Condition monitoring can be extended from critical assets to all areas of the plant via control systems, smart sensors and digitalization

ARTIFICIAL INTELLIGENCE

KEEPING A WATCHFUL EYE OVER THE CONDITION OF ROTATING MACHINES

BY DIEGO PARESCHI

Condition monitoring is a fundamental discipline using digital technologies that helps improve the safety and reliability of rotating equipment. Digitalization enables the monitoring of equipment on an unprecedented scale.

But just collecting data is not enough. It must be put to productive use. With a concept known as edge computing, data can be processed and analyzed locally with only the most relevant information being sent to the plant or enterprise-asset-management system.

This offers the opportunity to greatly extend the value of condition monitoring, which traditionally has been restricted to critical machinery. With edge computing, large fleets of non-critical assets are within easy reach of round-the-clock condition monitoring.

Checking condition

Condition monitoring has evolved over the years. From the 1980s, the focus was on wiring. Probes are wired to junction boxes and the signals are fed to monitoring systems housed in cabinets where they are read by a higher-level system.

Operational parameters are continuously captured and studied to predict future behavior. If the system detects an abnormality that exceeds a threshold value, it trips the machine to avoid damage. The data is extrapolated for further health analysis.

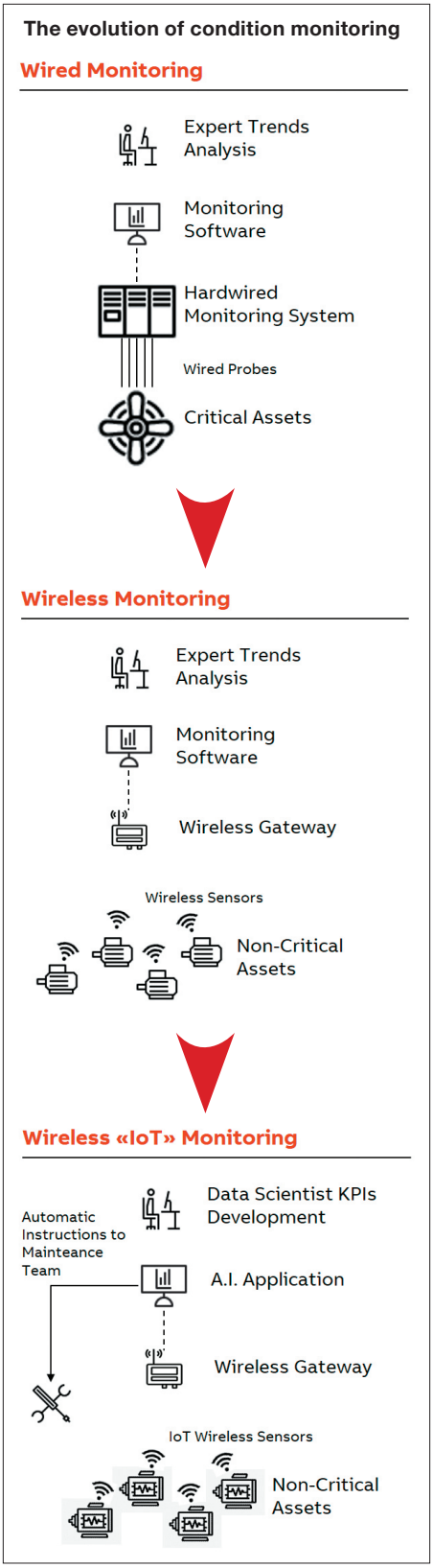
In the early 2000s, low-cost wireless technology became widely available. This expanded condition monitoring to more machines. However, it meant sacrificing the ability to continuously monitor the asset, as wireless sensors provide readings on a periodic basis to save battery power. Readings were collected and analyzed.

The use of wireless sensors has grown in the process and energy industries. But the investment required made it difficult to justify their deployment across large fleets of assets and auxiliary systems.

Brownfield sites, for instance, typically lack an existing wireless network infrastructure. More recently, technologies based on the Internet of Things (IoT) and Artificial Intelligence (AI) have improved the cost-effectiveness and accuracy of the condition monitoring.

This makes it feasible to monitor the condition of the many non-critical

The evolution of condition monitoring



Edge computing can bring the benefits of AI to turbomachinery in order to detect failure and prevent downtime.

devices that support rotating equipment. Wireless access points can be placed around the facility within range of these machines. Sensors communicate with the wireless gateway that transmits the raw data to a system for analysis.

With wireless technology, the fleet of monitored assets can be increased from less than 5% to about 20% of all machinery. But what about the remaining assets? This is where edge computing comes in.

At BASF's main site in Ludwigshafen, Germany, only a small number of its many rotating machines were being monitored. Sensors were deployed across the facility to detect bearing temperatures and vibrations and to send readings for analysis.

A single wireless sensor can generate up to 250 megabytes (MB) of raw data per day. More than 99% of it, however, is irrelevant to machine health trends.

Edge computing solves this problem. By processing data locally, inside the sensor attached

Sensors designed to capture and extensively analyze the readings are often referred to as smart sensors

to the machine, the volume of data sent to a higher-level monitoring system can be reduced from hundreds of MBs to a few kilobytes (kBs).

These devices store the measured raw data for a period of time, in the event the user wants to compare the raw readings with the processed information. Peripheral assets can tell the higher-level system any detected symptoms (such as vibration or temperature readings), and what it thinks the problem is.

This approach to monitoring is now being applied to critical machinery. These assets can be connected to a remote center enabling a team of experts to monitor a greater number of assets.

But critical machinery requires more than a smart sensors for analysis due to the quantity of information to be processed. Instead, a dedicated edge computer is connected to the machine's control panel.

It reads even larger large streams of data than a smart sensor and converts it into health insights and maintenance relevant information. This can replace the need for 24/7 monitoring performed by a remote operator. Human support is only needed when an anomaly or malicious threat is identified.

AI's role

There may be a trend in a vast sea of data that a human cannot detect, such as subtle changes over time. Artificial Intelligence (AI) can help to find these patterns.

Condition monitoring is about understanding status. Data can be translated into numerical key performance indicators (KPIs) that provide a value for the likelihood of a specific equipment failure. Data scientists are working to develop methods to predict failure modes.

By using mathematical modelling techniques, it is possible to define how a KPI will evolve in the upcoming weeks or months and calculate the residual time to failure.

With this information, a shutdown can be planned and executed. The more data processed by an AI engine, the more accurate become the predictions of the future behavior of the KPI. In turn, the threshold defining good or critical health can be even more precisely evaluated.

There will always be abnormal conditions caused by unexpected events or external factors. To cover all potential failures in all applications, it takes the involvement of human experts to add real value.

Monitoring systems can distinguish between a known pattern and an abnormal condition. Abnormal conditions are turned over to staff. A feedback loop can then be used to create new KPIs to consider new conditions and failure modes.

Edge computing and AI technologies, backed up by qualified employees, can systematically analyze the health of large fleets of rotating equipment, reducing plant downtime while improving productivity and performance. ■

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