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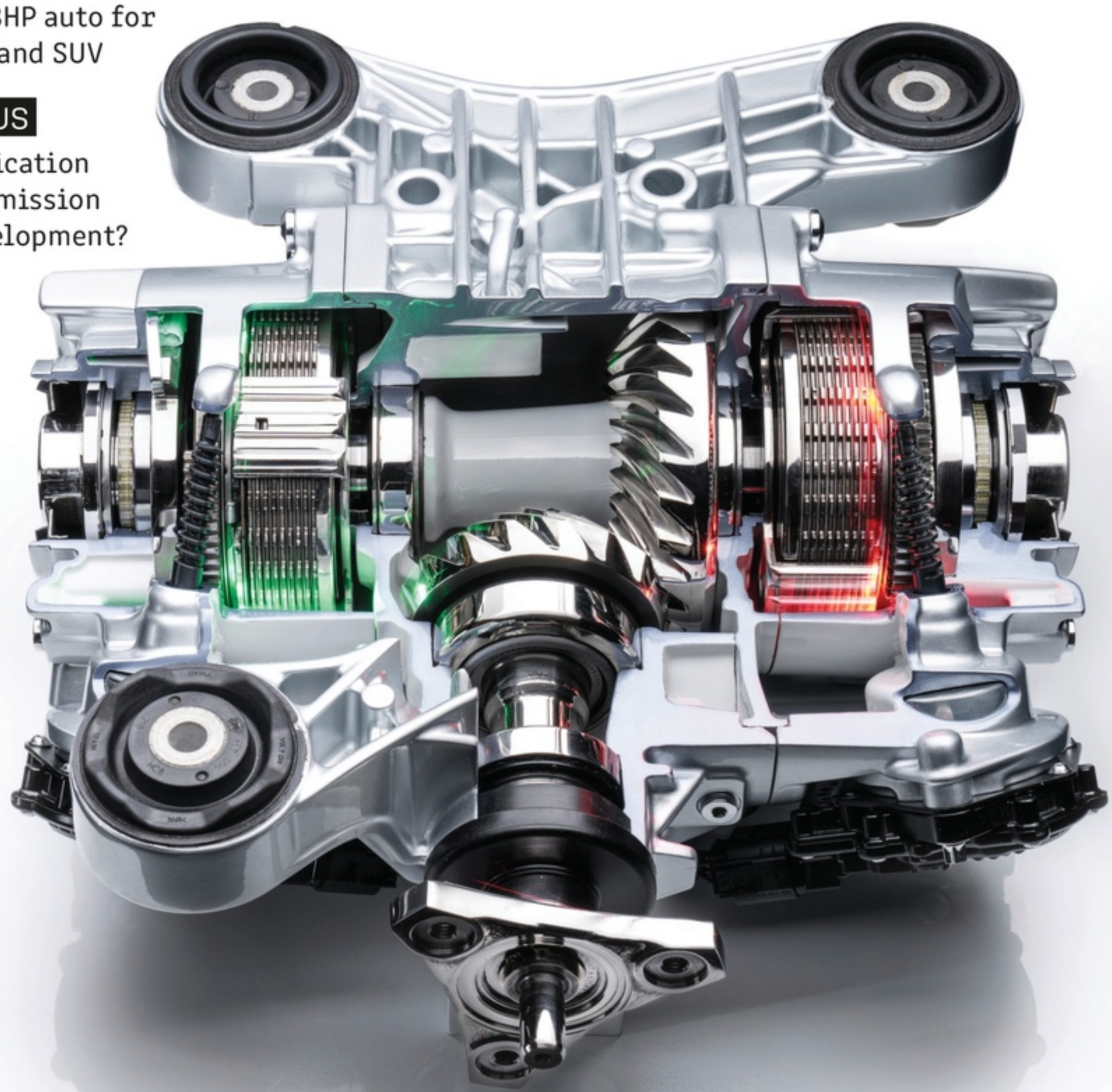
IMPROVING PERFECTION

ZF revisits its 8HP auto for BMW's latest grand SUV

SPECIAL FOCUS

How is electrification changing transmission design and development?



REAR STEER

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Generating Gear Grinding

Industry 4.0 ready

- All necessary IoT interfaces
- Touch-based HMI with intelligent operating support, process proposals, and active error prevention

Grinding Process monitoring

- Constant measuring of dressing and grinding intensities by innovative real-time data processing and tested algorithms
- Process data are recorded and stored in a database and remain 100 % traceable
- Comprehensive data analysis
- Automatic removal of pre-machined parts that are outside of set tolerances
- Closed-loop technology in collaboration with Mahr gear measuring machines

Machine Component monitoring

- Recurring automatic testing cycles of all relevant machine components
- Early detection of electromechanical deviations
- Optimization of maintenance costs

AMB
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REISHAUER
Gear Grinding Technology

Gear grinding

Automatic machine component monitoring can help alleviate NVH issues, improve productivity, eliminate rejects and reduce costs

Continuous generating gear grinding has established itself as the preferred method of hard-finishing automotive gears. The machine tools – the gear grinding machines – have reached an elevated level of maturity, which means there is little room for improvement on the mechanical side.

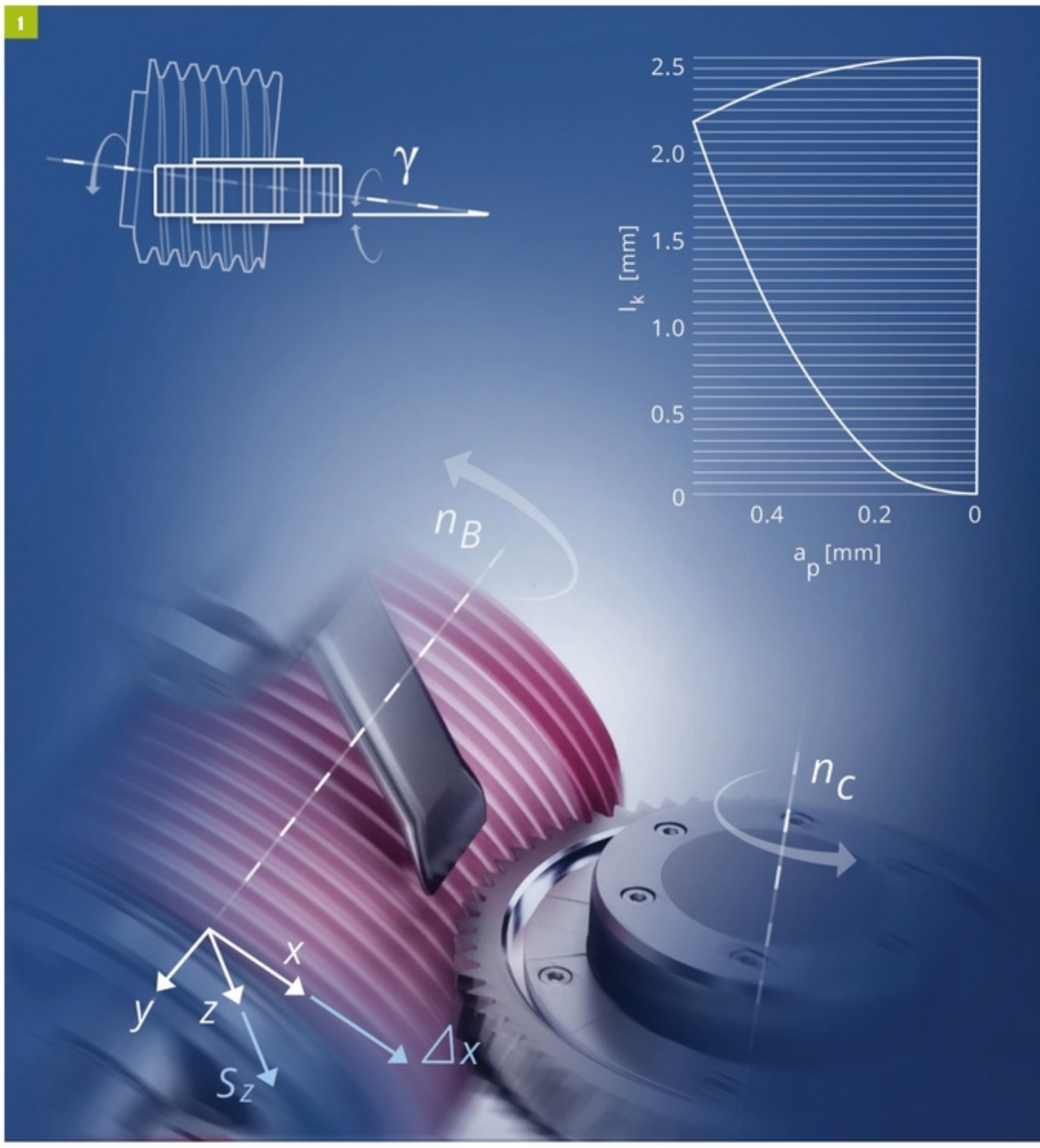
However, recent developments in process and component monitoring have added a new dimension to the performance of these gear grinding machines. Another key point of development focus is machine component wear over time. The critical question regarding wear is when might it start to affect gear quality and cause NVH issues. Through machine component monitoring, and by applying artificial intelligence (AI), it is possible to predict and avoid the negative impacts of wear. In the context of Reishauer gear grinders, component monitoring refers to all machine axes and their bearings used in the grinding process to achieve the required quality of the tooth flanks.

To combat the negative impacts of wear, Reishauer has now developed a process and component monitoring system, ARGUS, based on AI. There are several prerequisites for artificial intelligence to be effectively used in the first place. First, a large amount of curated data is needed, then it becomes possible to derive physical regularities on which to design algorithms. There is also a need for experts and professionals from the gearing industry who can program the algorithms required for AI. In a nutshell: AI has to be hard-won. What is called 'intelligence' in AI is based on lengthy processes of sending reviewed and curated data sets through neural networks. Subsequently, the data output results must be checked, revised and sent back through the neural network. In this manner, the AI system continuously learns, constantly corrects itself and adjusts the algorithms accordingly. This process is also called deep learning.

So, what can artificial intelligence do much better than human intelligence? AI can find the proverbial needle in a haystack at lightning speed. AI is based on pattern recognition, uncovering unusual correlations in enormous amounts of data that would usually escape human intelligence. AI is, first and foremost, a decision-making technology. In the context of component monitoring, speed and accuracy of the decision making are imperative, and AI is lightning fast.

CLOUD STRUCTURE

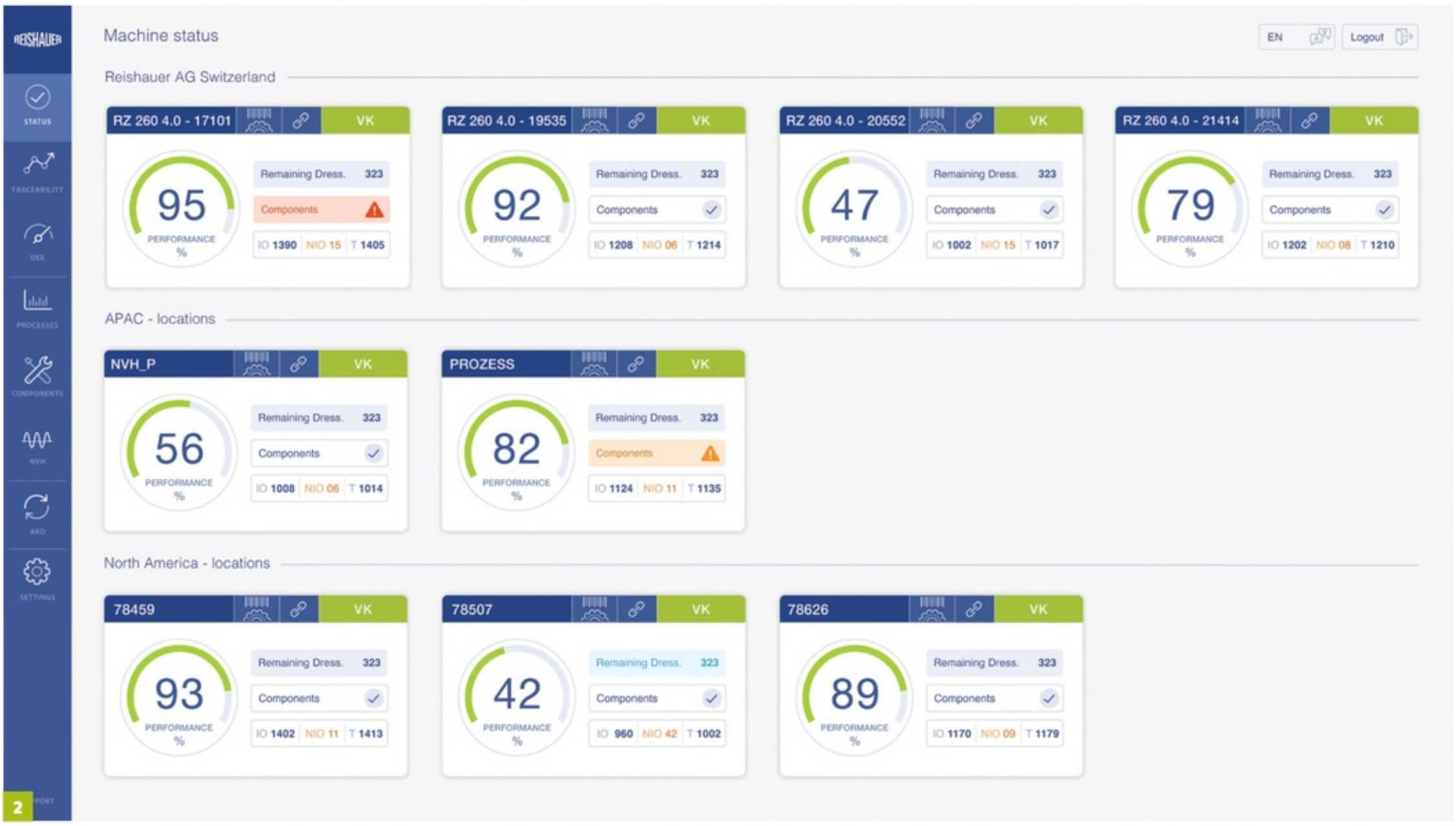
Automated component monitoring requires a cloud structure for data storage to cope with the large volumes of data continuously generated by countless grinding machines around the clock.



1. Automated gear component monitoring harnesses AI in order to quickly identify potential problems

Furthermore, it requires overarching machine algorithms that can evaluate the anonymized data about the states of the machine components in real time with AI.

The grinding machine runs autonomous cyclic tests that reflect the components' conditions. The grinding machines generate enormous quantities of signals but the signals are only useful if they can be interpreted. To this end, in the past it was necessary to bring in a highly skilled person who knew how to interpret and



analyze changes in the signals – especially in real time – because it is of paramount importance to interpret the data before any critical process condition can occur. No matter how experienced they are, this person will not be able to interpret the multiple problems in the volumes of data generated today. Automatic machine component monitoring (ACD) does not expect errors but is constantly evaluating and thus uncovering tendencies in the deviations. It is only on the basis of analyzing these tendencies that preventive maintenance becomes possible. Due to the large amount of data, ACD finds even the smallest errors or deviations. The detected errors can then be traced back to a bearing of a machine axis, for example.

Only enormous amounts of data, which are available anonymized in a cloud, make it possible to train the corresponding algorithms. It is important to mention that the legal regulations concerning data protection must be strictly observed. The machine can be checked as often as required without needing personnel or interrupting the production cycle, enabling preventive maintenance and reducing user costs as machine downtimes can now be planned.

Over time, the precision of the algorithms continues to improve as the knowledge gained leads on to further developments and refinements. In addition, since sensor technology is constantly evolving and always integrated into the ARGUS system, this continuously upgrades the analyses and the algorithms. Whereas failure analyses took a huge amount of time, with the help of ARGUS the Reishauer experts can perform a failure analysis incredibly quickly. For example, the specialists can predict a potential NVH problem (disturbing transmission noise) from the signals, preventing faulty parts from being installed in the finished transmission. Previously, such problems required an expensive and time-consuming trip to the user's site.

2. The dashboard displays the status of various machine tool components

SIMPLIFIED DATA

Even though there are high-level algorithms and a complex cloud architecture in the background, this complexity is broken down for the user in the web application, into an easy-to-interpret color code. If the light bar is yellow or red, this indicates damage development and component failure. Customers can subsequently give Reishauer specialists access to the data in the cloud. A specialist can then analyze the problem in the shortest-possible time and suggest appropriate corrective measures.

In addition to preventive maintenance, ACD's great strength is to index between 'good' and 'bad'. Thus, not only are trends visualized, but signal patterns are distinguished between 'good' and 'bad'. This differentiation helps users save costs by minimizing downtime and avoiding major damage to the machine.

Component monitoring is only one aspect of ARGUS. The other important dimension is process monitoring to move ever closer to zero-defect production. In summary, process and component monitoring can avoid NVH issues, improve productivity, eliminate rejects and reduce costs. ⦿