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# Predictive Wheelset Management: From Measurement to Demand Planning

**P**redictive wheelset management can be considered a key innovation for the railroad industry, as the requirements are mainly met with digitalisation and technology developments (e.g. transmission speed and storage capacity). This article will present a methodology for optimised demand planning of wheelsets.

TMH International is an internationally active manufacturer

and maintenance provider of rail vehicles. Maintenance planning is controlled at headquarters and carried out at the appropriate time, preferably locally near the customer. In our example that component is a particularly important one: the wheelset, a safety-critical wearing part to which certain standards apply to ensure safety. Its maintenance planning is also worthwhile from an economic perspective – by replacing them at an optimal, rather than scheduled time.

The aim is for the entire process – from performing measurements, to

monitoring values and planning and executing the maintenance – to be as digitalised as possible.

## Predictive, Data-Driven Maintenance

Predictive wheelset management is a preventive maintenance strategy. A single variable (often time or mileage) is assigned a high correlation to the component's wear curve, and experience and/or engineering knowledge is used to determine an interval after which the component must be serviced/replaced/maintained. This rule is



fragile because it is a static solution for a dynamic system. Data-driven wheelset management adds certain influencing factors to the solution (or model) by digitalising, evaluating and collecting the factors in the model. In addition to domain and engineering expertise, data science supports the accuracy of predictions with stochastics and other statistical/mathematical methods. The quality of the prediction is determined by the underlying data quality. What parameters are recorded and how accurately this is done is key. In the following section, we therefore outline a procedure that railroad companies can use to minimise measurement inaccuracies, thus laying the foundation for predictive wheelset management in the all-important process of data acquisition.

## Wheelset Measurement

Because the wheelset is a safety-critical wear part, its condition must be determined regularly by measuring critical parameters. This ensures safe rail operations and this

measurement data also informs immediate or future maintenance measures. The standard 'EN15313 – Wheelsets and bogies – Wheelset maintenance' specifies how these critical parameters are to be determined<sup>[1]</sup>.

The measuring instruments of the CALIPRI® series ensure that the measurement results are in accordance with the standard and are reliable and precise. This is achieved by using the patented CALIPRI principle and its unique tilt correction.

CALIPRI measuring equipment is used at TMH International to measure every single wheelset. CALIPRI also has the advantage that all wheelset parameters can be measured with one and the same measuring device in one measuring run, such as wheel profile results, wheel diameters, and wheel back-to-back distances.

## Data Storage

The measurement of the wheelsets is step one. Storing this

measurement data in a structured way so that further steps can be defined is pivotal.

TMH International stores its data directly in the cloud. The cloud-based software solution CALIPRI Predictor is the ideal repository for wheelset measurement data. The advantage for TMH International is that it doesn't have to worry about how the data gets to the cloud, nor does it have to make sure the data is secure.

This is all taken care of by the CALIPRI world, where, after a series of measurements has been completed, the results are immediately transferred to the CALIPRI Predictor via an automated interface. Here, the data is then safe from loss and (only) the owner of the data can access it at any time.

## Condition Monitoring/Forecasts

Decentralised data storage in the cloud has several advantages:

- The data is available





immediately after the measurement

- It can be used immediately for a condition report
- Access is possible via any terminal device

CALIPRI Predictor immediately provides TMH International with an overview of the condition of the entire fleet. Assigned individuals are automatically notified when tolerance limits are exceeded, allowing them to respond without delay.

The goal, however, is to prevent things from getting to the point where an unplanned, immediate maintenance measure is necessary. TMH International therefore uses the analysis functions of the CALIPRI Predictor to be able to initiate and plan these measures much earlier.

A core element here is the wheel profile data measured by CALIPRI. It can be used to compare the wear behaviour of individual wheels with each other and to identify and analyse differences. The development of wear over time not only allows an analysis of the past, but also a look into the future, making it possible to take the step towards modern maintenance and plan for the long term.

## Documentation / Verification

Data management must be defined to document the entire maintenance history<sup>[1]</sup>. The basic condition for this is the coordinated linking of the necessary data to the real process. The challenge is to avoid a data graveyard and instead create a knowledge database that allows the collected

information to be found easily and comprehensibly. In addition, the challenge is the error-free transfer of the data within the IT systems. For this reason, a standard interface was developed between CALIPRI Predictor and Boom Rail Solutions, in which all the requirements of the standard for the necessary data fields are met. In addition to this standard, there are also various verification requirements in the course of the ECM regulation. These can also be properly ensured with Boom Rail Solutions by documenting not only the vehicle and wheelset data but also the resulting and executed maintenance measures.

## Demand Planning

The main benefit of predictive wheelset maintenance is improving planning processes. The static determination of maintenance and inspection intervals described above accepts large deviations in the progress of the wear condition. Wheelsets are brought to the workshop earlier than necessary. This safety buffer can be interpreted as a buffer of model inaccuracy. Following this logic, the main goal is to create more robust models that can reduce this uncertainty. In this context, it is important to emphasise that the described further development of preventive maintenance can be incremental. The consideration of even just one influencing factor can therefore already generate significant added value. A special application of this approach is the improved demand planning of wheelsets. Railroad companies such as TMH International are faced with the challenge of managing a large number of different vehicles and thus wheelsets, and consequently

rarely have a constant, regular demand for certain wheelset groups. Instead, the varying wear curve combined with new acquisitions and market conditions lead to fluctuating demand<sup>[2]</sup>.

To change the maintenance of railway wheelsets from time-based via condition-based to predictive maintenance, it's crucial to implement a structured measurement and data handling procedure. This requires precise measurement devices and error-free, automated data transfer to specialised tools. CALIPRI measurement devices and cloud-based apps like CALIPRI Predictor are made for exactly this purpose.

Once this process has been implemented, it's just the starting point of continuous improvement of the prediction and thus, optimised wheelset maintenance activities and demand planning.

### References

[1] EN 15313, Railway applications – In-service wheelset operation requirements – In-service and off-vehicle wheelset maintenance, Austrian Standards Institute, (2016) p.15.

[2] Koether, R.: Distributionslogistik – Effiziente Absicherung der Lieferfähigkeit, Springer Gabler, 3, (2018) p.25.



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