Ellipse workbank to verify if any of the detected visual defects already have work planned to remedy them. Because these records are pen and ink on paper there is little scope to automate this process. As a result, it takes a significant time for a Track Section Manager (TSM) and a Section Planner to work through a patrol. The Maintenance teams are under considerable time pressures so being able to streamline this process is highly desirable.

Because Insight groups the multiple recordings of a defect into a single record, when a work order created in Insight is linked to a defect it is very easy to confirm that a work order is already planned to fix that defect. Insight won't include a defect in the list of actionable defects if a work order is planned which meets the assigned rectification timescale. Insight will alert you if the defect has worsened meaning the current timescale may no longer be suitable. The user can then arrange for the work to be carried out sooner.

The images that are available on the computer printout are small thumbnails whilst Insight displays the full images captured by the PLPR cameras. **Figure 4** shows the high definition captured in PLPR images; these images are collected by trains running at linespeed. In Insight the images can be made full screen and even zoomed in on. The picture quality assisted in a recent planning session to identify that what appeared to only be a missing track clip was actually broken housing.

The removal of the requirement to print out multiple sheets of paper to carry out the PLPR analysis exercise using PCT may have sustainability benefits as well.

RISK BASED MAINTENANCE (RBM)

As well as measurement trains, foot patrols are carried out on the network. In low-risk areas, especially if paired with difficult track access conditions such as long tunnels, an RBM regime may be implemented. This means that the foot patrol will not be required as frequently but intervention will be required at a lower threshold than the IL defect threshold.

Under TIGER, maintenance teams were required to manually compare defect details with the rules defined within local regime documents to identify what remedial actions are required and by when. Insight allows users to add the local regime rules so that RBM defects are automatically identified, and the actions presented to the users.

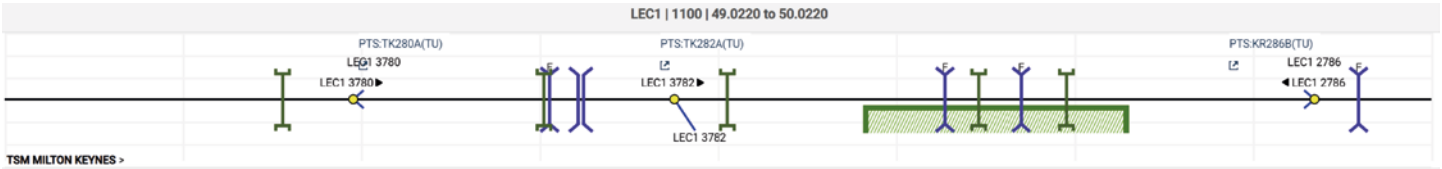

Figure 5: The asset schematic showing several lineside structures. Hyperlinks associated with S&C units allow viewing of that asset's Ellipse data.

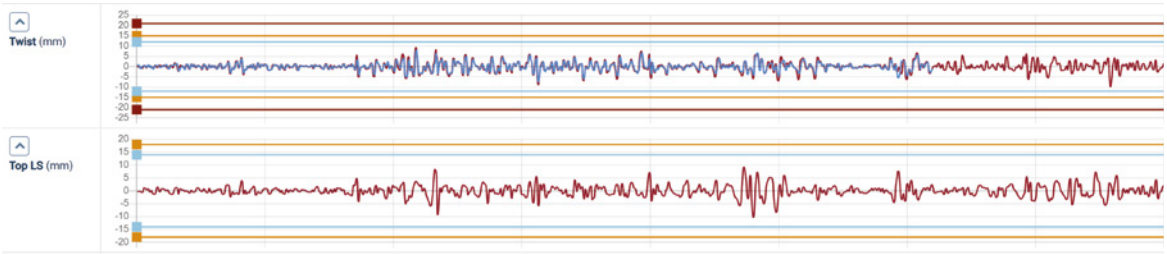

Figure 6: Different colour traces indicating different measurement dates.

LINEAR VIEWER & TRACE REVIEW

An aspect introduced in the last year is the Linear Viewer. This gives a visual representation of a wide array of railway data sources to assist in decision making. This provides many of the features that were within the Linear Asset Decision Support (LADS) tool. An asset schematic, as shown in **Figure 5**, is included which allows a user to orientate themselves with structures, earthworks and switches and crossings (S&C).

Multi-channel traces over multiple measurement train runs are available in-line with that schematic to allow analysis of changing conditions over time. This is shown in **Figure 6**. Users can add annotations either at a mileage or attached to a particular measurement run allowing decisions or considerations to be easily seen when reviewing these.

These annotations have the capacity to be incredibly useful to track designers for understanding the challenges that the track maintainer faces with a site which they have been given to design - these comprehensive thought processes and recurring themes associated with a site have been difficult to tap into unless a close relationship with the maintainer exists.

Track componentry, rail weight and age, track category and ballast age are included alongside the traces, as shown in **Figure 7**. In practice, these are not always the most accurate but having such a simple jumping off point can be a good indicator of whether accurate data exists or not.

TSMs and Track Maintenance Engineers (TMEs) are required to review their traces on a regular basis. Auditable trace review capability is available in Insight and is being improved based upon user feedback. Currently, users notice that extra data in Insight slows Trace Review sessions compared to paper-based sessions, but most agree it leads to better-informed decisions. The Insight team is working to speed up the data transfer with methods such as loading a smaller number of runs and only loading other runs on demand and allowing buffering of the next page's traces so moving from page to page is more seamless.

THE FUTURE OF INSIGHT

Listening to and responding to user feedback has been a core component of how Insight has been implemented. This is part of the reason track engineers, rather than IT professionals, have been used to roll Insight out in Maintenance depots.

Recent enhancements which are being adopted include Query Builder which is a powerful tool which will interrogate multiple databases and Core which gives a user-friendly interface to extracting information about Ellipse assets and incidents.

Further in the future is the Intervention Decision Support tool which will link to external systems to provide forward facing video and geospatial visualisations as well as measures of the effectiveness of previous interventions on a particular site.

Figure 7: A selection of some of the other data available in Insight's Linear Viewer.

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