Delivering Digital Asset Management in Rail

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Rail Alliance
Asset Management and Remote Condition Monitoring
15 February 2017
Wellcome Collection
Rail Technical Strategy - 2012

A resilient 7-day railway with world-class asset management which improves:

• Reliability
• Increases capacity and service levels
• Reduces delays

• Trains and track equipment are specified through a whole-system approach to monitor each other and cause less damage

In Hand

• Intelligent maintenance provides accurate timely information for condition-based intervention.

Enablers?
The Holy Grail - Never See Red

• Better risk management
  — Make decisions that minimise the risk of service interruption
• Scheduling the unscheduled maintenance
• Replacing high cost preventative maintenance programmes
  • Only maintain for cause
    • Dynamic Scheduling
    • Dynamic Depth of Maintenance
• Actionable data for maintainers and asset managers
• Requires:
  • Validated diagnostics and prognostics processes
  • Dependable and timely alert detection
  • Measurement data to be converted to Condition Indicators (CI)
Requirements for a Data Driven Approach

• The data driven approach is essentially a knowledge based approach
  • An understanding of how the CIs relate to the failure and the time to failure is essential
  • Accurate and robust detection of defects are essential for any type of machine learning approach

• Key to the process is validating the statistics that relate the CI to the defect and the Remaining Useful Life (RUL)

• Key architectural feature is that there is access to both RCM and Failure Reporting, Analysis and Corrective Action System (FRACAS) data
ISO 13374 Implementation Does Not Work

- Not Condition Indicators
- Not dependable
  - Too many missed alerts
  - Far too many false alerts
  - Difficult to verify and manage
- Unreliable measure of severity
- No measure of urgency
- What are the actions?
A FRACAS or similar process is essential for a data-driven approach.

FRACAS provides the knowledge of the correlation of RCM data with the damage observed.

Absence or weaknesses in the FRACAS process along with inadequately defined CIs present most of the problems in implementing a data-driven process.
Data-driven Predictive Maintenance Toolset

- RCM Data
- CI Data
- Signal Processing & Feature Extraction
- CFAR Autotrend: Adaptive Anomaly Detector
- Advanced Diagnostic Support
- Unified Prognostics Module
- Golden (Verification) Database
- Actionable Data

FRACAS Data
Adaptive Anomaly Detection

Using an adaptive threshold reduces this difference to zero.
Validation:
Health and Prognostics Assessment Programme

• Funded by Innovate UK and RSSB
• Asset class: London Underground Escalators
• Delivered a TRL Level 6 demonstrator proven in service
• CFAR Autotrend detected events that were validated and were timely enough to produce meaningful RUL
  • Average 382 days in advance of maintenance
  • Minimum 61 days and maximum 970 days
• No false or missed alerts
• The Unified Prognostics Module was developed and was demonstrated to provide risk based Remaining Useful lives which were validated
• Risk based dynamic scheduling demonstrator was produced to demonstrate the value of prognostics
Validation: HPA Results

- Fault identified by LU = 05.04.13  Maintenance Event on 12.09.13

- Left Vibration (trend) detection – 25.03.13
  - Followed by a level detection and a further trend detection

- Right Vibration (trend) detection – 27.10.12
  - Followed by a further trend detection and a level detection

- Enhanced prognostics capability
  - Approx. 5 months prior to fixed threshold detection and is 11 months prior to maintenance event
Validation:
Advanced Diagnostics Support Technology Programme

- ADST funded by Network Rail and RSSB’s Future Railway Programme
- Asset class: Track Circuit Indicators
- 11 Condition Indicators developed
- CFAR Autotrend detects alerts in the data at the same point or earlier without having to set and maintain the five fixed alert detection thresholds for each individual TCI. On average, 10 hours and 16 minutes earlier than current fixed threshold methods
- No false or missed alerts
- Feasibility study successfully demonstrated two clear functional features of Humaware’s toolset, which are:
  - Condition Indicators clearly identify changes in clear and occupied states for the TCIs without the use of fixed thresholds
  - Alerts produced by CFAR Autotrend can be used in a data driven Bayesian Reasoner to produce accurate diagnosis of the TCI root cause fault condition
Validation: ADST Results

- Defect; Deteriorating rail insulation, cables or connections
- Defect detected by the fixed threshold @ 22/01/15 at 08:3

- CFAR Autotrend Detection: Trend @ 21/01/15, 22:17
Validation: ADST Results

- CI = Inverse Clear

- 3 other CIs alerted
Conclusions

• Key enablers for intelligent maintenance are being developed
• Validated accurate, timely and robust alerts from RCM data demonstrated
  • Condition Indicator approach validated
  • Provide the accurate and timely alerts
  • Accurate and robust diagnostics
  • Risk based Prognostics
  • No fixed thresholds
• Intelligent maintenance demonstrated
  • Dynamic Scheduling
  • Dynamic depth of maintenance
  • No RAG – 50 shades of amber
• Operational evaluation needed to develop stakeholder UIs for intelligent maintenance
• Is the industry ready for this paradigm shift?
Thank you

Any Questions?