Safer switches and crossings

A transformational switches and crossing train-borne monitoring service, developed between Network Rail and Porterbrook, is supporting a new path for safe inspection of assets, taking track workers off the manufacturing line and into a place of safety.

Safety Achievement of the Year

THE CHALLENGE

It's 2.13am. It's mid-November, dark, and you're two miles into a five mile walk. It's been raining since you began and you're way beyond damp. At the stage of cold where it feels like it's inside your bones. Your body hurts. Your eyes feel blurry from staring hard, dazzled by torchlight. You've looked at 10 point ends, there are still 16 to go. Then you'll have to drive an hour home before you can sleep.

Switches and crossings are the highest risk asset in track engineering. Network Rail standards require them to be inspected up to weekly in some areas. This is either done during the day, disrupting the passenger and freight services, but usually done manually by a track engineer who walks along the track at night during a possession and looks at the asset using just a torch.

Following a number of serious incidents, near misses and a fatality in 2020, the way Network Rail inspects switches and crossings has to change to accelerate safety for colleagues and passengers.

A NEW REALITY

It's 10.37am. It's November, just started drizzling. But that's fine as you're working in the office today. When you started up your computer at 9am there was an email waiting with inspection footage covering all 75 switches and crossings in your patch.

You looked through the first 15 whilst listening to Chris Evans, tea and a hobnob in hand. You've already had a team meeting on three serious looking stretcher bar cracks and made a plan of action to get a team out during tonight's possession ready with the right tools and replacement parts. You've also shared two faults with the signal and telecoms team which they wouldn't have seen for four weeks. You make another cup of tea.

This year has seen a significant shift in the way switches and crossings inspections can be carried out, with up to 50% of on-foot inspections now possible using a new dedicated service that harnesses train-borne monitoring technology.

This technology is:
- Inspiring a change in how the rail infrastructure can be managed.
- Helping engineers move to doing more of what they are best at (fixing and maintaining), confident that they can leave physical inspection to technology.
- The frequent recording of data generates an insight and an understanding of assets not seen before. As a result, railway assets can be safer than ever before because engineers know more about why, when and how things fail to prevent that being a reality.
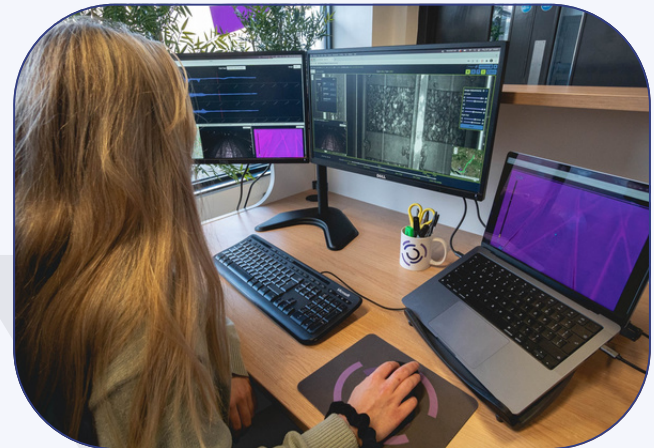
- The accuracy of the service has built confidence in technology, leaving engineers open to bringing more of it into their maintenance regime.
- It's also transformational in how the supply chain and Network Rail can work together to solve safety problems. As a priority of Great British Railways, joined-up working has been a default through the project and has meant a safer end result.
- It's demonstrated what can be done when everyone is on the same path and what's possible to unlock through teamwork and a 'can do' approach.

SIX MONTHS FROM IDEA TO SERVICE

In early 2021, a direct challenge came from the Network Rail board - produce something that would evaluate the ability to improve track worker safety for carrying out SC basic visual inspections – and get it up and running within six months.

Add to this a move where all maintenance work now must take place during line possessions or blockages, access to the railway is getting more difficult, time-pressured and focused on fixing not finding issues.

Following the clear call to action from the Network Rail board and a significant safety opportunity, no time was wasted in finding a solution. It meant thinking differently; harnessing visual technology instead of human eyes, establishing a focused team with solid engagement from all stakeholder groups and getting suppliers involved early to solve the challenge as a unit.

Network Rail's route and central teams set out requirements for a new service early on, which formed a specification for the solution:	With rolling stock a natural solution to meet the criteria, using an ex-passenger train would come with many other advantages:
- Forward/ rearward facing images + downward facing - Thermal imaging - Driver only operation - Can work day and night - Go anywhere - Work in traffic or in a possession - Data to desktop within 24hrs - Sub 1m locational accuracy, 100% of the time	- Cab each end for easy direction changes - Well supported by the industry (spares, maintenance, driver training) - In-built reliability - Speed - Route availability - Driver comfort and facilities - Environmental – reusing something that was to be scrapped

Led by Network Rail and Porterbrook, a multi-company project team formed and a solution took shape as a service; x3 ex-passenger trains kitted out with high-grade video and basic geometry measurement equipment then deployed onto the rail network as a dedicated switches and crossings monitoring service.

These autonomous visual inspection units (fondly known as VIUs) require driver only operation and use myriad cameras and thermal imaging to record high quality data about the condition of switches and crossings. The track visuals captured are to such a quality that you can see down to an individual bolt and are sent direct to engineers within as little as 20 minutes after recording. Engineers can view the data from a desktop computer, in the safety of an office – from there making informed decisions about what interventions need to happen and in what priority, to keep the railway running safely.

The service went from idea to a ready-to trial-train in just six months. Behind this was a cross-industry team who demonstrated tremendous collaboration throughout the project, drawing on the expertise of each member and coming together to work through barriers and blockers. It was a team keen to make progress and open to learning by doing not just discussion, and not letting a desire for perfection hold things up. Focus started from a place of "what can it do" not "what it can't do". Getting the units modified quickly and out into service allowed accelerated learning through end user feedback, thus allowing camera angles to be adjusted and lighting to be improved to get the needed image quality – but most importantly it has allowed us to develop the end user viewing platform to be very user friendly and intuitive. If something is easy to use, people will use it.

DG8 Design and Engineering transformed the units from passenger trains into inspection vehicles, with video and geometry technology added by Nomad, One Big Circle and Vista. The positioning system to pinpoint where faults would need investigation came from Machines with Vision using their RailLoc technology which provides locational accuracy down to 30mm. Colas trained up and provided drivers for the vehicles which Loram take care of and maintain at their base in Derby.

After six months development of the service it was put to action as a 12 month trial in Network Rail's Southern and Eastern regions. During this time, working with the maintenance teams, the systems have been enhanced to ensure the engineers get what they need to a point where it's been commissioned by Network Rail into a long-term business as usual service within a year of launch.

BOUND FOR THE SCRAP HEAP
...BUT WAIT!

A valued element of this solution has been the recommissioning of ex-passenger vehicles back into service. Ones that no longer had a purpose and were set for the scrapheap. This has set a new standard for how old rolling stock can be revitalised, supporting the positive shift towards a more environmentally conscious and sustainable railway.
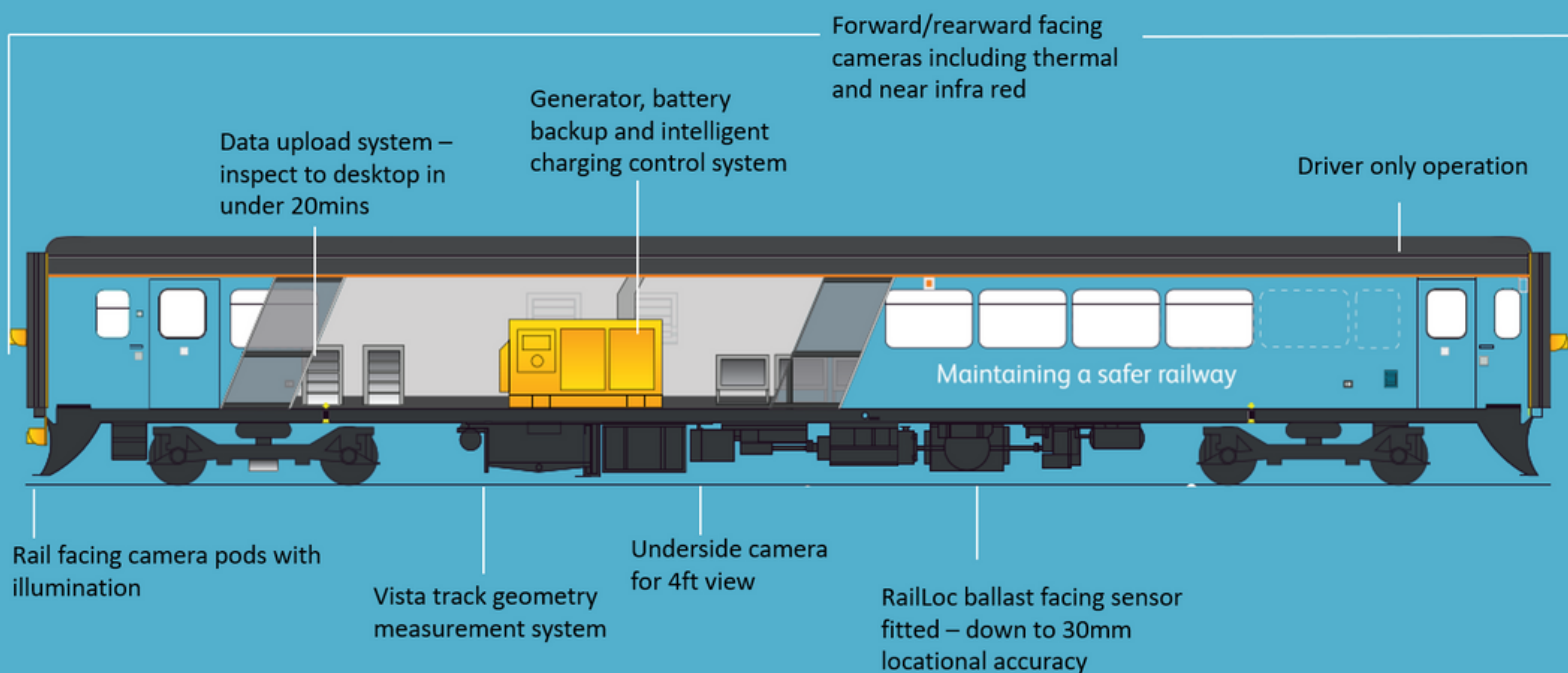
These specific vehicles had been on passenger carrying duties since they were introduced in the late 1980s, but the decision was made to not undertake modifications in line with the Persons of Reduced Mobility regulations, effectively ending their usable life as passenger carrying trains. The vehicles were withdrawn from East Midlands Rail in 2020.

The Class 153 train is the ideal platform for infrastructure monitoring. It is a single car train with a driving cab at each end, it has good gauge clearance, and the construction and maintenance of the vehicles are well understood making them easy to convert. Nothing much more sophisticated than that, but once in use we've found the trains to be hardy and nimble.

They are quick to deploy down most routes. Autonomous technology means a safer operation as with only drivers onboard fewer staff need to travel to and work on the trains, which run primarily at night.

How have the units been modified?

Data upload system – inspect to desktop in under 20mins

Generator, battery backup and intelligent charging control system

Forward/rearward facing cameras including thermal and near infra red

Driver only operation

Maintaining a safer railway

Rail facing camera pods with illumination

Vista track geometry measurement system

Underside camera for 4ft view

RailLoc ballast facing sensor fitted – down to 30mm locational accuracy

A SERVICE SHAPED BY ITS USERS

Frontline engineers were consulted from the outset about what they'd need to see digitally if they were going to forgo an in-person inspection of the track. Weekly sessions with track patrollers and other stakeholders helped shape the process to replicate what would be seen by the human eye on track, design the data interface led by One Big Circle and help to challenge and change current inspection standards.

The service wouldn't yet fully replace manual inspections as it can't replicate all checks and tests needed. However, it can support a mix; some patrols done manually at a much lower frequency and more carried out using camera footage from the units.

WHAT THIS MEANS FOR SAFER WORKING

With current switches and crossings inspections carried out in person by visiting a track, this comes with a number of risks which can be removed or significantly improved thanks to the switches and crossings monitoring service:

Working on the railway comes with train vs person risk of serious injuries, near misses and fatalities.

The new monitoring service means on foot inspections of switches and crossings can be reduced by up to 50% so engineers can spend significantly more time looking at the condition from the comfort and safety of a desk. This is forecast at 3,900 hours fewer boots on ballast in a year for one delivery unit alone.

With inspections often carried out in the dark using torchlight, colleagues can trip over assets and slip on ballast.

Travelling to and from the trackside comes with a risk of road and travel accidents. Redirecting people from track to desk removes these risks. Many inspections can now be done from an office, or even from home.

A cross on a map or a 360 view of the fault within 30mm accuracy before you arrive? Having video inspection data means engineers can plan their access and works delivery with safety in mind.

Seeing likely hazards, making an informed risk assessment of the area then taking appropriate tools or even expertise to remove and fix issues first time.

On foot inspection means the asset isn't being looked at under the load of a train – as it would in the real world. We know more about the track by inspecting whilst a train is rolling over the top which helps engineers prevent derailments.

This was a specific issue for Eastern region who have experienced a number of derailments as a result of faulty switches and crossings.

Inspections and rectification works are currently done in isolation of each other. That means the person who spots the fault, flags it for someone else (who hasn't seen the fault) to fix. That person is going to the track fairly blind, with minimal understanding of the issue. It's likely that they'll inspect it again before they can fix it. That means more exposure to the risks above.

Switches and Crossing monitoring footage can be used to look closely at a faults and spend time making a safe and clear plan before its rectification. Back at the safety and comfort of a desk.

MORE THAN JUST EYES ON THE GROUND

Although the original service purpose is to digitally replicate what the human eye would see when carrying out a basic visual inspection, the safety opportunity is significantly more than reducing boots on ballast.

Having a more holistic view of switches & crossings lets engineers move to a predict and prevent maintenance regime – rather than continue with one that can only be reactive.

That reduces time pressure and worker stress, gives space for collaborative, informed and efficient decision making – meaning the fault is less likely to repeat – so fewer track visits, fewer trips, fewer accidents.
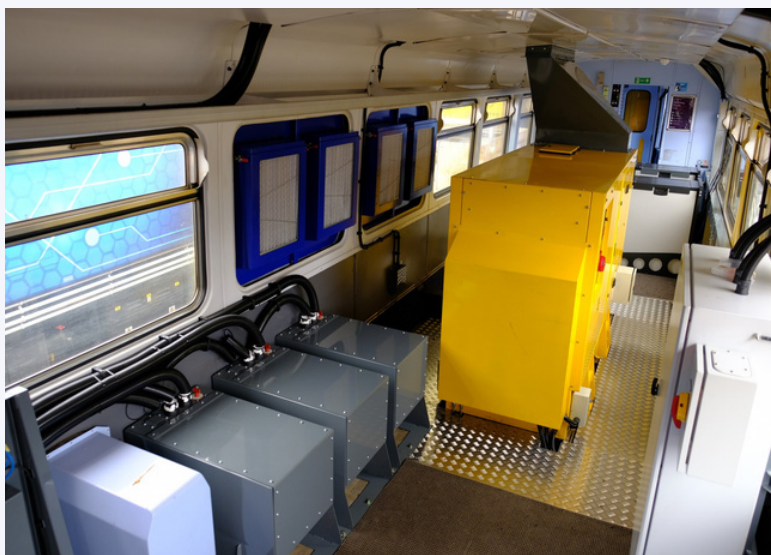
Let's look at an example - footage recorded by the unit may firstly help engineers spot a broken stretcher bar and the engineer could deploy a team to fix it. Thanks to the introduction of technology, engineers can track how quickly an asset is degrading by tracing data from multiple inspections.

This helps them prioritise their list of faults to fix by knowing which are the ones that need swift attention and which can wait. This reduces the risk of derailments and passenger (service) affecting failures as engineers can predict when an asset's likely to fail.

They can also discuss the best plan of action with their peers and work with other teams to manage assets with less time pressures and more preparedness. All conducive to a much safer environment and supports a shift to a more informed management of the infrastructure through a risk-based maintenance regime.

CONTINUOUSLY IMPROVING

There is a fierce desire amongst the team to continue to improve and evolve the service – looking at more ways it can be used to get people out of harms way by reducing the need to work trackside. This includes exploring how the units can do even more monitoring with the installation of additional technology, and managing its roll out across other regions. The next trial is taking place in the north-west and central England.

A trial for additional monitoring of plain line pattern recognition is currently being planned with Anglia route using the Class 153 trains so the track can be inspected from a desktop even more often.

With the overall frequency of track monitoring increased, engineers will have a more informed view of its condition and rate of degradation. They'll know when and where it's likely to fail, giving them the power to avoid passenger and service affecting failures and resulting schedule 8 payments.

They'll also be able to track the impact of weathering on the safety of the rails and develop more preventative management tactics.