Tools and Techniques for Data Driven Track Maintenance

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Overview

• Introduction
  – Big data

• Data driven maintenance – opportunities and challenges

• Tools and techniques
  – Case study: RAMP project

• Conclusions
About me

• Mechanical engineer

• 17 years experience in:
  – Rail vehicle dynamics
  – Wheel-rail interface engineering
  – Track geometry degradation

• Wide range of projects
  – WRI management and problem solving for light rail / metros
  – Measuring and predicting RCF
  – Evidence based standards changes

• i.e. spent of a lot of my career modelling / predicting things
Big data: are you a believer?
Are you a user?
You are in...

Whether you like it or not...
Data driven maintenance: opportunities and challenges
Opportunities

• Better knowledge of the current state of our assets
• Build up a ‘service history’ for assets
• Investigate asset performance over time
• Predict future performance / life / failure

“Find and fix – predict and prevent”

How far have we gone?
How far could (should) we go?
Problems (‘challenges’)

- **Data:** volume, quality, maintenance, storage
  - Location, location, location

- **Robust, validated, system level prediction models**
  - We are often less good at these (but getting better)
  - The models don’t need to be complicated (though they may be)
Problems (‘challenges’)

People:

Track engineer
Problems (‘challenges’)

People:
- Electronic Engineer
- Track Engineer
- Software Engineer
- Data Scientist
- Research Engineer
- Business Process Analyst
What we need

Data

Storage & Automated Handling

Analytics & Prediction Models

Interpretation Visualisation (actionable info)

\[
\begin{align*}
\bar{\theta} &= \frac{1}{J} (-T_b + P_{bd} \cdot R) \\
M' \cdot (\bar{\theta}, R) &= -F_{bd} - F_{ext} \\
\bar{\theta} &= \frac{1}{J} (-T_b + P_{bd} \cdot R) \\
M' \cdot R \cdot (\bar{\theta}, R) &= -F_{bd} - F_{ext} \\
\bar{\theta} &= \frac{1}{J} (-T_b + P_{bd} \cdot R) \\
M' \cdot R \cdot (\bar{\theta}, R) &= -F_{bd} - F_{ext} \\
\bar{\theta} &= \frac{1}{J} (-T_b + P_{bd} \cdot R) \\
(1 + M' \cdot R^2) \cdot F_{bd} &= -F_{ext} + \frac{M' \cdot R^2}{J} \cdot T_b
\end{align*}
\]
Prediction models

- Geometry deterioration
- Rail wear
- Point motor failure
- Ballast life
- Rail defects (RCF, squats, foot defect, plastic flow etc.)
- Rail fixings
- Bridges, formation and earthworks
- Noise
- Corrugation
- Economic (VTISM)
Tools and Techniques
Case Study
Case study: RAMP project

RAMP – Rail Asset Monitoring Platform

Project lead: Omnicom

Partners:

Part funded by: Innovate UK, RSSB
Rail Asset Monitoring Platform

- Cloud based platform for analysing data to understand the condition and performance of railway infrastructure
- Web accessible
- New or legacy tools hosted as ‘apps’
- Avoids being tied to proprietary systems
- Flexible – large or small analysis tasks
RAMP demonstrator app

- Automated analysis of TRV and UGMS data
- Prediction of 1/8th mile track quality based on local conditions
- A tailored user interface giving a ‘rich picture’ of track condition:
  - Omnicom video
  - Rail age
  - Discrete defect positions
  - Tamping history
- Future - prediction of discrete defect deterioration (track twist, top, alignment, cyclic faults etc.)
RAMP overview

Data Store

Analysis carried out in the cloud (development of YouShare)

Web accessible interface tailored to users requirements

Data Analysis Tools (‘Apps’)

Data Analysis Tools:
- OHLE Condition
- Track geometry deterioration
- Point Motor Failure
- ..........???

Route Asset Manager
Technical Support Engineer
Frontline maintainer

Omnicom
University of Huddersfield Institute of Railway Research
CYPBULA high performance pattern recognition systems
University of York
RAMP process

- Cloud storage 'listens' for new data
- Initial processing - divide into TME area
- Cleansing: remove spurious data
- Location: alignment <1m

- Calculate track quality
- Track quality prediction model
- Prepare reports & add rich picture data
- Web based user interface

- Tamping predictor
- Discrete defect prediction
- Background geometry monitoring: alerts

Future
RAMP demonstrator - benefits

**Route Asset Manager**
- Obtain picture of future track condition
- Better prioritisation of maintenance effort
- Understand the underlying durability of track geometry
- Support maintenance and renewals decision making

**Technical Support Engineer**
- Quickly investigate ‘repeat offenders’ & poor track quality
- Determine effectiveness of maintenance
- Predict future track condition
- Develop maintenance plans

**Frontline Maintainer**
- Improved information for decision making
- Prioritise defects which deteriorate rapidly
- Improve tamping plans
Track geometry app

Reports Dashboard RAMP Project Overview

Overview Information

Trace Review Information

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Rate of change Review

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Download
Track geometry app
Track geometry app

User selects track section and latest shift. The current track quality is displayed in discreet eighths. Quality is logged as satisfactory, poor and very poor.

Track quality deterioration can be mapped, with predictions based on 30, 60 or 90 days.
RAMP - future development

RAMP Portal

Home  Analysis  Quality  Defects

Back/FWD
Last/Next Defect

Predict
+6 Months
On/Off

Route  STENSON JN TO TRENT EAST JN
Location  SSJ1 – 1100
Milepost  25
View width  1 mile

Rich picture:
Rail age
Tamping info
Railhead defects
Settlement rate
S&C locations

On/Off
Export discrete defects

Twist (3m)
Top Left
Dip Angle
Top Right
AL35
AL70
MT70
Gauge
Crosslevel

125/0  124/7  124/6  124/5  124/4  124/3  124/2  124/1
Conclusions
Conclusions

• Asset data will increase exponentially
  – Smart components (internet of things)
  – Mobile devices (collecting and delivering data)
  – Smaller, cheaper on-train measuring systems

• Data will be (already is) more than engineers can manually interpret

• Biggest challenges will be:
  – Combining data sources to give a rich picture
  – Using multiple data to predict future asset performance
  – Delivering the results in optimal way for variety of users

• Opportunity – unlocking the benefits of ‘predict and prevent’
Finally (just for fun)

Introducing........

The IRR ‘Track360°’
Augmented Reality Glasses
Next Train: Down Fast 3 min 05 secs

- Defects
- Track Geometry +90 days
- Features

- Ultrasonic #3442
- Missing Clip
- Track twist 1:290
- Repeat cyclic top
- Lat Align 15mm
- Culvert Under
- Loose heel block
Thank You