In-service wheelset monitoring: a presentation of case studies where wheel history evaluation was effective for improving the maintenance process

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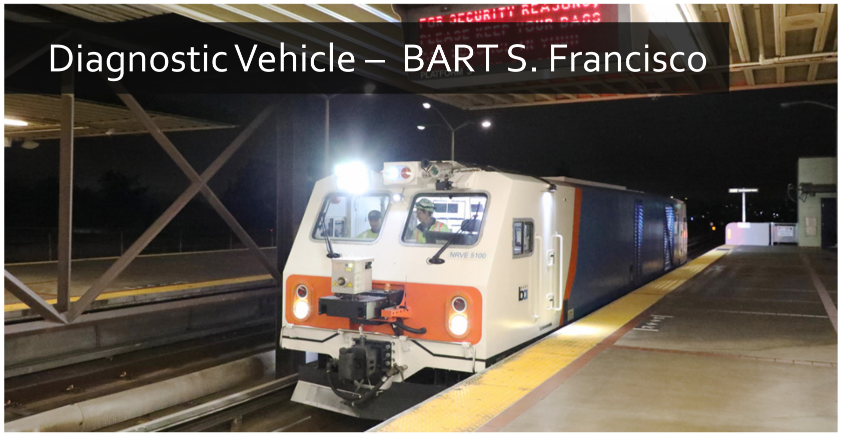
Outline

1. Introduction – some facts about Mermec
2. In-service wheelset monitoring – changing the maintenance
3. In-service wheelset monitoring – the measuring system
4. Case Study 1: Equivalent conicity monitoring
5. Case Study 2: Wheel out of roundness early detection
6. Conclusions and future works

Introduction – few words about Mermec

- Serving **railway diagnostics at 360°**
- 40+ years of **experience**
- Designing & delivering high-tech solutions

for infrastructure monitoring..



Diagnostic Vehicle – BART S. Francisco

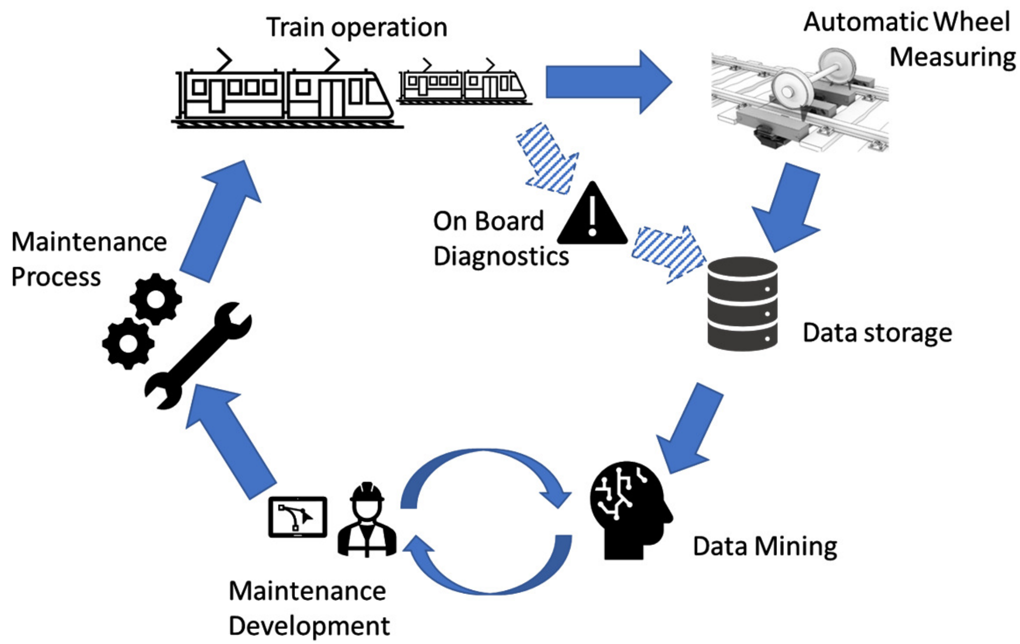
..and rolling stock monitoring

Wheel Monitoring System - UAE

In-service wheelset monitoring to change maintenance process

Ingredients & recipe:

1. Fleet of vehicles
2. Automatic wheel measuring
3. Data storage system
4. Data mining process
5. Maintenance Development
6. Maintenance Process



In-service wheelset monitoring – the measuring system

Automatic system features:

- **Flexible,** to be able to measure trains travelling at any speed to maximize the inspected wheelsets / year.
- **Precise**, to be able to provide consistent results over long periods of time and different environmental conditions.

In-service wheelset monitoring – the measuring system

Automatic system features:

- **Accurate**, as ensured by a calibration process that meets the standards of metrological labs (in-house laboratory accreditation according to EN17025).
- **Reliable**, as a result of a periodical metrological confirmation process (according to ISO 10012) and a continuous self-monitoring of the system.

In-service wheelset monitoring – case studies

CS1

Equivalent Conicity monitoring to predict instability at high speed and optimize train availability

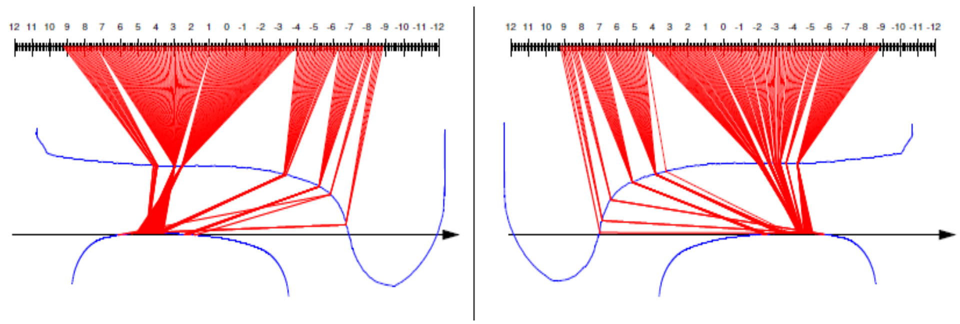
CS2

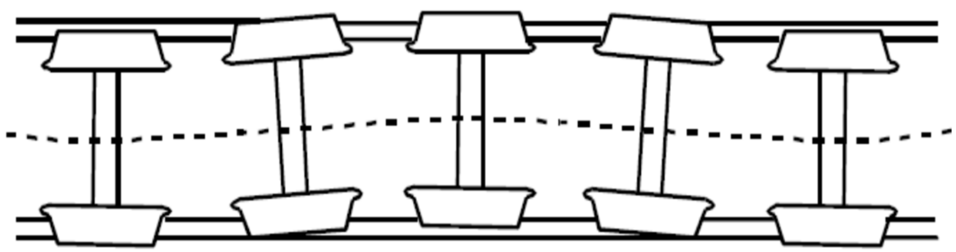
A new contactless method for **out-of-roundness** early detection

CS1: Equivalent conicity monitoring

Equivalent Conicity is :

- an indicator of the coupling behavior of the wheelset and the track
- an indicator of the lateral stability of the wheelset.





Wheelset oscillation can turn into:

- Low ride comfort
- Critical bogie hunting
- Speed limitation

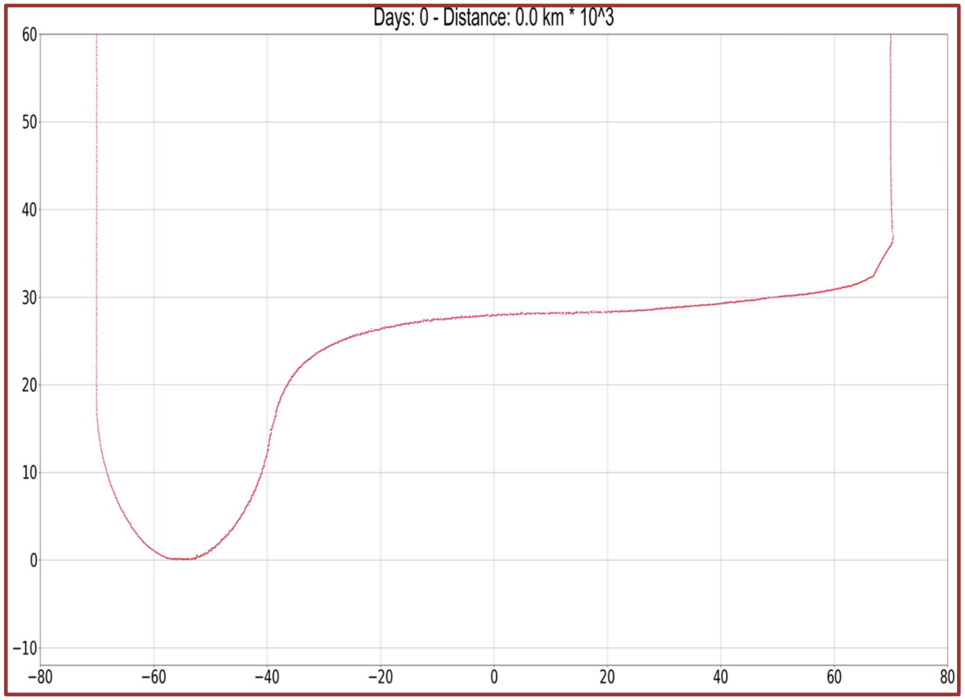
CS1: Equivalent conicity monitoring

In service wheelset monitoring allows tracking the evolution of the wheel profiles over time to identify:

- Wear types
- Wear rates
- Wear anomalies

Wheel profile evolution can show

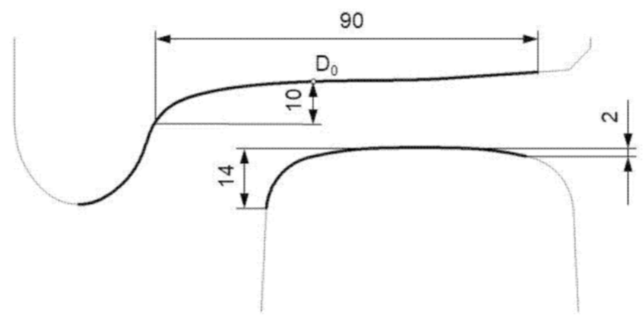
- Flange wear
- Tread wear



CS1: Equivalent conicity evaluation

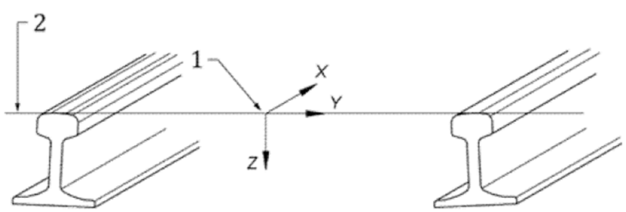
The equivalent conicity is evaluated using the following parameters as measured by the system:

- the left and right wheel profile
- the back2back
- the diameter difference



And combined with the following parameters:

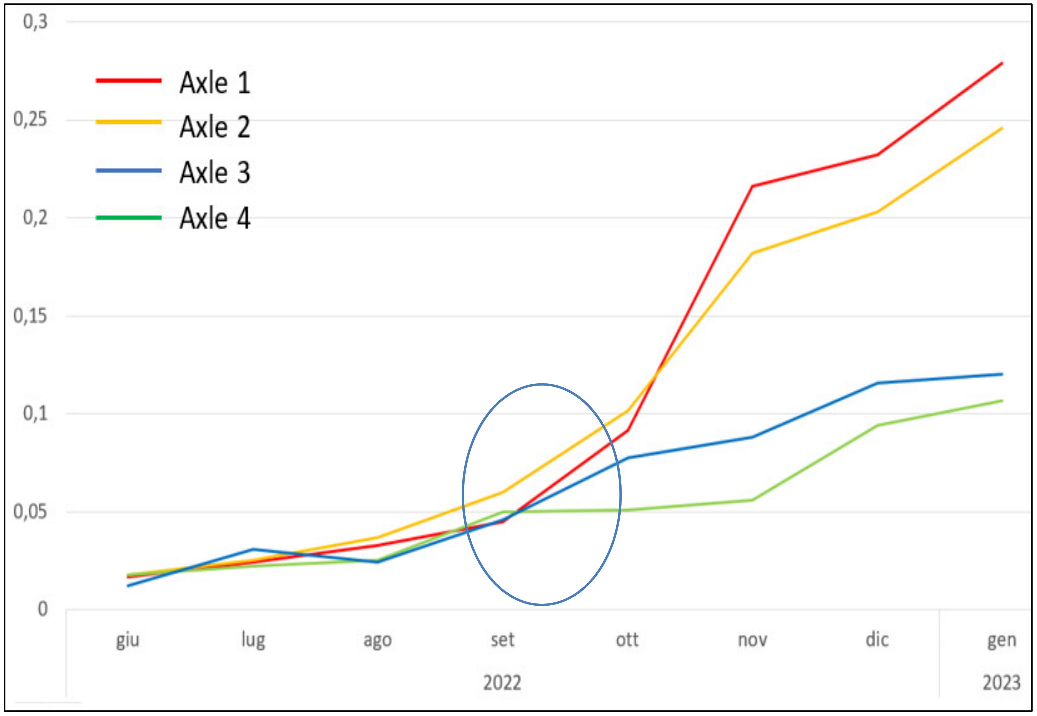
- Nominal Rail profile
- Nominal Track gauge



CS1: Equivalent conicity monitoring

Continuous tracking of Equivalent conicity is useful:

- Wear evolution can be unpredictable, with sudden changes in shorts periods of time.
- Equivalent conicity can evolve very differently on wheelsets belonging to the same wagon, if not the same bogie.



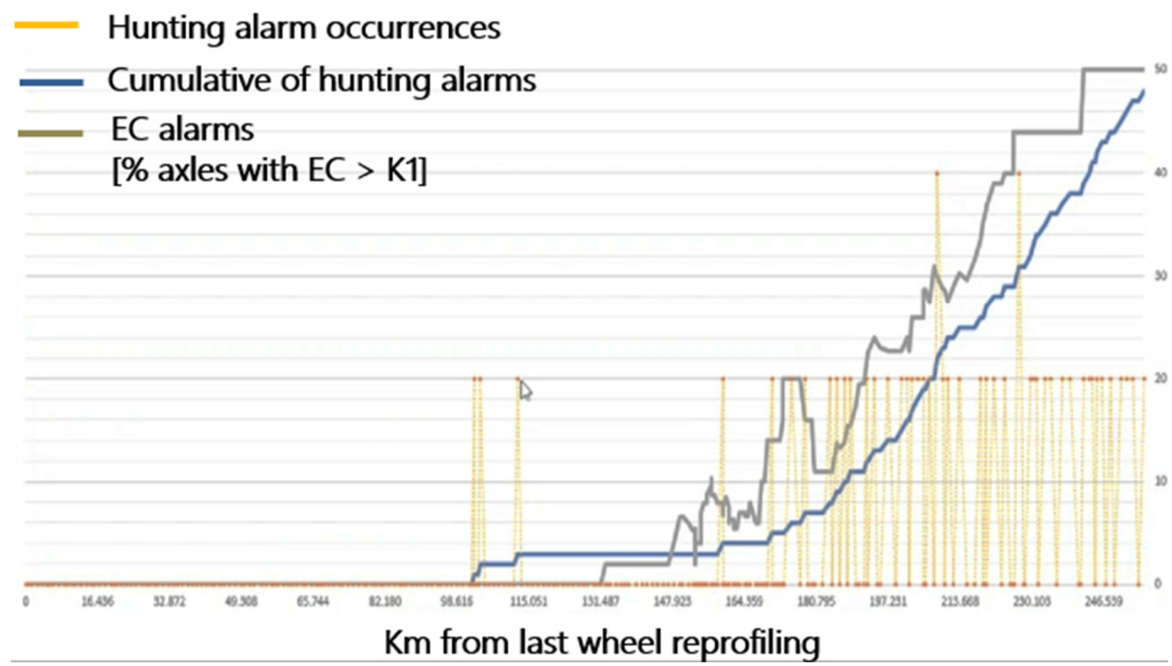
CS1: Equivalent conicity monitoring

The issue:

- Hunting alarms

The analyses:

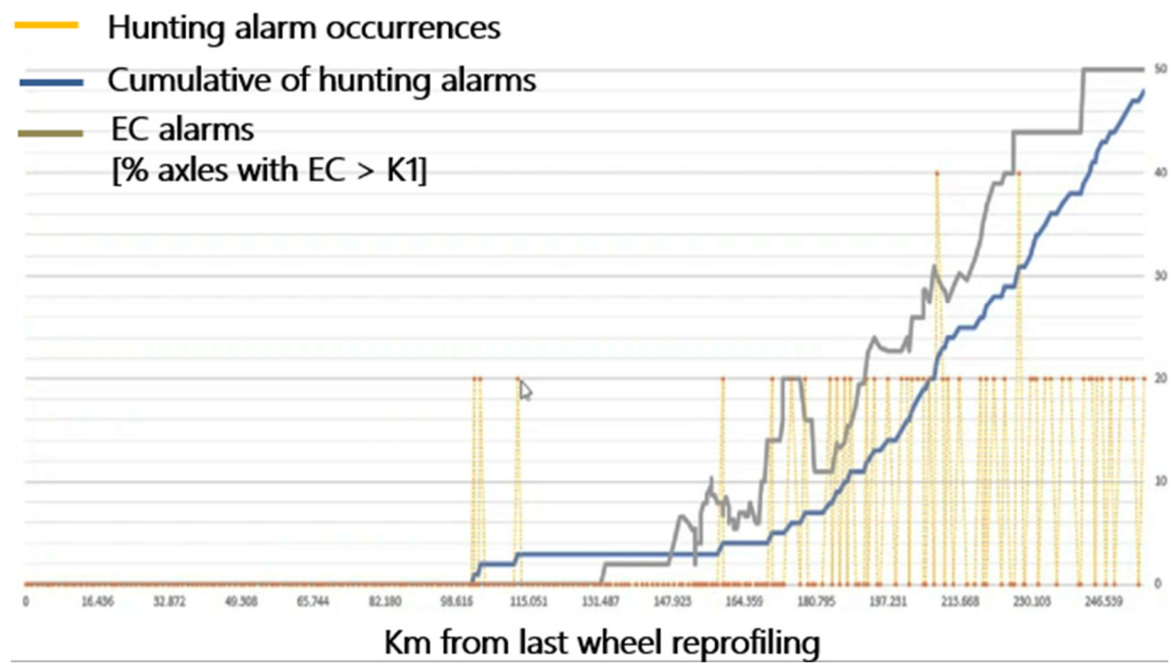
- On board diagnostic data has been correlated with in service wheelset measuring data



CS1: Equivalent conicity monitoring

The evidence:

- hunting alarms are correlated with EC values.
- single wheelset condition seems not important.
- Multiple wheelset having EC bigger than a mild threshold seems to be more important.

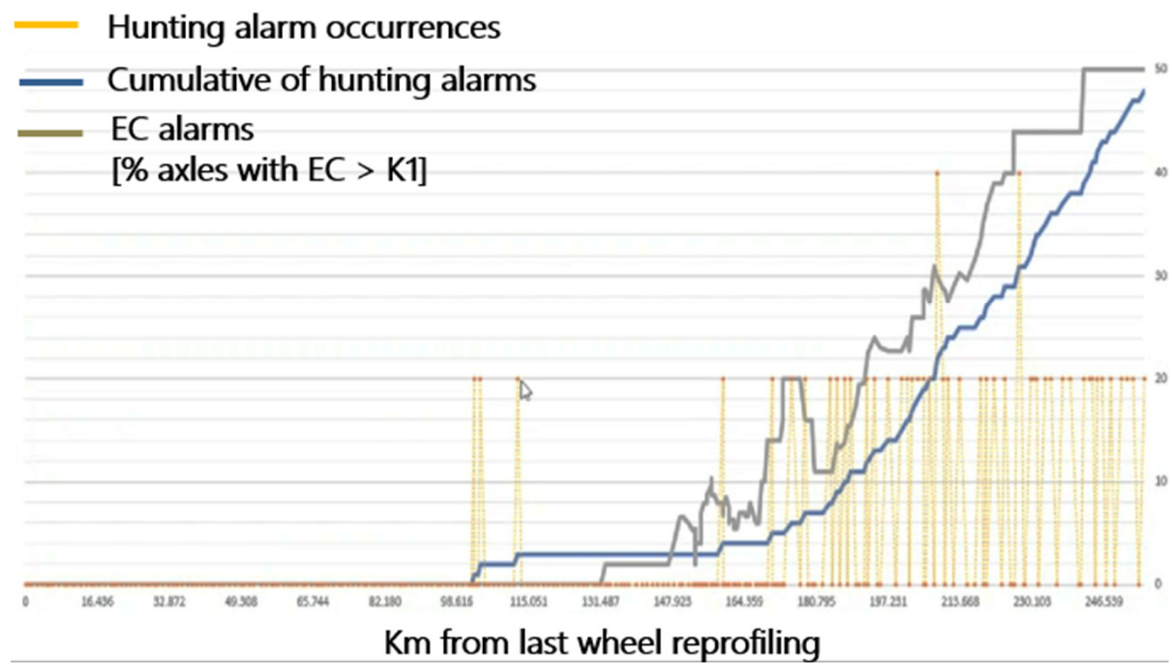


CS1: Equivalent conicity monitoring

The solution:

- A Predictive indicator based on the % of wheelset with EC exceeding a trigger threshold.

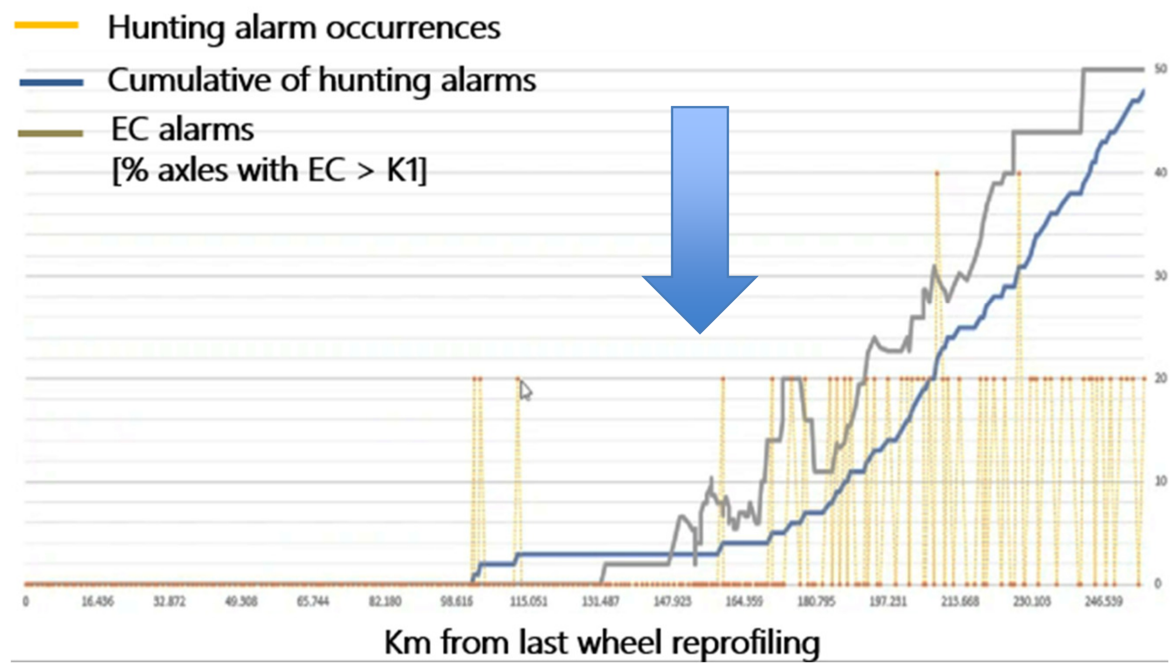
- The predictive capability of the indicator has been verified on the available data of the same type of train (2022).



CS1: Equivalent conicity monitoring

Counter measurements:

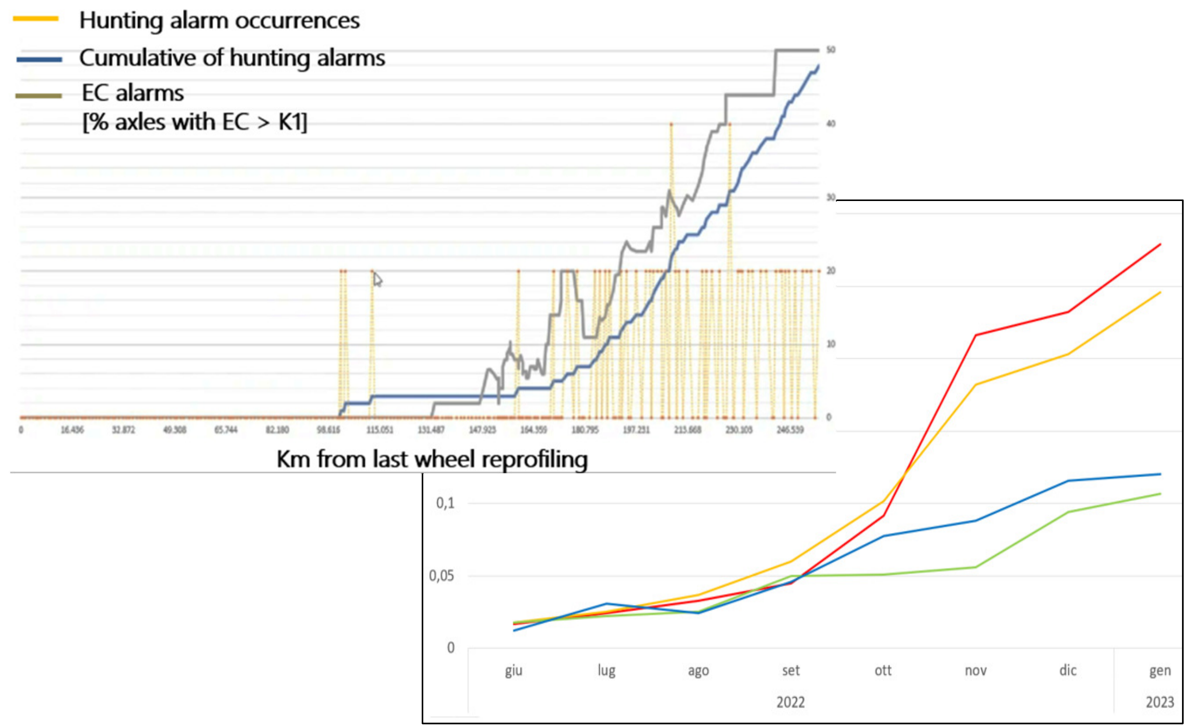
- plan maintenance before instability degrades train operation.
- change train mission to avoid high speed track sections



CS1: Equivalent conicity monitoring

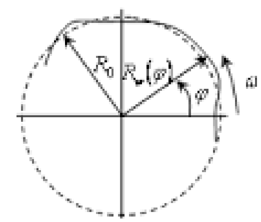
Next steps:

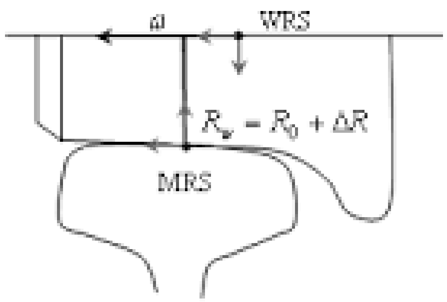
- Is the predictive indicator valid also for other types of trains?
- What is the root cause of the early hunting alarms / EC variation?

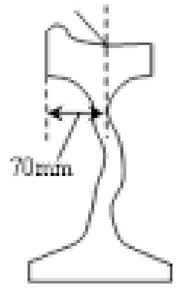


CS2: Wheel out of roundness early detection

Definition:
all in-service permanent changes to the shape of the tread contact zone of the wheel either **periodic** or **stochastic**







Causes
- Wheel/rail tangential creepage forces
- Bogie/wheelset vibration
- Wheelset diameter differences
- Uncontrolled sliding between wheel and rail

CS2: Wheel out of roundness early detection

Effects

- Reduced lifetime of wheelset / infrastructure
- Increased noise at the train transit
- Increased stress on the bearings
- Increased vibration on the bogie

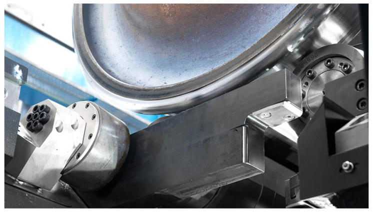
Early detection

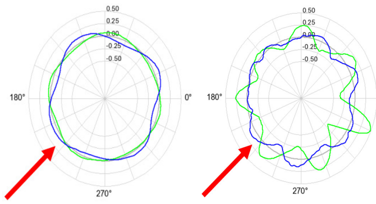
- Prevent problems from spiralling
- Reduce the amount of metal removed during reprofiling
- Preserve the infrastructure integrity

CS2: Wheel out of roundness early detection

Measuring technologies:

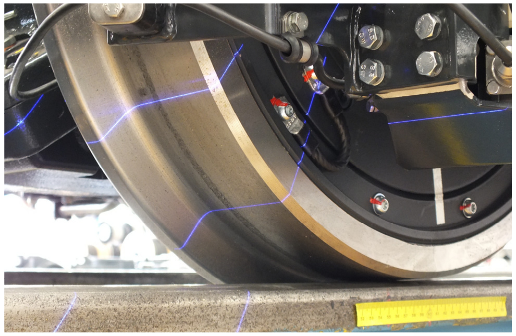
- Contact probe systems (i.e.: UWL / contact systems)
- Force detection (i.e.: WILD system / edge WILD system)
- Imaging system (i.e.: Tread imaging system)





New approach: Profilometry

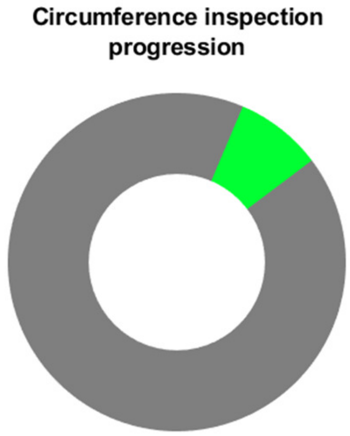
The application of contactless, in-service wheel profile monitoring gives the possibility to approach the OOR detection from a new perspective

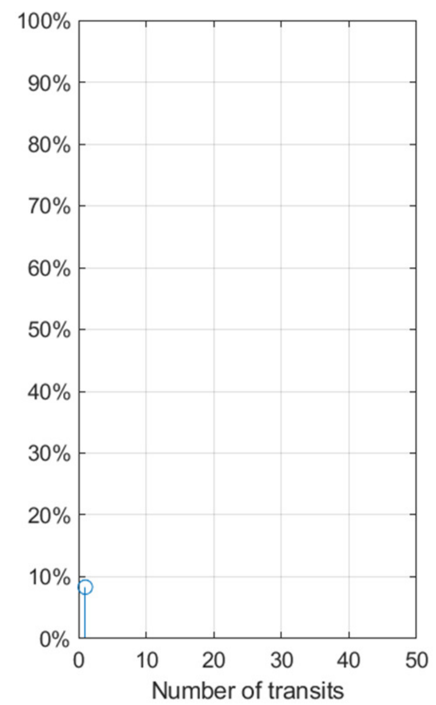


CS2: Wheel out of roundness early detection

Method highlights:

- **Statistical basis**
- 4 sections inspected for each passage
- Circumference inspection progression is
  - 70% after 15 passages (P-OOR)
  - 80% after 20 passages
  - >95% after 45 passages (S-OOR)





CS2: Wheel out of roundness early detection

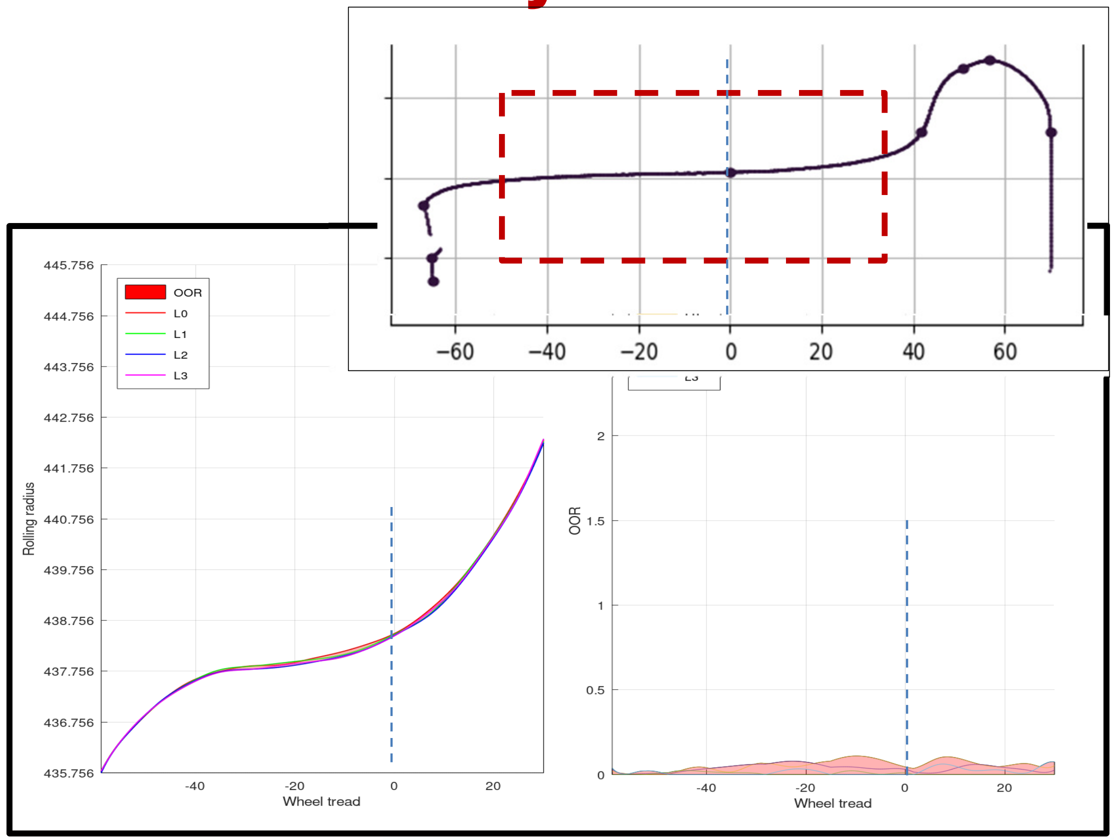
Method highlights:

- Measurements carried on the cross section
- OOR evaluated on the whole transversal tread profile

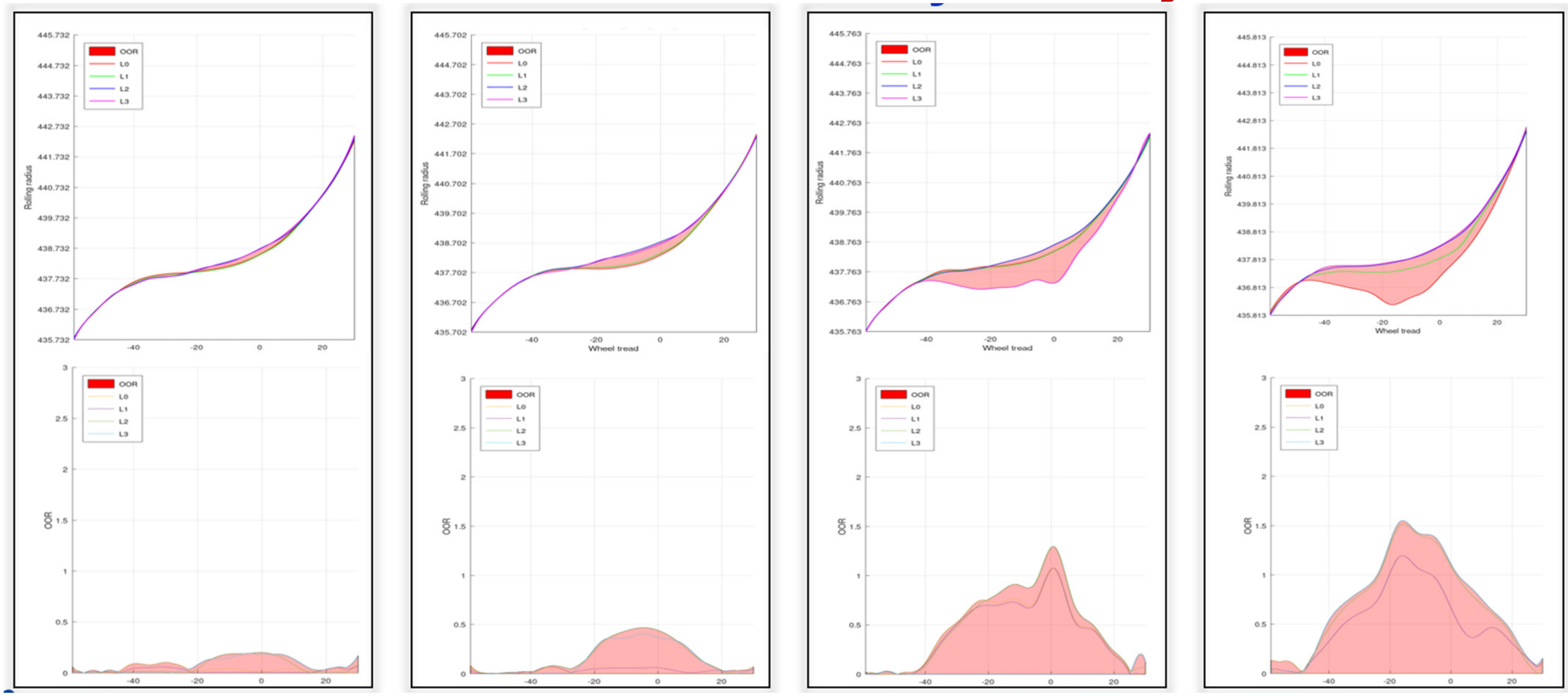
Complete Transverse Profile

Frequent Inspections

Evaluation of Radius variation



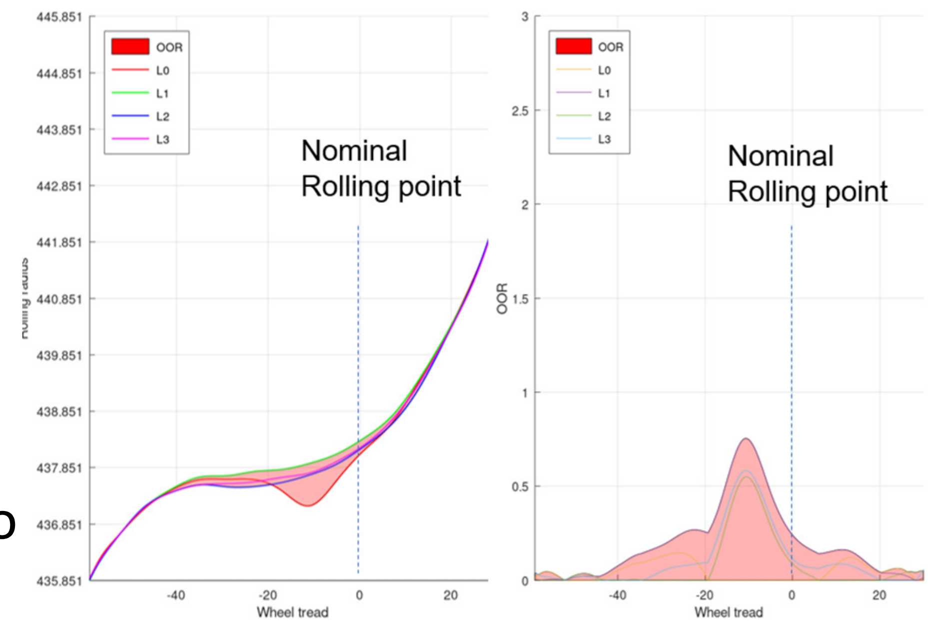
CS2: Wheel out of roundness early detection



CS2: Wheel out of roundness early detection

This method detects:

- defects development anywhere across the wheel tread.
- small defects when they are not yet generating impact load on the track.



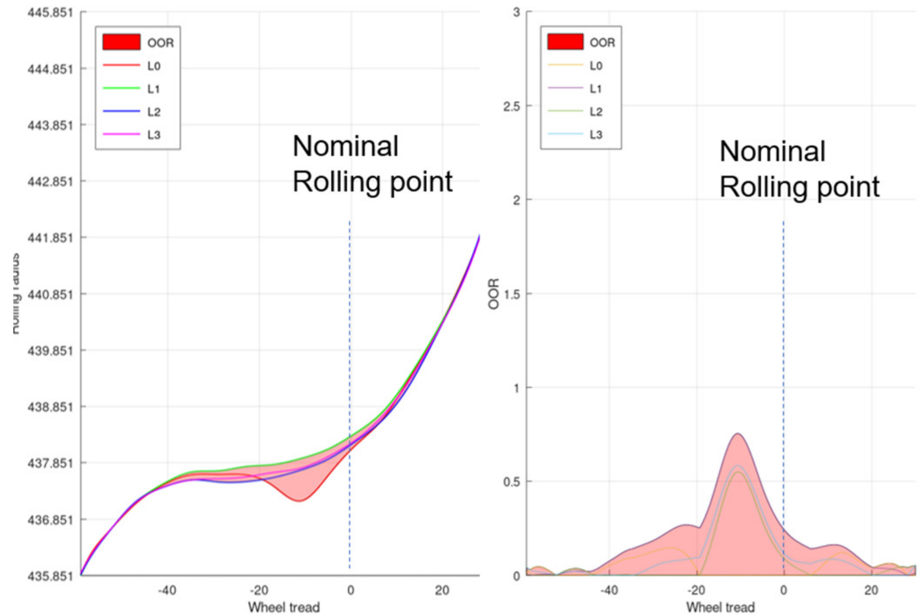
Conclusion:

This approach is a valuable additional way to better assess the roundness of wheels, early detect OOR defects and prevent infrastructure damages.

CS2: Wheel out of roundness early detection

Next steps:

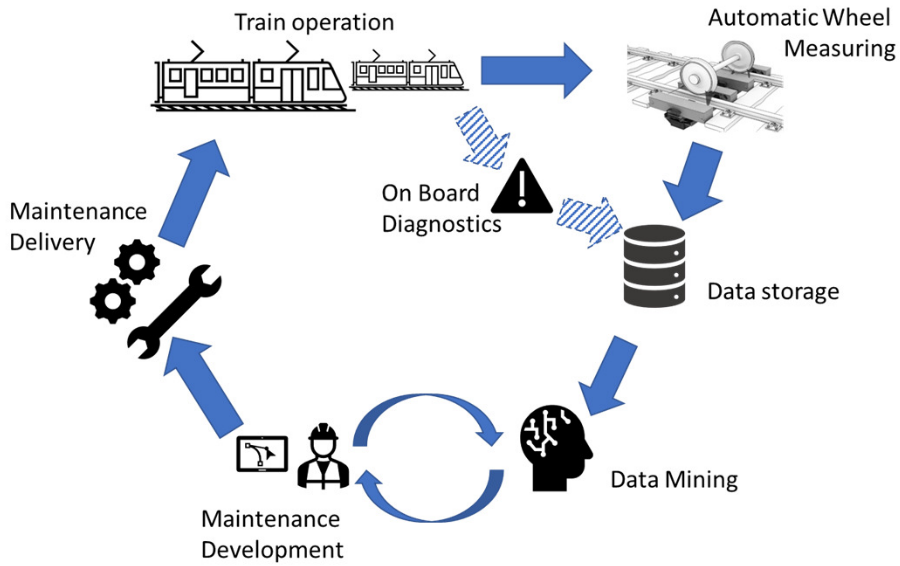
- Validate the accuracy of the statistical approach with a reference measuring instrument.



Conclusions

CS1 showed that maintenance can avoid speed restriction in high-speed trains using predictor indicator based on equivalent conicity.

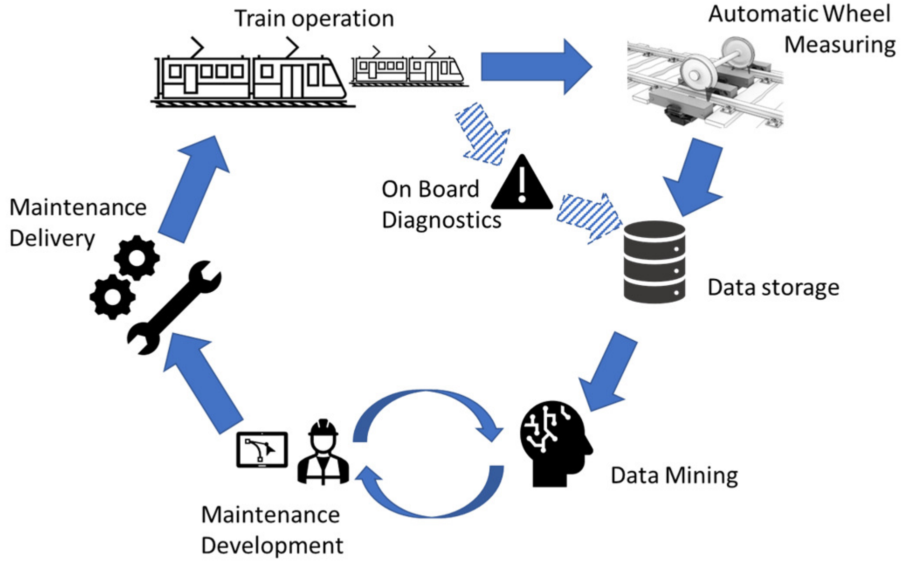
CS2 showed that maintenance can extend lifetime of wheelset using in-service wheelset monitoring data with statistical approach to early detect OOR defects.



Future works

Deeper Analysis on Wheel Profile wear evolution:
characterize the contribution of each factor to wheel wear and thus enhance the capabilities of the system to predict wear evolution.

Real Equivalent Conicity:
merge infrastructure data with rolling stock data and extract a Real Equivalent Conicity parameter.



Thank you !

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If we don't change the direction we are going, we are likely to end up where we are heading!