Maintenance 4.0 - From big data to smart data

Asset management in rail transport: Obtaining and evaluating status information as well as key figures

To utilise the advantages of industry 4.0 in rail transport, different adjustments of the present process sequences in rail companies are necessary. This includes for example individual solutions for the condition-oriented maintenance or resource optimisation. New working methods on the basis of continuous communication, from sensor technology to the mobile device, with automated IT-supported data processing by intelligent algorithms address the maintenance 4.0 focus areas knowledge management, information processing and collection as well as communication with mobile devices. This means that maintenance 4.0 can also be realised on the rails.

Economic railway system maintenance requires clear cost targets as well as quality agreements. Modern companies have identified the resulting potential as a strategic factor of success and added value. Regular monitoring of the rail road condition is indispensable for a perfect maintenance strategy. Especially the aggregation and evaluation of data from different sources, such as on-site visits, inspections, measurement drives, video drives or repair are a challenge for every operator, owner and maintenance officer of railway infrastructure systems. In this connection, the key focus isn't just on the gathering of data, but on the evaluation of data with the consistent monitoring of railway conditions, the requirement for an optimal maintenance strategy

Within the scope of the long-term cooperation of ZEDAS GmbH Senftenberg with different railway infrastructure companies (EIU), diverse solutions regarding the asset management (comprises an organised approach, which enables companies to maximise assets or minimise liabilities) have been realised, such as measures for defect and failure detection, order processing, deadline optimisation and resource planning. The objectives of these companies are safety, availability, effectiveness as well as sustainability. One cannot achieve this with a focus only on the minimisation of the maintenance expenses. Maintenance is no pure cost factor but the price for availability.

It is therefore necessary in the era of Industry 4.0 to use intelligent algorithms to synthesise collected data into useful information, i.e. the basis of decision-making. This transforms big data into smart data. Automatic evaluations of the result documentation, cause evaluation and order recording should allow reliable analyses. By means of technical diagnosis applying multivariate methods, software-based prognoses regarding CAPEX (characteristic balance sheet value referring to investment expenses for fixed assets) and OPEX (as opposed to CAPEX, OPEX refers to the operating expenses such as costs for raw materials, operating materials, personnel) can be given. Multivariate methods (also multivariate analysis methods) make it possible to examine several statistical variables or random variables simultaneously. In this way, correlation and/or dependency structures between the variables can be analysed and identified. In this connection, key figures only considering the maintenance costs without allowing for the load and the condition are not sufficient. In order to achieve this, the data gained from different IT systems and in different process steps needs to be used in the most efficient way possible. Especially the aggregation and analysis of data from different sources are a challenge for every operator, owner and maintenance officer of railway infrastructure systems. In this connection, the key focus isn't just on the gathering of data, but their evaluation with permanent monitoring of conditions, the requirement for the selection of the optimal maintenance strategy. The zedas®asset software solution provides an industry-specific instrument with

which decision-relevant status information can be gained.

Smart asset management and maintenance

Based on the structured railway infrastructure systems and components, all relevant process, operating and measurement data can be monitored, analysed and managed in one asset management software. This also includes the display of the railway system condition including the life history of all systems. All maintenance-relevant information on defects, failures, inspections, deadlines, orders, measured values or limit value violations are displayed and monitored in a centralised manner. In maintenance schedules, inspections/on-site visits are defined that can be initiated not only cyclically or depending on the load, but also in accordance to a condition-dependent maturity prognosis based on the analysed railway infrastructure data. In this way, intelligent derivations such as deadline maturities ("smart data") can be generated from this mass data ("big data"). The generation of work schedules as well as check lists for the budget planning is possible, as well. Performance times, materials and spare parts can be assigned to the work steps, in order to plan resources in a proactive manner. For all tasks, order-related information can be integrated with reference to rules and manuals.

ZKI - condition/cost index

The aim is to plan the necessary maintenance measures and resources in a more efficient manner

and to increase the availability of railway infrastructure systems. Especially the investment and budget planning on the basis of reliable data constitutes a challenge for many rail companies.

To make the decision when to take action and how to fund it, key figures alone are often not enough; this rather requires complex analyses, e.g. of status degression, the costs and the duration of the entire action plan, as well as of the consequences resulting from non-availability. The condition/cost index, or ZKI (in German: Zustands-Kosten-Index) for short, serves as a supporting tool for decision-making in this context. This index combines defined factors such as operating classes of railways, system classes and route categories in a complex proprietary assessment scheme based on the experience gained from the use of the zedas®asset AMS. A general rule to apply here is: the higher the index, the more urgent the action. The following points are taken into consideration for the calculation, for example:

- Costs of preventive and corrective maintenance
- Proactive prognosis (fig. 1)
- Safety, speed (classes) and load (tonnes or number of axle passages per time period)
- Availability, including redundancy
- Revenue of routes ordered by priority
- Condition index based on changes to the measured data as an objective criterion for manual inspections

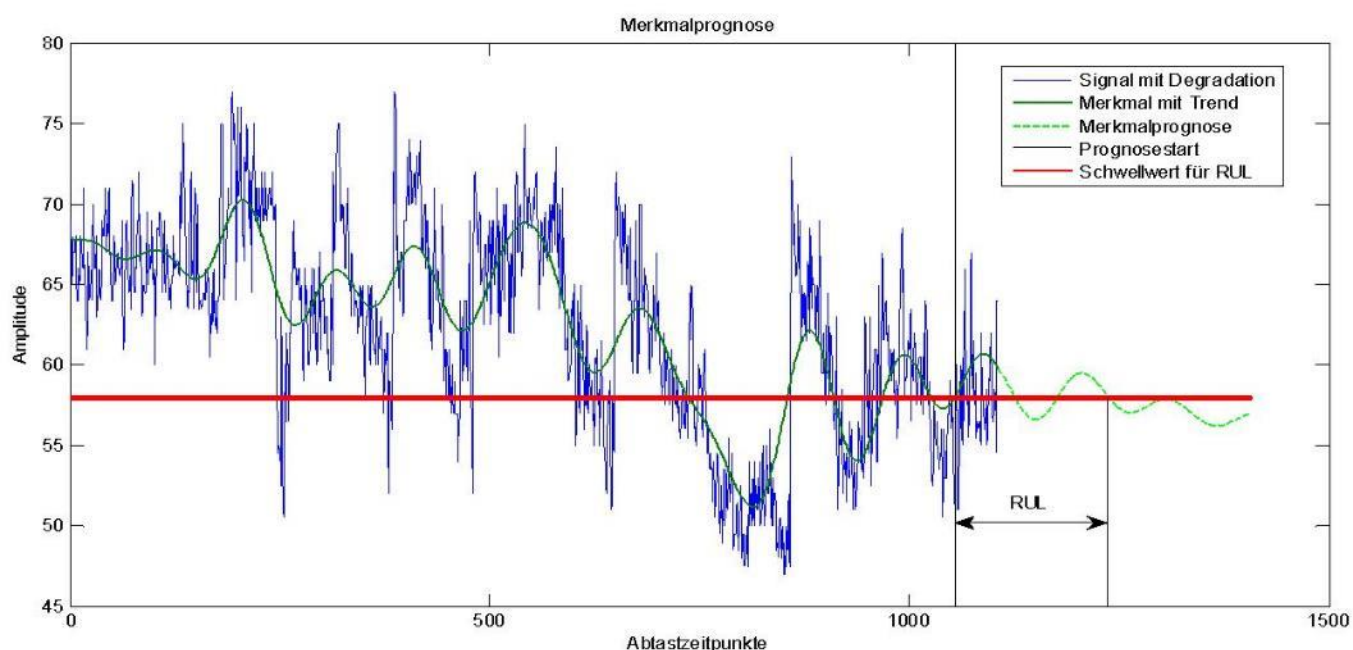As result, the analysis software thus supplies a proactive prognosis. Using multivariate analysis

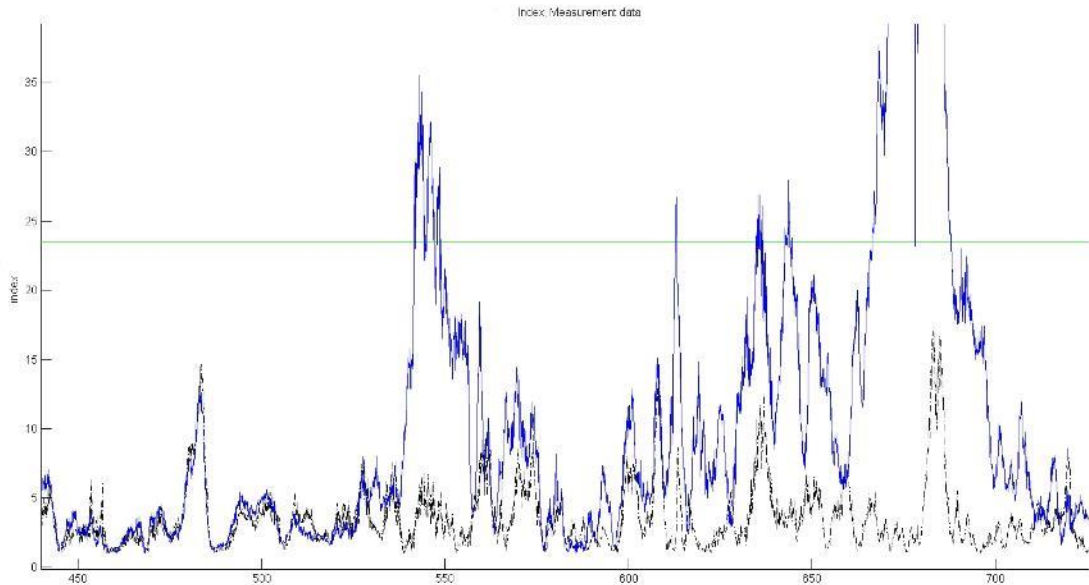Fig. 1: Prognosis on the remaining useful life (RUL)

Fig. 2: Example condition index

methods, a prognosis on the remaining useful life (RUL), the time until the next failure to be expected, can be given based on the data on the wear development and the maintenance history. The following applies in this context: The more precise and comprehensive the historical data (with reference to load and to external influences), the more exact the prognosis. Practical experience shows that this reliable data history is often (still) missing. One problem that, thanks to maintenance 4.0, will soon be a thing of the past.

Summary

Railway infrastructure companies are permanently faced with the challenge of making decisions regarding improvement measures based on status information and key figures. When these measures are completed and how they funded is a complex consideration taking the degree of change in condition, the costs and the duration of the measure as well as the consequences resulting from non-availability into account. The condition/cost index (ZKI), which is the result of the consistent implementation of the requirements from maintenance 4.0, serves as decision-making support. In order to gain intelligent smart data information from the big data "graveyards", condition monitoring, diagnosis and maintenance management must be considered as a unit in the sense of a holistic asset management.