Time to eliminate the data graveyards

ASSET MANAGEMENT Railways are collecting increasing amounts of asset condition data, but unless their processing systems are properly upgraded and integrated the full benefits of holding this data may not be realised.

RFI makes extensive use of MerMec's Ramsys data management tool to handle the large quantity of records gathered during measuring car runs.

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The need for efficient and effective use of data to drive infrastructure and rolling stock maintenance has long been recognised. But all too often asset condition data is collected and used only once — just to check if safety parameters are met. This valuable information is then left to die in so-called 'data graveyards'.

The situation could get even worse, as new approaches to data collection, such as unmanned diagnostics and automatic track patrolling, are increasing the amount and the variety of data produced, for example automatically-recognised defects resulting from adoption of vision technology (Fig 1). At the same time, growing demands for more efficient and cost-effective management of railways should be putting pressure on operators and maintainers to make the best possible use of their asset data.

With more than 500 MerMec measuring systems sold in 40 countries we are also contributing to the production of huge quantities of data to support condition-based maintenance, and we can see sharp differences of breadth and maturity in the way such information is being used for decision support. Some railways are indeed making best use of their data, whereas others are only beginning to explore the possibilities.

From collection to usage

Many railways do not currently have information systems and processes in place that could be described as 'best practice', and this has been one of the key reasons for the development of the Ramsys maintenance management decision support system. This is intended to fill the gap between asset condition data and Enterprise Asset Management, Enterprise Resource Planning and other IT systems used by railways to support maintenance. With dedicated, engineering-type analysis tools such as deterioration modelling and space and time-based visualisation to support predictive maintenance planning, Ramsys is already either being used or in an advanced phase of evaluation by 13 railways around the world.

Ramsys customers include RFI in Italy, SNCF in France, Rio Tinto Iron Ore, and Brookfield Rail (formerly WestNet Rail) in Australia.

Before the introduction of dedicated systems like Ramsys, most

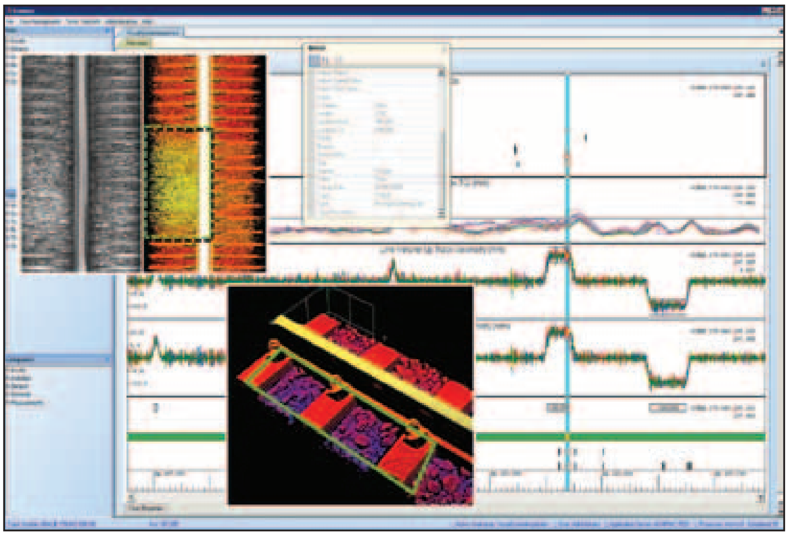


Fig 1. Correlation of detected ballast and track geometry defects.

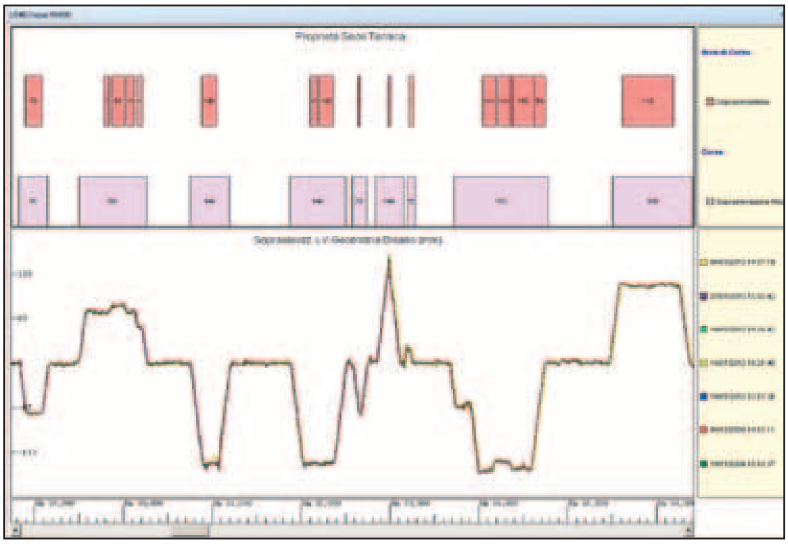


Fig 2. Integrated visualisation of design and measured cant parameters.

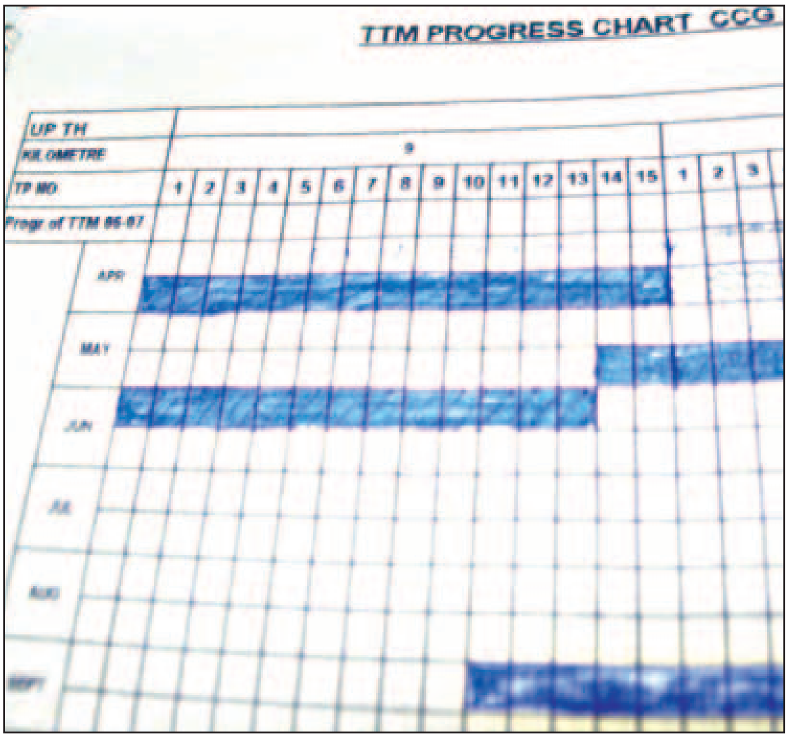


Fig 3. Some railways still hold some of their track maintenance data in paper registers.

railways managed their asset data using multiple unlinked computer systems for condition monitoring and maintenance, ranging from EAM/ERP systems to specific tools for data recording and maintenance planning, some of which had been built in-house. These systems often relied on the skill and experience of a small group of individuals to ensure the data was entered, reviewed, analysed and interpreted correctly.

As an example, the introduction of Ramsys at RFI has allowed individuals to automatically access and process the asset data for about 25 000 km of track. Known by RFI as 'InfraManager', the system has replaced various tools used by maintenance planners at regional level, which were neither integrated nor standardised. The outcomes of InfraManager's processing engine, which uses a defined set of business rules, are structured in graphical and textual reports, giving 150 key users the information they need about when and where maintenance and renewals need to be scheduled, as well as related work priorities.

Input data is mostly taken from the SAP-based maintenance information system called 'InRete 2000' and several diagnostic systems. Handling an average of around 100 data objects per track-km per year, InfraManager processes more than 2·5 million data objects a year (Table I).

The size of the records associated with each data object can be extremely large. For example, a single parameter measurement on 1 km of track would require data to be taken every 500 mm at least, generating a minimum of 2 000 records per km per survey.

RFI Maintenance Engineering Director Gian Piero Pavirani recognises that 'it is necessary to turn data into information', making best use of the data available, whilst eliminating the risk that processing an excess of data may waste time or lead to vital data not being used at all.

The introduction of Ramsys at Brookfield Rail followed a focus on staff and cost reduction that led to the failure of the corporate asset management system. According to Bruce Makin, Civil Standards Engineer at Brookfield Rail, 'asset, defect, condition and measurement data analysed to make informed planning decisions became siloed. Track data was increasingly difficult to locate, with days spent sourcing accurate information

Table I. Data objects in a year's processing at RFI

Type	Description	Data objects
Defects	Critical, intervention and warning alerts	218 536
Activities	Work Orders	738 007
Measurements	Parameters measured during diagnostic surveys	102 315
Assets	Technical objects on which maintenance is executed or data relevant to the maintenance work	1 683 084
Renewals	Capital works	5 180
Total		**2 792 122**

prior to commencing analysis.

'Multiple versions of the same data type became common, with no single source of truth available. Decision making regarding maintenance and renewal plans became increasing difficult, reducing the ability to make network wide strategic approaches to maintenance.'[1]

In New South Wales, RailCorp is currently introducing new vehicles to carry out Mechanised Track Patrols across its network on a fortnightly cycle. A new condition monitoring system will be included on one of these vehicles. This system will have the ability to cover the network much more regularly than the current approach. It is expected that the more frequent data captured from the MTP inspections will provide valuable inputs for future long term predictive maintenance planning within the organisation.

The Ramsys decision support system will also be deployed to analyse the huge flow of data that will be acquired by the vehicles; this will enable all the network maintenance staff to correlate data, search the real causes of any defect, and plan accurate and preventive maintenance procedures.

Typical data usage issues

Over the years, our team, including experts in both railway diagnostics and maintenance engineering, has had the opportunity to analyse the maintenance processes of several railways at different levels.

The information requirements for condition-based maintenance are often tailored to specific functions, bringing together basic condition data and other asset information. These could include defects and related causes, asset characteristics, work history, accumulated traffic, line speeds, and so on. Even a 'simple' process of identifying defects from recorded condition data may require additional information. For example, rail type is required for assessing rail wear, or curve design parameters to identify cant defects (Fig 2).

If this additional information is not available, then the resulting analysis can be affected. We noticed that over the years some railways are coming to recognise the value of holding more complete data. In a couple of recent cases, one in Europe and another in Australia, we have seen the introduction of rules which require that a maintenance work order in the scheduling system should not be closed if all the required data have not been reported back.

Even when good quality data is available, it still has to be integrated, correlated and processed using standard business rules to extract proper information for decision-making, but this is easier said than done. A 2010 survey by the UIC working group on Track Condition Monitoring[2] observed that 'the data provided were not always used to their full extent. Process owners tended to look at the available monitoring information, then determine how to use it, and build the processes around it rather than specifying their actual needs.' The UIC working group concluded that 'one of the reasons for mismatch of data, information, and decision-making was that the systems were developed by measurement engineers and manufacturers, who were not always fully informed about the decision-making processes at management level.'

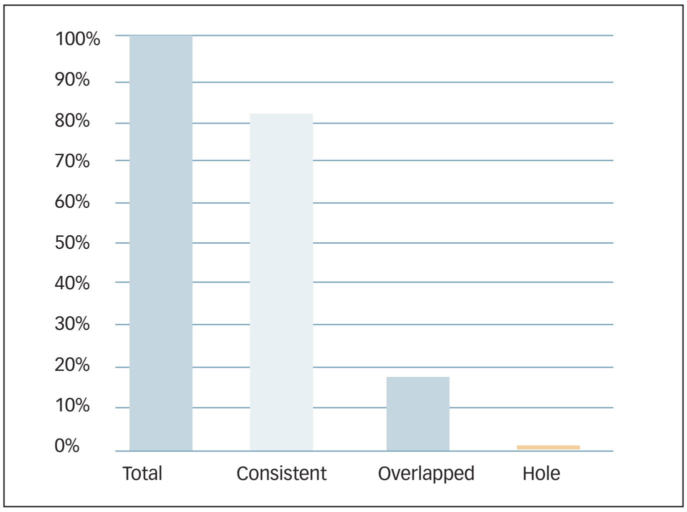
Even if the decision-making requirements are specified, the methodology for extracting and processing information necessitates the application of several business rules. However, this requires many hours of work and can itself constitute a barrier to proper usage. Ad-hoc spreadsheets are sometimes used to plan maintenance, but these are very laborious, can be imprecise, and may not be integrated with other systems. Often, the data held in different systems are not brought together to provide the overall picture.

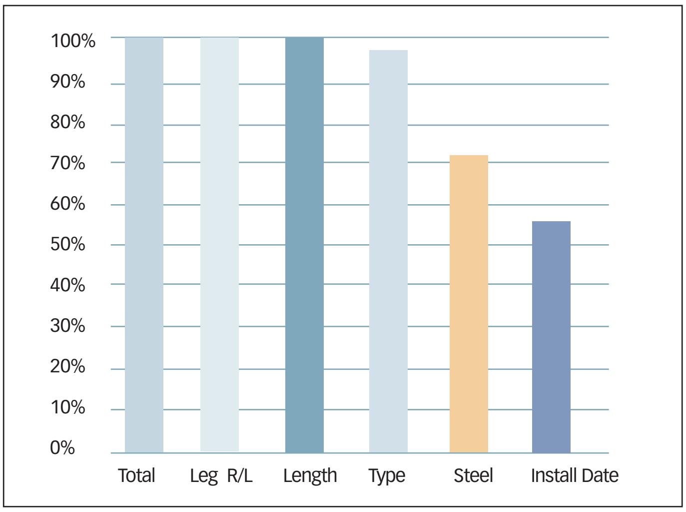
Depending on the complexity of the business rules, ease of access to the data sources, number of assets and other factors, manual processing may require many hours of staff time to update a maintenance plan following the collection of new data.

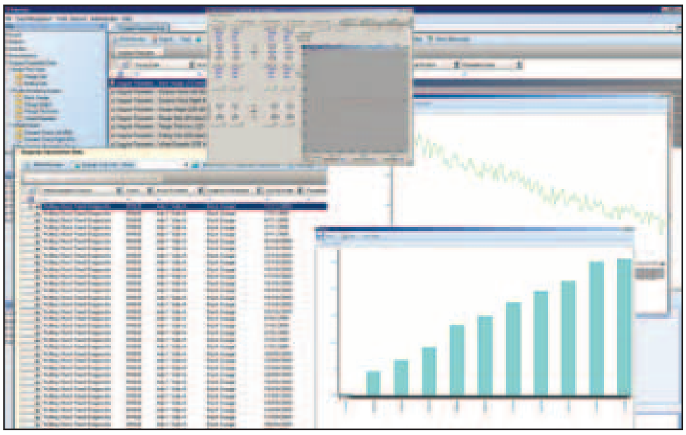
Good usage not only depends on the availability of data, but also on the ability to process it at low cost, using proper tools. So, any lack of data or tools can affect the value that can be extracted. Early experiments with decision-support systems in Europe during the 1990s revealed problems in matching basic data, such as track

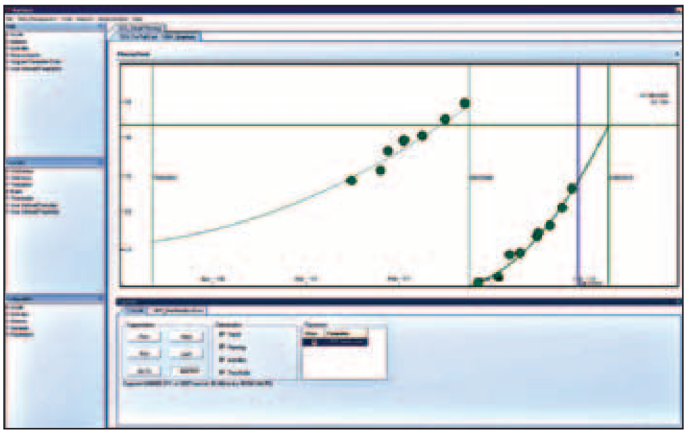
Below: Fig 4. Quality distribution of rail asset data.

Below right: Fig 5. Attributes distribution for consistent rail asset data.









Above: Fig 6. Deterioration of wheel profile parameters over time.

Above right: Fig 7. Deterioration of rail profile parameters over time.

geometry records, with inspection reports and component inventories. At that time, it was feasible to do the job manually, but automatic transfer of this data proved almost impossible, and in some cases it still is.[3]

For some railways, the situation has not changed in recent years, and the identification of maintenance requirements is still largely a manual process. In particular, full track recording history (more than the last one or two surveys) cannot be efficiently translated into maintenance actions at a given location and sometimes past work data is only available on paper (Fig 3). Moreover, important information and requests for maintenance are communicated outside the system, perhaps via paper forms, verbal messages or handwritten notes, which leads to double-keying of data. In other cases, data may be stored in external databases or proprietary formats, so the information is not easily accessible to the end users.

This creates the risk of important maintenance work being overlooked, forgotten, or not followed up. Opportunities exist for information to get lost or data entry to be delayed; in the worst cases the data can turn out to be invalid or obsolete when it is eventually used. Therefore, data verification is a fundamental aspect to be considered for decision making. Any information system is subject to the classic rule of 'Garbage In – Garbage Out', so if invalid data is entered, the resulting output will be meaningless.

Figs 4 and 5 illustrate the typical quality of rail asset data exported from an asset registry of a railway not using decision support tools. Almost 20% of the network is characterised by an overlap of rails at the same location (Fig 4). And even where the data is consistent, critical information, such as the rail installation date, is missing for more than 50% of the network (Fig 5).

Using data more than once

By contrast, these problems are reduced when a railway's asset registry is coupled with proper tools to automatically update and correlate the data coming from the field. Asset data can be verified and accessed easily when required, allowing the information to be used properly for condition-based or predictive analysis. In such cases, both condition and other data are used more than once, adopting business rules involving more than one parameter and specific algorithms for deterioration modelling. For example, it is possible, in advance, to check data quality, assess the criticality of a defect, define work priorities, calculate current and past deterioration rates, and so on.

Figs 6 and 7 show deterioration trends for infrastructure (rail head loss) and rolling stock assets (wheel diameter and flange height), where the full history of measurements can be used to establish either wear or improvement (due to maintenance) rates for the entire life of the asset based on deterioration modelling. Thus, the condition and maintenance data are used all the time, whenever new data are collected, maintenance and renewal plans updated or maintenance audits are undertaken.

Data usage brings savings

So is there any good recipe for either reducing or eliminating 'data graveyards'? The answer is definitively yes. In particular, specific decision support tools are necessary, and more action is needed at railway, national and international institutional levels to encourage standardisation.

When considering whether to invest to improve data usage a railway needs to consider all aspects of its condition-based maintenance chain, to see how current barriers to data usage can be overcome. This will show the clear benefits that can be gained from introducing decision-making tools, which justify the investment and the associated changes.

With many measuring and diagnostic technologies on the market, these need to be coupled with the best methods to enhance the decision support process. With proper functionalities and interfaces with external networks, advanced tools like Ramsys allow end users to make full use of their collected data for better decision-making.

Driving maintenance and renewal with intelligent rules based on asset condition data, rather than predefined cycles and corrective actions, represents the most advanced and cost-effective approach to asset management. Experience so far has shown that properly implemented condition-based maintenance can save up to 30% in terms of resources compared to a cyclic or usage-based approach. Additional important benefits include reducing the number of accidents, minimising the disturbance of rail traffic (therefore increasing the availability of the network), and optimising asset life.

References

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3. Jovanovic S. Condition-based decision making minimises track costs (RG 5.03 p277).