Ultrasonic Rail Inspection

NetworkRail

What is the situation?

Ultrasonic inspection can be split into manual and train borne testing which is carried out by an ultrasonic test unit (UTU). The UK rail network is inspected using a combination of both capture methods at inspection frequencies driven by track category. As with all methods of Non-destructive testing (NDT), cracks can only be detected when they are a certain detectable size. Testing therefore has to occur between the point of crack detectability and before the point of failure. It is therefore important to understand the capability (sensitivity and reliability) of the testing system and the propagation rates of rail defects to set testing frequency and defect removal time frames.

The introduction of semi-automated train borne inspection (UTU) has enabled NR to manage track defects far more effectively and has had outstanding performance results both safety and operationally. UTU's inspect around 64,000 miles of track using 4 trains over 750 shifts annually.

Increased capacity and demand from our customers is presenting significant challenges, as limited access needed to inspect and repair defects necessitates engineers to provide as much warning as possible to plan work. The challenge is for ultrasonic inspection to detect defects earlier enough to allow planned removal and prevent speed restrictions.

Rail breaks are now <10% of the numbers experienced at the time of Hatfield (2000) where the trend has plateaued and improvements will be more easily achieved focusing on areas where ultrasonic inspection interacts with such as complementary data sources, databases and user tools.

Broken Rails 1998/99 to 2016/17
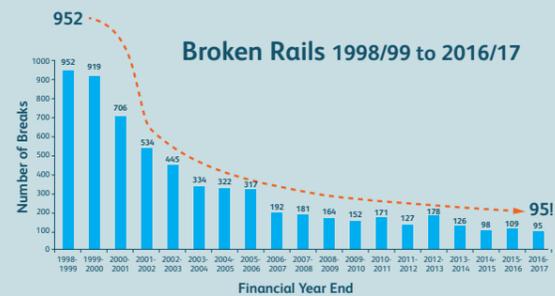
fig1. In 2016/17 we had 95, the best ever! This represents a reduction of 90% in 15 years. This reduction is against an average 50% increase in traffic over the same period.

Analysis of causes
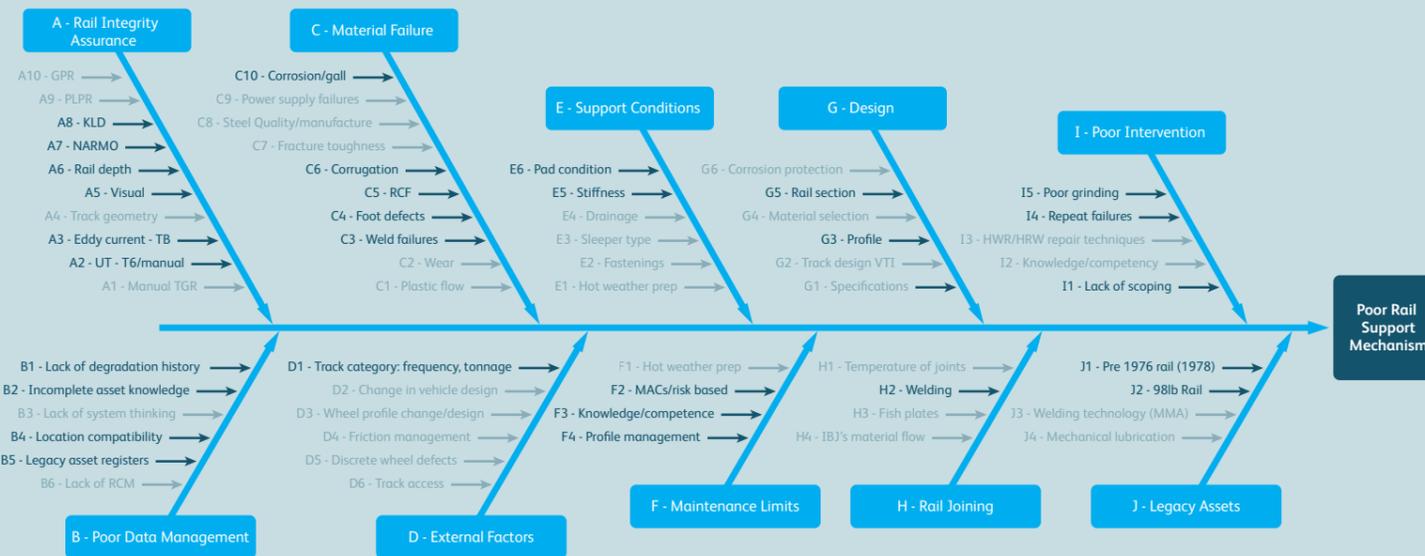
Priority problems

Specific priority problems
- No access available.
- Improved detection.
- Data amalgamation.

Related goal
- Faster testing speed.
- Reduced broken rails and improved safety.
- Less manual verification.
- Earlier warning of rail defect.
- Improved defect knowledge.
- Holistic risk control.

Benefit
- Access to timetable.
- Industry regulation measures.
- People off track.
- Less disruptive planning.
- Asset life extension.
- Safety improvement.

Scope

There is greater demand to run trains which reduces opportunities to maintain and inspect the track. Traditional methods of inspection cannot deliver the testing sensitivity alone or the ultrasonic test trains inspect at the speeds needed to blend in with normal train operations.

A number of initiatives to improve current testing speed capability (30mph) have been undertaken but there is always a trade off against detection performance. A small increase in speed will not permit running within the timetable, therefore significant speed increases are desired.

Early detection of defects is also desired to facilitate cost effective removal or provide enough warning to plan for a possession. Ultrasonic pulse-echo testing technology along with B scan analysis is well understood and the industry is seeking to expand the use of this technology further to improve data records and assurance. However, ultrasonic inspection alone cannot provide the detection sensitivity desired, but combining other technologies can provide improvements. Projects such as the Intelligent infrastructure programme are helping deliver the digital railway is considering this.

Vertical longitudinal split detection walking stick capability and manual B-scan are currently being explored with suppliers along with a vision to accommodate S&C inspection and placing VT, ET & UT on a trolley.

Specific research needs

To address these challenges further research and development will need to consider the following factors:

- Understand the detection criteria and risk associated with each defect type.
- Inspect plain line CWR track reliably at a minimum of 60 mph.
- Understand the assurance requirements and provide auditable records of inspection.
- Consider or provide a method to amalgamate other testing data into analysis to improve detection performance.
- Provide manual inspection systems delivering the same outputs.
- System to manage defect population from inspection programme, compliance, detection and removal.
- Methods to inspect track with no need for manual verification.
- Fully automated analysis of inspection using algorithms / neural networks.
- System to detect transverse foot cracks reliably at high speed.

Expected impact & benefits

Faster UTU:
- Better access for ultrasonic test trains within the timetable resulting in less possession disruption.
- More inspection undertaken in 1 shift possible 20% saving on operations budget.
- Deliver greater testing capacity without the need for more trains.

Improved defect detection performance:
- Earlier warning for maintenance and repair leading to less disruption to the customer.
- Improved safety and reduce broken rails.
- Reliable data turned into useful information – delivering predict & prevent maintenance.

Combined data analysis:
- Improved detection capability.
- Localised risk mitigation possibilities for defect management.
- Rail life prediction and risk modelling possible with database/tools.