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Machine Learning

A DATA-DRIVEN CRYSTAL BALL

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A DATA-DRIVEN CRYSTAL BALL

Predictive maintenance is not magic: A complex plant consists of a large number of subsystems interacting with one another. Only when every subsystem is functioning correctly can the plant fulfill its purpose. Individual parts are critical: if they fail, the entire plant fails. Predictive maintenance helps to avoid situations such as these and saves considerable costs.

As an example, let us look at a ship: Undetected damage leading to the failure of a crane could leave the entire ship unavailable for a planned task. At the very least, the financial consequences are considerable. But in the worst case, the result is a dangerous situation for both people and the environment. To best avoid this scenario, there are various different maintenance approaches available.

Maintenance strategy 1: Reactive

Still a common approach to maintenance, repair work is carried out after a failure has occurred, such as exceeding a critical temperature or falling below a minimum oil pressure. An alarm is triggered, and the oil can icon lights up red on the dashboard. However, in this scenario the fault has already occurred and immediate maintenance is required. The warning light is helpful, but it doesn't give service crews any time to plan. The right spare part may not be available, and crew might not be free to perform an immediate repair. The plant is at an unproductive standstill. Reactive maintenance is expensive and insufficient for critical systems.

Maintenance strategy 2: Preventive

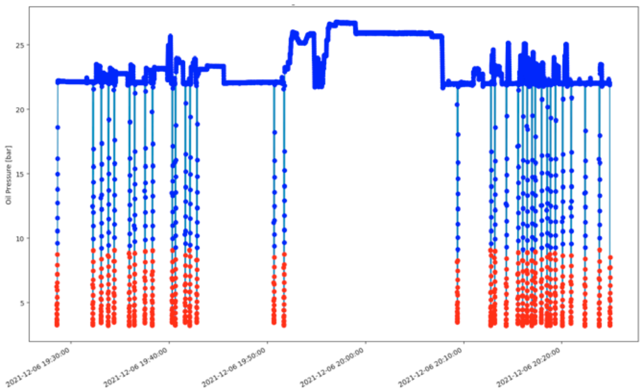
Preventive maintenance strategies try to avoid such situations: Maintenance is performed based on a component's average life expectancy. Sometimes, however, the part is still fully functional at the time of replacement. This wastes money and resources. If, on the other hand, exceptional operating conditions have accelerated aging, the repair window can be missed: The defect occurs, and the system shuts down. Costs in both cases are unnecessarily high. But sometimes critical systems with undetectable fault mechanisms, such as creep or fatigue, require the application of preventive maintenance.

Maintenance strategy 3: Predictive

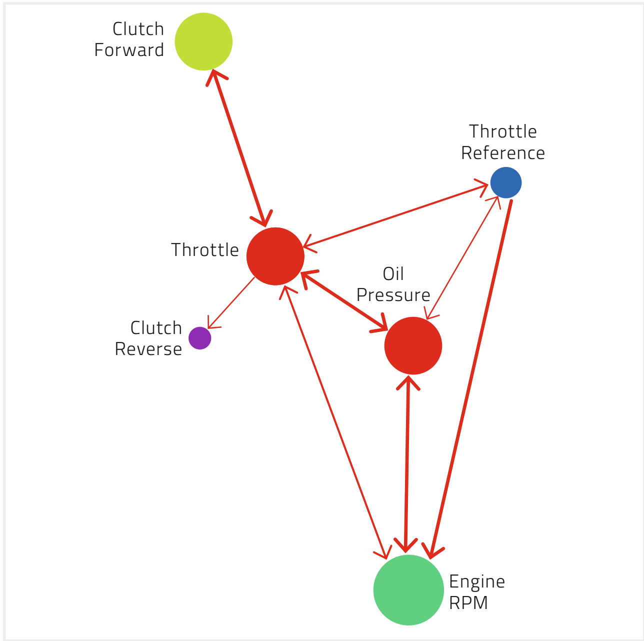
Ideally, maintenance is performed exactly when – and only when – it is actually necessary. This is definitely the most cost-effective approach. With predictive maintenance methods, you know in advance exactly when this point in time will occur, you can plan service and spare parts, avoid failures and reduce unproductive downtime.

Optimized maintenance

In reality it is necessary to apply a mix of maintenance strategies. These depend on the failure type identified, how far in advance they can be detected, and their criticality to the system. Bachmann's Artificial Intelligence (AI) tool helps engineers to detect multiple types of failure even earlier,



Data gaps during recording and non-expected operating values (in red): Bachmann uses graphs such as these to assess the validity of a customer's data. The cleaneddataset then trains the machine learning algorithm.



There are correlations between the individual subsystems on a ship. Thus, from the state of a subsystem, a prediction can be made about the possible availability of the entire ship.

The wider the lines (called "edges"), the greater the dependency of each signal. The larger the diameter of the nodes, the greater the influence of the signals on the overall system.

enabling the application of predictive maintenance to a wider variety of items.

Returning to the above example, now becomes possible to know weeks, or even months, in advance, whether or not the ship will be available for use at a particular time.

The challenge of realism

Setting alarm thresholds for automatic alerting is tricky. They can vary depending on process conditions. At one point during operation, values may be completely normal, but at another they may indicate a critical anomaly. It takes expertise to distinguish one from the other, and intelligent algorithms that can perform this task during operation for many parallel processes.

Searching for clues in the data

Bachmann uses artificial intelligence methods, in this case machine learning, to train fault prediction, opening up new possibilities for predicting the availability of plant components and, subsequently, the entire plant. The first step is to look for patterns in the plant's usually extensive measurement and sensor data that differ from the expected normal state. Statistical methods and graphical representations such as plots or heat maps assist this process. Gaps in the recording or anomalies are thus easily identified. Together with the plant operator and their expertise, these can be evaluated and the data cleaned up.

No magic

In a further step, corresponding correlations between data are identified, recognizing the influence or interdependency of parameters or subsystems. With this information, neural-network models are trained based on real system data – at a point when it is known to be running fault-free. If these models are overlaid with condition monitoring sensor data, and thus with the current state of the system, intelligent algorithms can be used to identify trends at a very early stage. The better such a system is trained, the more precisely it is possible to predict whether, and for how long, the plant can continue to run under the given conditions – or how much time the maintenance team has to carry out their work.

Ergo: We don't need a crystal ball. In the future, with the right data, advanced analyses and sophisticated, self-training algorithms will perform these tasks. This will make it possible to assess developments in advance, identify potential future damage risks and, if necessary, remedy them in good time. With the right spare parts and tools. From the right service personnel. At the right time.

SYSTEM VALIDATION WITH AEGIR MARINE

Together with AEGIR Marine, one of the major qualified stern seal & propulsion service providers for seagoing vessels (headquartered in the Netherlands), Bachmann is investigating 17 possible wear scenarios for propulsion propellers. Starting with a fully reconditioned propeller, individual parts such as bearings or seals are replaced by specifically worn parts during a long-term test. In the process, the team is researching at what point, and with which methods, faults can be detected during operation. In this way, algorithms are trained and the quality of prediction further improved.

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