Hunting at Vale EFC

Case study of bogie hunting at Vale EFC between 2009 to 2017, and the inter-relationship between track and rollingstock

Paul Bladon, Denis D’Aoust, Pedro Freire
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Vale EFC (São Luís Line)
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Carajás Railway:
• The line is 892 km long, TR68 (136 lbs)
• Broad gauge 1.60m, rail head profile unchanged since 2009
• Runs from Carajás Mine to São Luís Port
• Carajás Mine is largest iron ore mine in the world

Rolling Stock:
• Iron ore trains typically 330 cars long, sometimes 340
• Axle load = 31.5-37.5 tonnes
• Loaded trains = 41,000 tonnes
• Trains use 2x1x1 or 1x1x1 loco set up
Vale EFC (São Luís Line)

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São Luís Line - Brazil
Wheel-Rail Interface Data

Wheelset Based

- Angle of Attack (AOA)
- Tracking Position (TP)

Truck Based

- Inter-Axle Misalignment (IAM)
- Tracking Error (TE)
- Rotation (ROT)
- Lateral Shift (SHIFT)
- Hunting / Lateral Instability
Wheel-Rail Interface Data

TBOGI-HD system collecting data since September 2009 since then:

1. Unexpected patterns in the data at a population level
2. How do patterns correlate with changes in rollingstock, track maintenance, wheel wear and rail wear?
3. How did the inter-relationship between track degradation and rollingstock degradation manifest?
Wheel-Rail Interface Data

Trucks used at Vale EFC:
- Ride Control with frame brace (GDTs and GDUs)
- Ride Control without frame brace (GDTs)
- Ride Control with pads and without braces (GDTs and a small number of GDUs)
- Motion Control Barber, pads integrated with bearing adapters (GDU)
- S2E Barber with split wedges and pads (GDUs only)
- S2R Barber with pads (small number of GDTs)
Pre-2010 rail replaced with rail that had shorter life and was prone to vibration

GDU bogies began entering the fleet

Manual track maintenance

Rail replacement with better quality rail

Major rail replacement and ballast renewal + bogie maintenance
~200,000 axle count per month

~500,000 axle count per month
2009 - 2011

Loaded vs Empty Hunting, per month
Sept 2009 to Dec 2011

Date (month)

Percentage of traffic hunting 7-14 mm (%)

Hunting Empty 7-14 mm  Hunting Loaded 7-14 mm
Pre-2010 rail replaced with rail that had shorter life and was prone to vibration

2009 - 2011

GDU bogies began entering the fleet
Pre-2010 rail replaced with rail that had shorter life and was prone to vibration

2009 - 2011

GDU bogies began entering the fleet
Peak-to-Peak
Observations: 2009-2011

1. Average degradation rate for hunting defects was 14 months

2. Degradation trends typically not steep, were manageable by rolling stock maintenance

3. There were still some steep trends - degradation within 1 month - that required quicker intervention

4. Hunting degradation predominantly manifesting when cars empty, which is normal for heavy-haul
2012 - 2013
2012 - 2013

Loaded vs Empty Hunting, per month
Jan 2012 to Dec 2013

Percentage of traffic hunting 7-14 mm (%)

Date (month)

Hunting Empty 7-14 mm  Hunting Loaded 7-14 mm
Manual grinding/tamping, and sleeper leveling

2012 - 2013

Replaced previous rail (25m sections) with better quality rail in longer lengths (250m sections)
March 2012

Fixation Renewal

1st Intervention
Manual Maintenance

Manual Grinding

Sleeper Leveling

Manual Tamping
Manual track maintenance

Hunting Peak-to-Peak, GDT Bogie 4, Empty Direction
2012 - 2013

Manual grinding/tamping, and sleeper leveling

Replaced previous rail (25m sections) with better quality rail (250m sections)
March 2013

2nd Intervention
Rail Replacement
Rail replacement with better quality rail
Observations: 2012-2013

1. Predominantly GDT bogies that experienced repeat hunting
2. Degradation time for gradual-onset defects reduced from average of 14 months to average of 7 months
3. Bogies that experienced sudden-onset loaded hunting were different bogies to those that experienced gradual-onset empty hunting
4. Sudden-onset and gradual-onset hunting defects continued degrading without significant changes in speed (per bogie)
Manual grinding/tamping, and sleeper leveling

2014 - 2015

Major track overhaul:
Replaced rail, ballast cleaning/renewal, mechanical tamping and leveling

Plus a bogie maintenance regime focused on the extreme defects

1. Still predominantly GDT bogies experiencing repeat hunting

2. Vale noticed frame braces starting to break in 2014, and significant increase in twisted/broken frame braces in 2015. Also marked increase in asymmetrical wear in wheelsets.

3. Hunting bogies divided into three main types:
   a) Gradual-onset defects when empty
   b) Gradual-onset defects when loaded
   c) Sudden-onset defects when loaded
Type (a): Gradual-onset defects when empty
Continued developing much as before, but increased rate of incidence
Type (b): Gradual-onset defects when loaded
Hunting Peak-to-Peak, GDT Bogie 20, Loaded Direction

Hunting Peak-to-Peak (mm)

Date

Speeds decrease
Speeds increase
Type (c): Sudden-onset defects when loaded

• Almost always, a bogie that develops a gradual-onset hunting will do so in either empty, or loaded condition, but not in both

• Sudden-onset hunting developed in loaded condition

• Gradual-onset defects typically reached significantly higher severity levels than sudden-onset defects:
  – Gradual-onset defects continued upwards toward and beyond 35 mm
  – Sudden-onset defects were typically asymptotic to ~21-28 mm

- The main wear on the rail prior to Nov-Dec 2015 was surface shelling - experienced much more RCF than wear.

- Rail replaced in Mar 2013 and Nov-Dec 2015 - difference in 2015 was that also sleeper and fixings renewal, ballast maintenance, renewal, and levelling.
Was the rail change in Nov-Dec 2015 the panacea it appears to be?

Yes and no: it was only part of the solution

With the WRI, it is almost never just one thing

During the same window of time, Vale repaired a lot of the trucks with extreme hunting
Hunting Peak-to-Peak, GDT Bogie 20, Loaded Direction

Axle 4 Left

Axle 4 Right

30-Jun-14 to 28-Sep-14

Diameter
25.8
26.7
Flange height
27.2
27.7
Flange thickness
32.3
30.7
Flange gradient
11.96
8.94
Thin Flange
30.6
29.1
Flange angle
51.49
64.27
Vertical Flange
6.88
5.84
Rim Thickness
50.7
60.7
Rim Taper
1.53
1.32
Grooved Tread

Peak (mm)
21
28
35
2016 – 2017
2016 - 2017

Loaded vs Empty Hunting (7-14 mm), per month
Jan 2016 to Mar 2017

Percentage of traffic hunting 7-14 mm (%)

Date (month)

Hunting Empty 7-14 mm  Hunting Loaded 7-14 mm
Observations: 2016-2017

- Loaded hunting: back to normal with specific trucks degrading, and no longer an indication of a population-level issue
- Empty hunting: back to normal with specific trucks degrading, but indication that a subset of trucks are hunting badly at higher speeds
- Empty hunting severity is non-linear in response to speed: a small increase in speed can correspond to a much greater increase in hunting severity (if a bogie is already unstable)
Overall
2009 - 2017
Observations: General

- Gradual-onset defects indicates specific bogies, and individual trends are steeper when the track condition is deteriorating.

- Sudden-onset defects with population shift in the incidence of defects, indicates a lowered tolerance of that population of bogies to a common condition (in this case, the track).
Supersite Data

With the assistance of Track IQ, it was possible to compare the TBOGI-HD data with data from other systems at the site:

- **WCM**: Wheel impact data (Track IQ)
- **WheelSpec II**: Wheel profile data (Mermec)
- **RailBAM**: Bearing acoustic data (Track IQ)

Information retrieved from Track IQ Data System (WMS)
Supersite Data
What does it mean?

The Wheel-Rail Interface is a relatively Closed System

Things do not happen in isolation
What does it mean?

What does it mean?
Conclusion

Vale demonstrates different uses of the data:

• Identify specific bogies that are experiencing accelerated degradation due to trendable defects

• Warn of population-level issue by identifying a gross shift in a particular type(s) of defect
Thank you!