RailKonsult

Office of Rail Regulation

Review of European Renewal and Maintenance Methodologies
Technical Appendix Number 1

Asset Inspection, Condition Assessment and Decision Making

Reference BBRT-2012-RP-0001

The authors of this report are employed by Balfour Beatty Rail Technologies. The work reported herein was carried out under a Contract placed on 5th March 2008 by the Office of Rail Regulation. Any views expressed are not necessarily those of that Office.

Executive Summary

This paper is one of a series commissioned by the Office of Rail Regulation in order to gain an improved understanding of maintenance and renewal techniques used outside Great Britain. These reports have been produced as part of the PR08 process.

This report focuses on the use of European best practice in general asset management, resulting in fewer, higher quality inspections and a coherent, flexible asset management system.

Track assets are best managed by an effective, efficient but simple process:

- Track inspection processes both foot and mechanised, followed by;
- Effective analysis of the data received, leading to;
- Correct decision being made as to when to intervene with maintenance and renewal work.

The benefits identified through the use of this system include:

- Reduction in the level of incorrect or sub-optimal work;
- Regular proactive interventions, reducing the proportion of expensive reactive work done;
- Improved safety, as hazards such as broken rails and track irregularities are identified sooner and dealt with; and
- Lower inspection costs with higher inspection quality.

A principal driver of moving towards this inspection philosophy in the Netherlands was the removal of inspection staff from working on a ‘live railway’, i.e. outside possessions.

The paper describes the system originally devised for use in Germany, as it is used in the Netherlands.

Adopting the inspection analysis and decision making practices being used in the Netherlands provides the potential to lower the following costs in Great Britain:

- A 75% reduction in Track Inspection costs (£6.67m) when applied in the first instance to Prime and London South Eastern routes in Great Britain;
- By reducing Train Inspection a potential saving per annum of 20% (£1.94m) is possible; and
- By improved targeting and planning of tamping machines a saving per annum of 20% (£3.14m) is possible.

There would be other, broader, benefits such as reduced life cycle cost through extended asset life, improved safety and train performance.

Acknowledgements

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- ProRail
- Strukton RailInfra
- Erdmann Softwaregesellschaft mbH

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1.0 INSPECTION, ANALYSIS AND DECISION MAKING

1.1 Background

During a tour of several countries in 2007 by members of the Office of Rail Regulation, they made the following comments:

"Some railways appear to be further forward than Network Rail in

(a) Their implementation of user-friendly information systems; and

(b) Their culture of acceptance at working level".

"Best practice asset management requires appropriate inspection regimes for different asset groups and includes the potential for introducing a risk based (rather than a rigid time based) approach".

"Railways we visited appear to undertake less frequent manual inspection of their infrastructure than is currently practised by Network Rail. Indeed, it was often the subject of comment by those we met in other organisations and there was widely shared surprise that Network Rail still relies upon relatively high frequency of manual inspection"

"It goes without saying that any potential changes in an inspection regime must be carefully handled, never compromise the knowledge that is acquired and therefore deliver at least the same level of safe asset management that is achieved by the existing processes. We simply observe that it is the experience of other railways that technology changes and new inspection methods do provide significant opportunities to adapt and even improve inspection regimes".

Although arrived at independently, the conclusions and observations made in this paper reinforce the view gained by the ORR.

This report describes the inspection, analysis and decision making methods used in Europe. These are based on mechanisation of the process where possible together with the use of IT support tools, to assist engineers in making timely and correct decisions.

Whilst references are made to specific products and systems that are in use in particular countries, there may be other products available that provide a similar functionality. The report does not review available alternatives, or their comparative merits. The case studies are included as being indicative of alternative approaches in asset management.

Note that this report excludes consideration of specialist inspections such as ultrasonic examination of rails and structure gauging.

1.2 Extent of Methodology

The principles of lower inspection frequencies and improved analysis are widely used in Northern Europe. Although other countries use similar processes and systems, this report focuses on the Dutch practices for:

- Inspection;
- Analysis; and
- Decision-making.

The Netherlands has been selected as they employ similar inspection vehicles as Britain and their asset management strategy is supported by what many consider 'state of the art' decision support software. This software is already used on the HS1 route in Great Britain and is to be trialled by Network Rail.

1.3 Applicability

The activities described in this report are primarily classified as maintenance. However, the process is applicable to deciding the scope of all work, irrespective of whether it is maintenance or renewal.

In order to deliver track maintenance, track renewal and partial renewal activities efficiently, it is crucial to intervene with the correct work at the correct time. For example, a small fault spotted early and correctly diagnosed can be put right before it requires large, expensive intervention.

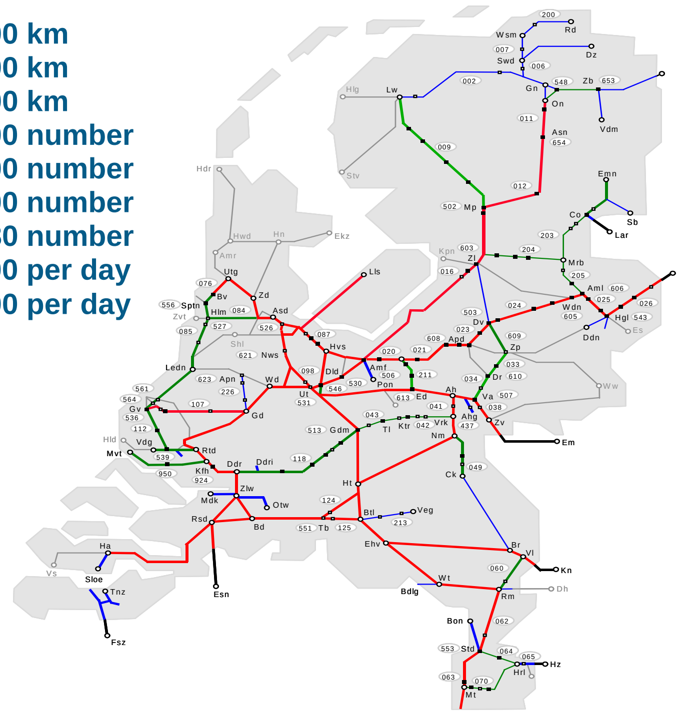
2.0 EUROPEAN APPROACH

2.1 Method Deployed

The following section focuses on a description of the inspection practices being undertaken in the Netherlands. Although reference has also been made to further developments that are currently been made to improve the process, these are not considered within the later sections of the report.

The following diagram illustrates the size and extent of the Dutch rail network.

Network length	2,800 km
Track length	6,500 km
Electrified track	4,700 km
Switches	8,700 number
Bridges and tunnels	4,500 number
Level crossings	3,000 number
Stations	380 number
Passengers	900,000 per day
Trains	6,000 per day



2.1.1 Inspection

In the Netherlands, track inspections are currently undertaken through a combination of:

- Foot inspections;
- Inspections in the cab of a service train;
- Inspection through the use of specialist track inspection vehicles; and
- Use of specialist camera trains for switch and crossing inspections.

Safety concerns were one of the primary change drivers in developing new inspection techniques. In response to Government safety experts, ProRail have directed for safety reasons that all track maintenance work undertaken in the Netherlands will be carried out within possessions. A two-year period was allotted for this change. This has meant that Strukton RailInfra, one of several maintenance contractors, has had to develop an alternative inspection regime and this is referred to within this document.

The changes required to meet the above challenge will have the effect of changing the inspection strategy to:

- Specialist foot inspections within possessions;
- Inspections in the cab of a service train;
- Inspection through the use of specialist track inspection vehicles; and
- Use of specialist camera trains for switch and crossing and plain line inspections.

The table below shows the current frequency of track inspections in the Netherlands.

Type of inspection	Frequency	Remarks
Foot inspection track (Proposed) Foot inspection track (Current)	4 x per year 13 x per year	Strukton propose using video inspection from July 2008 (camera trains) Patrol
Train cabin inspection track	13 x per year	On service trains frequency dependant on contract
Measurement train inspection (Lines above 40kph)	2x per year Strukton 2x per year ProRail	With the UFM120
Video inspection	Switch inspection	Used for category A, B and C type switch inspections. Also Proposing to use on plain line inspection from July 2008
Switch safety inspection	Class A 52x per year Class B 26x per year Class C 13x per year Class D 4 x per year	Foot Inspection frequency depends on tonnage, speed and number of switch movements Strukton currently using camera trains and video inspection
Switch inspection (measurement)	Class A 2x per year Class B, C en D 1x year	Either manual or using measuring trolley
Permanent camera inspection	Class A inspections	Currently testing at some class A switch locations. Aim to support camera inspection runs where difficult to run camera trains to correct inspection cycle

Foot inspections in the Netherlands are undertaken by competent track inspection staff. They carry out visual inspection to identify new faults and use outputs from the track inspection vehicles to check these faults on site. PDA equipment with integral GPS equipment is used to help find the faults recorded by the inspection train. Inspection staff are split between those who patrol plain line and those who also undertake specialist inspections such as through switch and crossing layouts.

Contractors' staff undertake all foot inspections in the Netherlands and no attempt has as yet been made to overlap functionally driven inspections. Information received in discussions with ProRail staff indicates that inspection frequencies in the Netherlands have been reduced over the last 50 years as:

- Jointed track has been replaced with continuous welded track; and
- More sophisticated track inspection vehicles have been introduced.

Cab Rides are undertaken on a similar basis to Britain, with the local Inspector riding in the cab of a service train. Here the Inspector checks and can identify through 'the seat of his pants' the location of the vertical and horizontal accelerations that the train experiences, indicating the presence of track maintenance problems.

Two types of dedicated inspection vehicles are used in the Netherlands. These are the UFM120 infrastructure inspection vehicle and the Camera Inspection trains. The latter trains currently run over the Strukton contract areas only.

The UFM120 is run on lines having a speed of 40kph or over at a frequency of 4 times per year, twice for Strukton and twice for ProRail. The data is shared between infrastructure owner and contractor from each run.

On the high-speed route between Utrecht and Amsterdam the frequency is increased to 6 times per annum. In discussion with the Strukton engineers, it is understood that there is a view that a frequency of 6 times per annum would be a better frequency for the whole of the network, as they believe this enables more effective analysis of deterioration and thus improved maintenance planning.

Measurement trolleys are frequently used on lower speed lines not covered by the inspection trains.

Inspection data taken from foot inspections is kept on a database, whilst data from the inspection trains is downloaded into a proprietary analysis system (see section 2.1.2 for details).

The Camera Trains are modified locomotives each fitted with a number of line scan cameras to provide vertical and panoramic pictures of the track infrastructure. No track geometry recording equipment is used. Four locomotives are employed to undertake the camera inspections of switch and crossings identified in the A, B &C category. The camera trains can undertake plain line inspections as well as S&C. These trains are capable of operating at line speeds of 100kph.

Currently, video inspections are only used for S&C. However, the contractor is additionally preparing to use this system for plain line inspection from July 2008. This will be supported by a risk based foot inspection during possessions. The contractor stated their belief that a mixture of foot and video inspection would improve efficiency of the process without imposing additional risk.

A video suite was observed at a Strukton office in Breukelen where the video outputs are inspected by a team of inspection staff. They were observed undertaking an inspection of a switch and crossing layout using a walkout report and a standardised priority system. The inspection also covered a review of maintenance work undertaken on the layout. The following picture depicts the layout of the video suite.

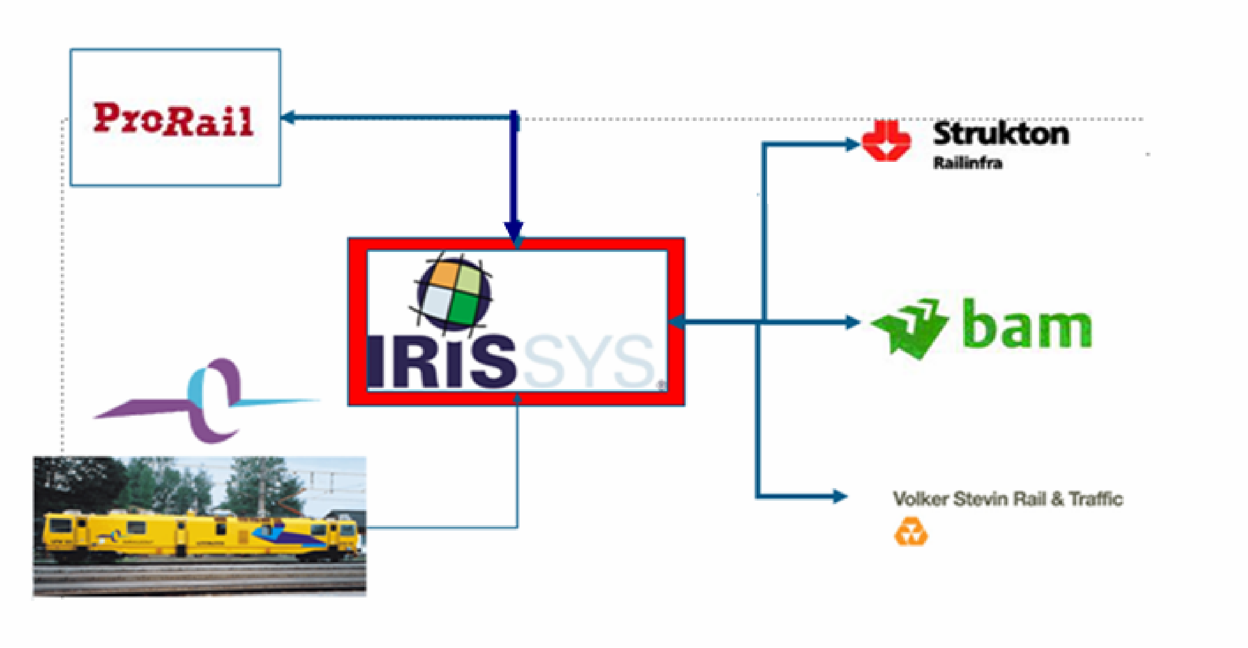
Courtesy Strukton RailInfra

Within the video suite it was also possible to use the analysis system in conjunction with the video footage to ensure the correct maintenance intervention decision was made. The contractor's maintenance engineer also stated that he was supportive of using both the video and analysis system to check the compliance of all work undertaken by the maintenance staff against quality standards.

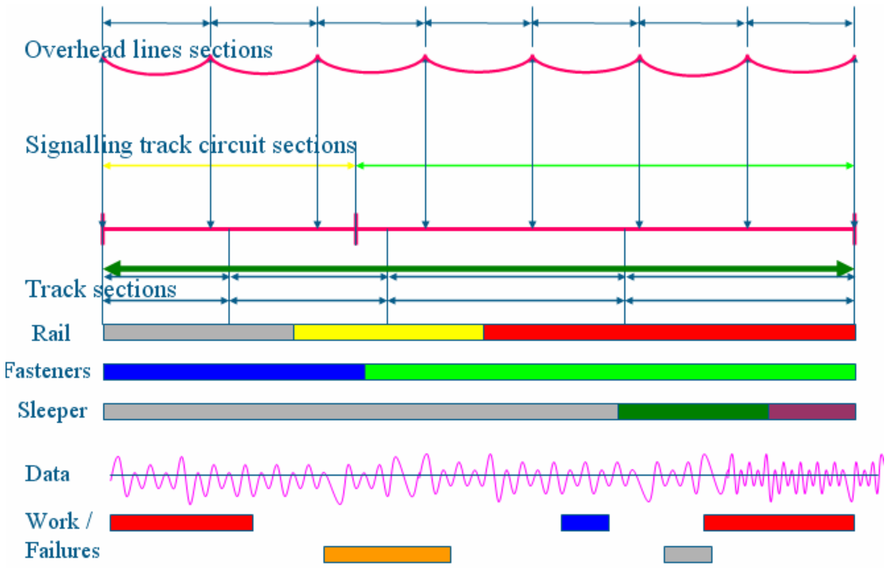
2.1.2 Analysis and Decision Making

In the Netherlands, data from the inspection train is maintained and analysed using a software system called IRISsys (**I**nternational **R**ailway **I**nspection and **S**ervices **Sys**tem). The system is a derivation from The **I**ntelligent **I**nspection **S**ystem (IIS) that was introduced to DB in 1994 and is configured for the German rail system. IRISsys was developed from the principal of IIS, but is designed to be more readily configurable to the IT infrastructure available to each country. IRIS has been progressively introduced into the Netherlands since 2002.

The system supports the analysis and decision making process, enabling Dutch railway engineers to make informed decisions to achieve an optimal asset management position. Information from the recording train runs in the Netherlands is shared between ProRail and all of the contractors as indicated below.

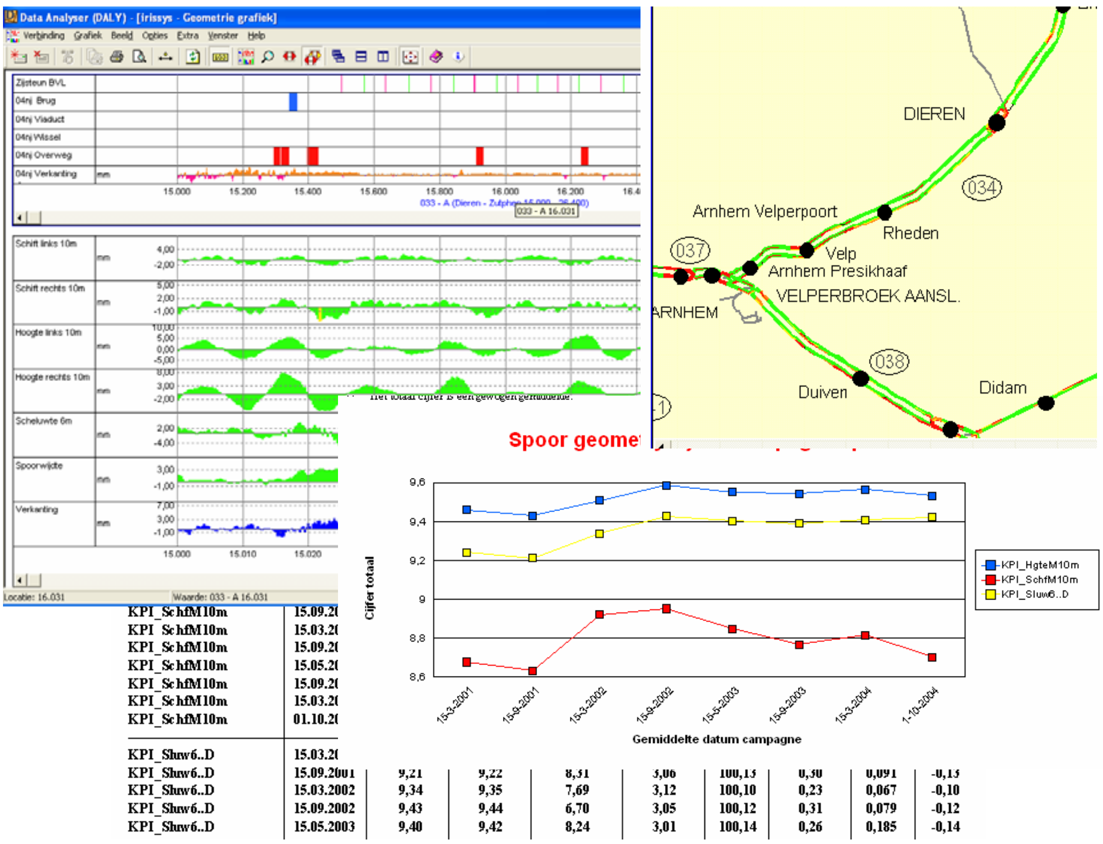


Information is kept in a 'Linear' database. This means, in simple terms, that layers of information are stored on top of each other along the line of route rather than in tables. This can include any infrastructure feature or measurement data taken from it. The following diagram explains this layered approach.

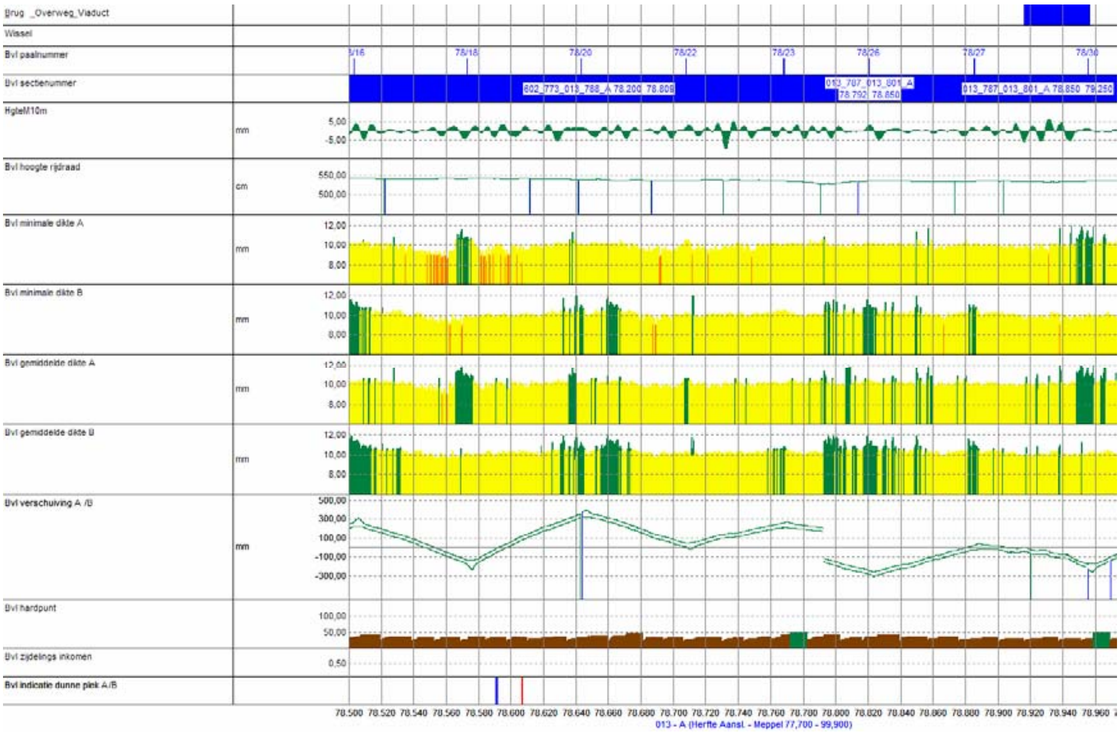


Using the system, an engineer identifies the area that he wishes to analyse and downloads this slice of data from the main server to his own workstation.

The system is highly configurable in report terms, so the engineer can configure reports in line with the analysis he is undertaking. An example of this is as shown below. This illustrates how the analysis can range from a detail level (e.g. looking at individual faults) through to high level (e.g. locations of faults by type throughout his contract area).



Reports can also combine infrastructure types so that the interaction between say overhead line and track can be compared. This is shown in the screenshot below.



Maintenance and safety intervention levels are set within the system and areas requiring intervention are identified to the metre. Intervention levels are coded yellow to indicate where maintenance intervention is required and red to indicate where safety intervention is required.

Maintenance intervention levels are set so that the contractor has the ability to plan and undertake remedial works before safety of traffic might be threatened. Safety intervention levels indicate to the contractor that immediate action has to be undertaken to safeguard traffic.

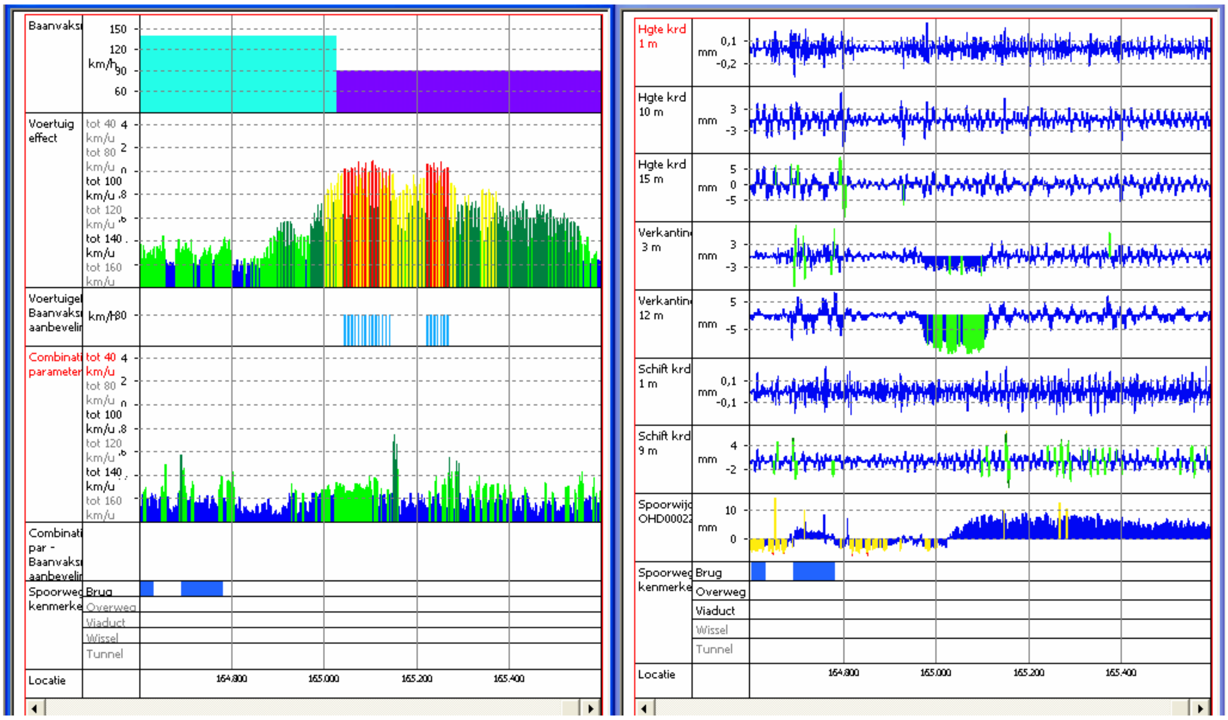
It is understood that the contractors would like to have a more rigorous intervention level so that they could move towards a more preventative regime. On the recently constructed high speed line different levels of intervention have been laid down, leading to a more preventative regime.

A key feature of the analysis system is its ability to enable analysis to be undertaken by:

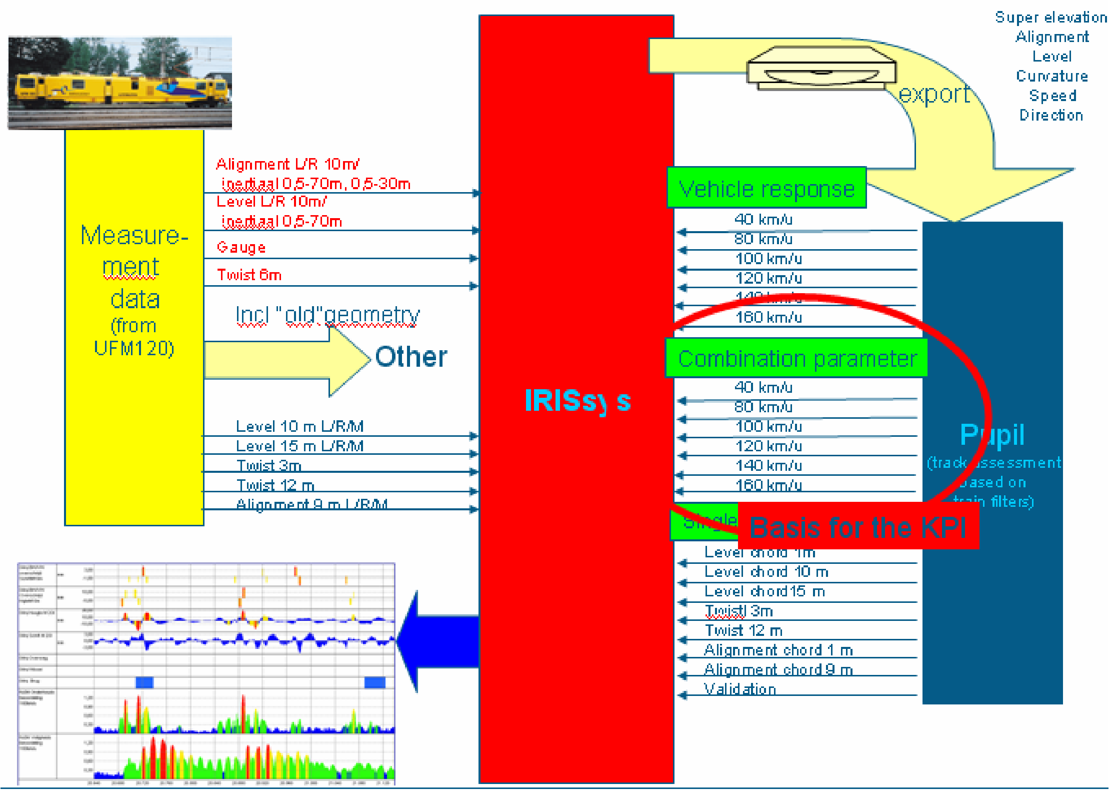
- Single track recording parameters;
- Combination of several recording parameters; or
- Combining track-recording parameters with vehicle parameters.

This enables an engineer in the Netherlands to detect locations that are dangerous for a specific vehicle type to operate over at line speed, even if track-recording parameters are satisfactory. It also provides the engineer with the maximum speed that these vehicles can safely run over the particular section of track.

The following diagram illustrates that although neither single nor combined parameter measurements are showing the need for intervention, the vehicle responses are indicating an unsafe position for vehicles with the consequential need to impose a speed restriction.



The flow diagram below shows how vehicle dynamics and track geometry measurements are integrated together. This is achieved by exporting data to a separate vehicle response programme and then re-importing into IRIS.



As noted previously, inspection data taken from foot inspections is kept on a database, whilst data from the inspection trains is downloaded into the system for analysis and determination of when to intervene with maintenance or renewal treatment. The system includes not only information from the inspection vehicles on the condition of the track, but also the condition of the overhead line and the output from ultrasonic testing of the rails and can also import data from other measuring systems such as ground penetrating radar and trolley recording.

The maintenance contractors in the Netherlands also identify renewal proposals for ProRail to develop into renewal programmes using the same inspection and analysis software. ProRail Engineers' use a process for prioritising each renewal proposal and the analysis system to enable the renewal programmes to be developed.

It was also noted that the contractor's engineer uses information from the remote monitoring systems attached to switch and crossings and video recording as an aid to undertaking optimal maintenance intervention at switches.

2.2 Management Approach

The contractor said that the use of the inspection and analysis system had enabled a much tighter control of the work planning and execution from that used before the system was available. He stated that a weekly meeting held between engineers and supervisors combined the outputs from both the visual, inspection and camera trains to ensure that maintenance intervention was correctly targeted and optimised.

It was also stated that Eisenbahn Bundesambt (EB), the German rail regulator, is proposing to use such a system to monitor the performance of the German Infrastructure owner, Deutsch Bahn. The first aim is to monitor track quality by track segment against the cost of maintenance.

2.3 Technology Involved

Two types of inspection vehicles are used in the Netherlands for track geometry / infrastructure recording. The first type is the UFM120 machine and the other is the Camera Inspection Train. The latter only operate over the Strukton contract areas.

The UFM 120 runs at a maximum of 120kph and is a fully inclusive track and overhead line inspection vehicle having very similar systems to that of the UFM 160 (SMT) and NMT inspection trains operating in the Britain. Measuring systems such as overhead line, track geometry and rail profile are provided by several suppliers and integrated into the machine and its locational positioning system through Plasser and Theurer software.

Video inspection is undertaken using a 'Benntec' line scan camera systems.

3.0 CURRENT BRITISH APPROACH

3.1 Methodology

3.1.1 Inspection Processes

Foot inspection is usually undertaken at intervals of 1 to 2 weeks, depending on the route category. Teams based at local depots, reporting to a Track Supervisor, undertake these inspections.

Track Supervisors and Engineers also have to undertake track walks to set frequencies. Cab riding by track supervisors and engineers is undertaken on service trains at set intervals.

The standards related to track inspections have been subject to considerable change since privatisation, through ever increasing safety requirements and the increase in traffic. This has resulted in increased train delays due to the need for diversions and speed restrictions required to be imposed in order to provide a safe environment in which to undertake track inspections.

Imperfections in the foot inspection process have also been cited as contributors to several high profile derailments that have occurred in Britain in the recent past.

3.1.2 Analysis and Decision Making

Generally in Britain, main line track engineers use a software system called TGS to support them in making a decision on maintenance or renewal intervention. This provides an output that uses $^1/_8{}^{th}$ mile segments. In addition, decision-making is supported by traces and other reports from the inspection trains. However TGS has not had such a long development period.

Network Rail have some experience of operating the IRIS system on High Speed Route 1, since it opened and are understood to be successfully using the system to optimise the maintenance intervention on this route. Additionally Network Rail is understood to be developing a trial of the IRIS system in the South East of the country.

It should be noted that other systems also exist in Britain e.g. 'InfraView' developed initially for use on the London Underground Infrastructure.

3.2 Management Approach

Network Rail manages the inspection of the British rail network, including foot and mechanised processes. They have identified that they wish to move from a reactive track maintenance regime of 'Inspect, Find and Fix' to a 'Predict and Prevent' regime. They say this will require a robust understanding of current asset condition, the factors causing asset degradation and the nature of this degradation. This can only be achieved by regular and objective asset condition monitoring, delivered by automated systems.

3.3 Technology Involved

Five inspection trains are currently used to monitor the track geometry in Britain. These are:

- New Measurement Train (NMT);
- Southern Measuring Train (SMT);
- Track Recording Coach (TRC);
- Track inspection coach (TIC); and
- Track Recording Unit (TRU).

These undertake inspection runs over all routes to different frequencies. Prime routes such as the ECML, WCML, and the GWML are covered at two weekly intervals. It is understood that the current recording mileage is circa 120000 miles per annum.

Data from the inspection train is downloaded to their Engineering Support Centre at Derby, from where it is disseminated to Track Engineers for analysis and decision-making.

4.0 BENEFITS

4.1 Asset Management

The following benefits are likely to be realised over time if a similar system for inspection, analysis and decision making to that used in the Netherlands is adopted in Britain:

- Reduced foot inspection costs as frequencies are decreased;
- Asset management benefits of this will be a reduced requirement for track access to undertake the foot inspections; and
- Efficiency benefits will include a reduction in time spent on inspection as alternative inspection regimes are introduced and proven.

The following table indicates the differences and similarities between both foot inspection and inspection train frequencies across a number of European countries.

Frequency of Track Inspection

	Netherlands	Germany	Australia	Switzerland	Great Britain	Comments
Manual Inspection						
Foot Patrol	4 wks	9-26 wks	0.5-2 wks	4 wks	1-4 wks	GB inspections vary by tonnage and speed
Track Inspection		9-26 wks	13-52 wks		13-26 wks	GB inspections supplement, DB inspections alternate
Cab Ride	4 wks	-	2-4 wks		4-26 wks	
Automated Inspection						
Measurement Train	13 wks	9-78 wks		13-52 wks	2-52 wks	Also use UGMS equipment fitted to sevice trains in GB
Video Inspection	-			-	-	Video recording undertaken by measurement trains
Specialist Switch Inspection						
Visual	1-13 wks				0.5-1 wks	Inspection frequency varies on tonnage and speed
Measurement	26-52 wks					Manual or measuring trolleys used in Holland
Permanent CCTV Inspection						
Priority Sites	-			-	-	Currently under trial in GB and Holland

Data Sources		
	Netherlands	Strukton
	Germany	Work Procedures for the Maintenance of the Permanent Way of the DB Netz AG
	Australia	ARTC TEP 13 Track Examination Handbook - System Overview Issue 1.5
	UK	NR Standard NR/TRK/001 issue 2
	Switzerland	SBB

The following is a direct relationship between foot and machine inspections undertaken in the Netherlands and Britain.

Comparison between UK and Netherlands Inspections (Foot and Inspection Trains only)

Type of inspection	Frequency Netherlands	Frequency UK	Remarks Netherlands	Remarks UK
Foot inspection track	13 per annum current	Ranges from 52-13 inspections per annum with patrolman supplemented by Supervisor walks 4-6 p.a and Engineer 50% of area p.a.	Foot inspection plain line being changed to virtual inspection from July 2008 (Strukton contract areas)	Foot inspections in UK depends on speed and equivelant tonnage. Inspections in certain track categories of CWR may be relaxed after risk assessment. Subject to risk up to 75% of CWR may be inspected using suitable on-track vehicles
Cab Rides	9 per annum	Supervisor undertakes between 2 and 12 p.a dependant on category, Engineer undertakes between 1-6 dependant on category	On service trains	On service trains
Measurement train inspection	2 per annum (Contractor)	1-4 times per annum	With the UFM120 covering routes in the Netherlands with linespeed greater than 40kph.	Using NMT / SMT and other inspection trains
	2 per annum ProRail	2 weekly frequency operated on prime routes		It is understood that the NMT / SMT are undergoing enhanced inspections on prime routes. UGMS equipment fitted to service trains also measures track geometry, frequency unknown
Video inspection	Switch inspections	Video recorded by NMT and SMT inspection trains	Undertaken by special camera inspection trains	Details of video inspection in UK unknown
Switch safety inspection ivb	Class A 52x per year	Ranges from 104 - 52 foot inspections per unit per annum	Current inspection frequency depends on axle load and is undertaken by video inspection (Strukton contract areas) or by foot inspection	Inspection is dependant on speed, tonnage and type of S&C
	Class B 26x per year			
	Class C 13 per annum			
	Class D 4 per annum			
Switch inspection (measurement)	Class A 2 per annum		Undertaken using manual or measuring trollies	Detailed special inspection of S&C is undertaken if condition imposes additional risk RT/CE/S/053 applies
	Class B, C and D, 1 per annum			
Permanent camera inspection	Depends of class	Currently under trials on some locations	Currently under trials on some locations on class A awitches	Under trial in both countries

Additional benefits that will accrue include reduced costs for mechanised inspection as the number of runs per annum is reduced significantly to European levels.

A reduced programme of inspection train runs is unlikely to affect preventative maintenance planning, subject to improved decision support software being introduced. A reduction of these train runs, however, in the short term might affect the incidence of Level 2 track geometry faults being found until higher intervention levels and a true ‘preventative maintenance’ regime is introduced.

The advent of camera inspection trains, or perhaps the running of the current inspection vehicles on special runs as camera trains has overall efficiency benefits on costs.

Improved programming of track renewals will result as deterioration rates are tracked more effectively. Optimal programming of track renewals will provide greater assurance that they are undertaken at completion of life cycle and not prematurely. Additionally, enhanced monitoring of track quality following renewal (as practiced in the Netherlands) would result in a higher standard of delivery from the track renewal contractors.

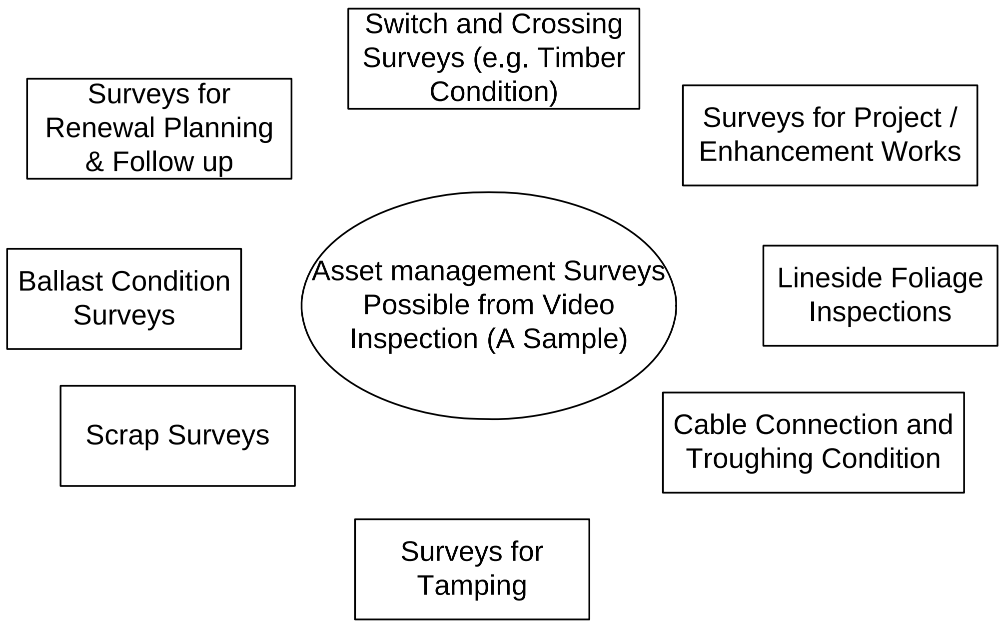
The use of a computer based inspection and decision support type system would also assist with the difficult decision of whether to renew or undertake partial renewal (life extend) of switch and crossing layouts.

The use of such a system may assist Network Rail with improving performance across its maintenance organisation or within track renewal contracts. Additionally, the ORR may use the system to monitor Network Rail's performance, as it feels necessary. This would be similar to the position being adopted by EB in Germany.

Network Rail have identified that they wish to move from a reactive maintenance regime towards a more efficient preventative system. This will require a comprehensive inspection, analysis and decision making system similar to that described previously to support this.

If video trains were run and the outputs were available to all, a significant number of on track inspections and surveys could be undertaken in the office rather than on the track. This would provide efficiencies, improve safety and reduce track access requirements. In the Netherlands the contractor is already using the video pictures for a number of other infrastructure related surveys.

The following diagram shows just a sample of the uses made with asset management from video inspection runs.



4.2 Efficiency Savings

This section is not intended to provide a rigorous business case assessment. For example, capital investment requirements are excluded and no discounted cashflows have been considered. It is, however, included to provide an indicative view of the potential operational opportunity available if similar approaches were adopted in Britain.

4.2.1 Foot Inspection

The following table identifies the potential saving in foot inspection if the 4 weekly Dutch inspection frequency was applied to routes in the prime and London South East category. These routes have been chosen for analysis on the basis that they generally have a good track condition and that they have significant track access challenges for conventional inspection.

Savings if Dutch Inspection Frequency applied to GB (Prime / London SE Routes only)							
Plain Line Inspection Only							
Staff Involved with UK Foot Inspections (UK Frequencies)							
Route Category	Kilometres by Route category	Inspection Frequency	Kilometres Inspected per week	Total track Kms inspected per year	Total track miles inspected per year	Cost per Track Mile £	Total Cost £
Prime	9601	Weekly	4800 (2)	254400	158077	40	6323080
London SE	3899	Weekly	1949	103297	64185	40	2567400
						Total	8890480
Staff Involved with UK Foot Inspections (To Dutch Frequencies)							
Prime	9601	4 Weekly	1200	63600	39519	40	1580760
London SE	3899	4 Weekly	487	25811	16038	40	641520
						Total	2222280
							Savings
					Potential saving per annum prime and LSE routes only £		**6668200**
					Saving %		**75**
Notes							
Inspection savings only considered for prime and LSE routes for first phase due to better condition of infrastrutcure							
Inspection savings may be possible on other routes							

The source of the quoted cost per track mile is Network Rail's 2007 Annual Return.

4.2.2 Mechanised Inspection

The following table assesses the total number of track geometry assessment trains that would be required in Great Britain to undertake mechanised track inspection at the same frequency as in the Netherlands (i.e. 4 times per year, all routes above 40kph).

Track Kms	Total Kms required	Km run per day (2)	Run Days for 2 trains	Inspection Train Requirement (1)
31564 (total)				
25994*	103976	250	416	2

Notes
* Track kms assessed at speed in excess of 56kph
(1) Based on a maximum of 250 shifts per vehicle maximum per annum
(2) Based on experience from the Netherlands of an average recording run of 250km per day

Current Network Rail ICM running costs for 5 trains are £9.7m (Year 1 CP4). This excludes the cost of additional two-weekly inspection runs currently undertaken on the prime routes. These are estimated at 3 runs per week average over 52 weeks, i.e. 156 per annum at £15k per run giving a total of £2.3m.

Potential Savings from calculations above are estimated at 60% of existing ICM costs, i.e. £5.82m.

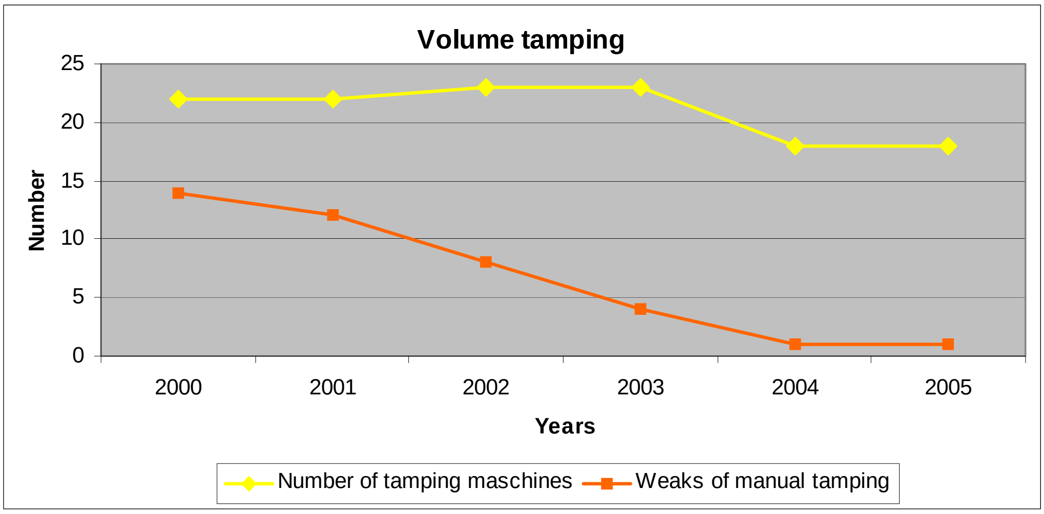
Note that these savings exclude additional prime route inspections and are calculated using 2 inspection trains only.

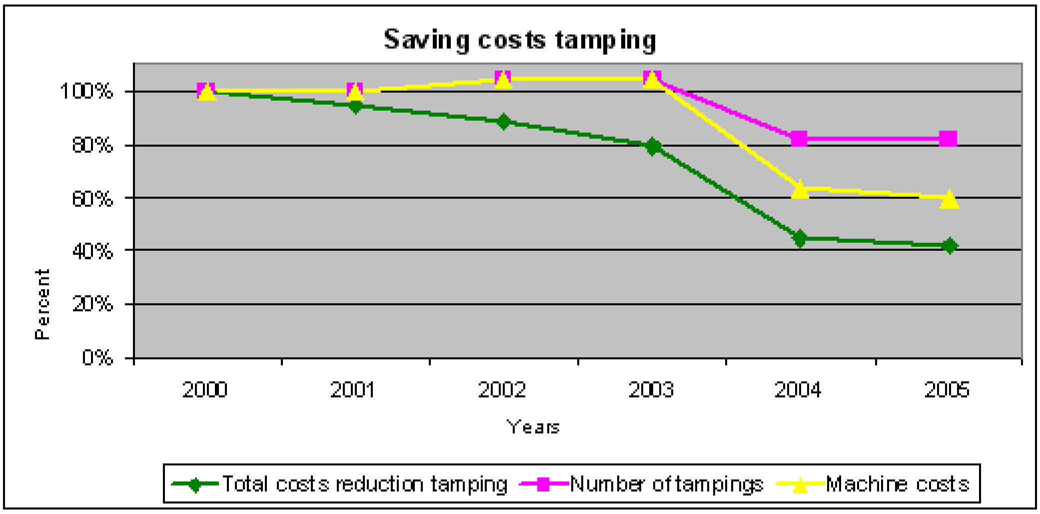
However some of the vehicles that are used for inspection are fully depreciated. Therefore, the potential saving is likely to be reduced to in the region of **£1.94m (20%).**

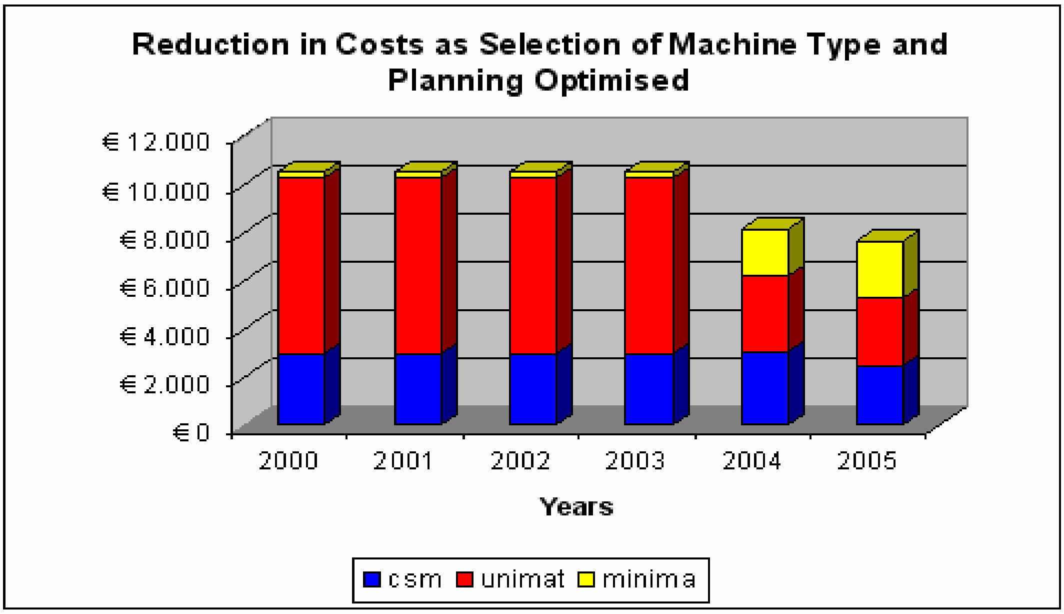
4.2.3 Improved Programming of Maintenance Intervention Works

The use of IRIS in the Netherlands to programme tamping machines delivered efficiencies of between 20 and 40% in each of the regions it was adopted in. The variance is due to differences in the individual contract areas, such as pre-existing track conditions.

The following diagrams illustrate how the volume, overall and cost per tamping shift were reduced on one particular contract area. It is interesting to note that the Dutch engineers are now also identifying the most efficient tamping machine type to undertake the work required.







This case study of the savings available from better targeting of the tamping resource is seen as illustrative of the savings potentially available across all maintenance activities.

The possible savings in Britain, based on Netherlands practice, are 20% of the current annual costs. This equates to £3.14m per annum, based on plain line tamping amounts of 6080 track kilometres at £2.58 / metre (based on ICM 2006 figures).

ProRail are also proposing shortly to use the system to ensure they agree with the contractors tamping programme. The aim of this monitoring is to audit the contractors' asset management and provide information to commercial managers within ProRail.

4.3 Life Cycle Costs

The importance of understanding the degradation of the track infrastructure and when to intervene with maintenance or renewal activity has long been known within railway engineering. More effective analysis techniques and correct intervention timescales, coupled to high quality renewals and maintenance delivery, will extend track life cycles and optimise costs.

5.0 SAFETY ISSUES

Any reduction from the current British frequency for foot and inspection train monitoring will undoubtedly lead to concerns being raised by various stakeholders within the railway industry.

Safety issues that will need to be addressed include:

- Any reduction in foot inspections will reduce the number of basic visual inspections confirming the integrity of the infrastructure. A potential mitigation to this would be through the use of cameras on inspection trains (or other suitable vehicles such as in the Netherlands) to undertake virtual inspection in an office environment.
- Any reduction of mechanised inspection frequencies, if it is not to impose risk, will require enhanced decision support software being introduced concurrently. Staff will need to be trained in its use and new preventative intervention levels will need developing, so that infrastructure work is undertaken earlier in its deterioration cycle).

- Human Factors are already a considerable influence on the ability to undertake an effective foot inspection. If the inspection regime is changed to a mixture of risk based inspection foot and virtual inspection, the human factors elements of undertaking both would need to be assessed for potential added risk.
- The ability to undertake these changes will depend on developing a robust project plan, delivered in a realistic time scale by competent people, such as dedicated change managers supporting in-house area champions.
- A positive safety aspect associated with the reduction in foot inspections would be a reduction in the risk of staff being struck by rail vehicles, as less staff would be required to work ‘red zone’. If camera systems were also used to undertake other infrastructure related inspections, such as ballast condition surveys, then the risk of staff being struck by a train whilst undertaking these inspections would be further reduced
- Increased reliance on software decision support systems to undertake maintenance and renewals at the correct time may result in increased risk of asset failure if the system is not correctly configured and used by competent and fully trained staff. A robust project plan to realistic timescales including training and structured software implementation would be required.

It was noted that ProRail Engineers stated their support for the adoption of the new inspection regime, whilst still being cautious about the possibility of video inspectors missing defects due to fatigue whilst undertaking the virtual inspection.

The contractor has undertaken extensive evaluation of the human factors involved with the new inspection regime, including full risk assessment and introduction of appropriate mitigation factors. They are confidant that safety risk will not increase through the introduction of the new inspection process.

6.0 IMPLEMENTATION INTO GREAT BRITAIN

6.1 Estimated Implementation Duration

6.1.1 Decision Support System

In discussions with the supplier, it is understood that Network Rail are developing plans to trial the IRIS system in the Southern England. As previously noted, the system is already in use on High Speed Link (HS1). A team from Network Rail recently visited the Netherlands to evaluate how the Infrastructure Manager (Prorail) and the contractors use the system.

It should be possible therefore to undertake an initial trial and complete an evaluation by the start of CP4.

Based on European experience, it will take a further 3 years to fully optimise the benefits of the system, although the benefit streams will start before this. This timescale includes:

- Development of the system to take the master data;
- Developing the supporting IT architecture;
- Configuration of the software; and
- Training.

Key lessons learned from the Dutch implementation of the system that are transferable to a British implementation programme are:

- The Infrastructure data that has to be input to the inspection and analysis decision support system needs to be accurate;
- The end users and their requirements must be fully defined;
- The system must be configured to provide the analysis and reports required;
- The IT architecture must be aligned so that information from other sources can be input to the system;
- A comprehensive change management programme is required to implement the system and gain the benefits; and

- An 'End User Group' is likely to benefit the implementation and exploitation of the system into the UK

6.1.2 Reducing Inspections

Similar pressures to those being experienced in the Netherlands are likely to force change into the current British inspection regime. Fewer track inspections, more reliance on ever improving technologies, less disruption to rail traffic and modified inspection regimes are the likely outcomes.

A reduction of foot inspections, therefore, is likely to be phased, as new systems are put on trial, safety validated and then embedded. Using the former GTRM mechanised inspection concept as a basis, it is likely that trials would initially be undertaken on routes where predominately good track condition exists and where there is difficulty with undertaking foot inspections due to train frequency. The first phase would therefore be likely to be on the Prime and London South East routes. It is envisaged these routes could have modified inspection regimes on them within 3 years with the extension of these to other routes within a further three years (see 4.2 for potential efficiency benefits).

This incremental approach is likely to ensure that the new processes are safety validated appropriately, trialled and accepted by the industry.

6.1.3 Previous British Trials

During the period 1998 – 2002, Balfour Beatty Rail and GTRM undertook extended trials of an alternative inspection regime. Both contractors were at the time providing maintenance services to Railtrack, latterly Network Rail.

The reason for these trials was to develop a more efficient inspection regime for the high speed prime routes they then maintained. In addition, the proposed increase in speed on the WCML to 140mph would have prohibited foot inspection completely.

Trials were held on the WCML during the period from 2001 to 2002 and a new inspection process was built for this purpose. The process consisted of running a dedicated inspection vehicle over each line of the WCML in a two weekly cycle. Video and track recording data from the train was processed into discs by Omnicom Engineering based in York and distributed to supervisor's depots within 48 hours. At the depots video suites were established in a quiet location and the data inspected by a competent track inspector.

The 'virtual inspection', as it was called, used the same paperwork and defect prioritisation as used in normal patrols and was subject to a strict timescale (e.g. only 20mins inspection at a time) to ensure that 'human factors' did not allow attention to lapse. The new process was supplemented by a risk based foot inspection approach on the basis that poor track required more inspection than good.

Extensive tests were undertaken to ensure that additional risk was not imported to the infrastructure, mainly because of human factor issues. It was found that no additional risk, in human factors terms, was imported using the new process.

These trials proved that an inspection regime similar to that adopted by the Dutch could be successfully introduced into the British rail system without a detrimental impact on safety and asset performance levels.

6.2 Constraints and Dependencies

Reducing foot and inspection train frequencies will be subject to a major change programme involving development of new methodologies, trialling of these and then implementation.

It is to be hoped that cooperation with Dutch Railway Engineers, the use of previous British experience of trialling new inspection regimes and industry cooperation will assist with the necessary change.

6.3 Investment Requirements

The following figures for the IRIS system are given as a very rough guide to the total investment required if the system was to be procured for the whole network. The supplier's costs are evaluated as:

- Software procurement £5m
- Training and initial support £750k

Additional expenditure that is likely to be required includes:

- Safety assurance work involved with inspection regime change and software introduction (estimated at £750k);
- Development of camera systems on existing inspection trains or possibly alternative camera vehicles, estimated at £5m (based on fitting of enhanced camera systems to already owned vehicles); and
- The development of video suites £875k (based on 35 locations at £25k per location).

It is noted there will be additional, internal, Network Rail investment required such as staff attendance at training courses.

It is expected that alternative proprietary systems would require similar levels of investment.

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