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WHITEPAPER

The digital plant: A four-step approach to predictive maintenance 4.0

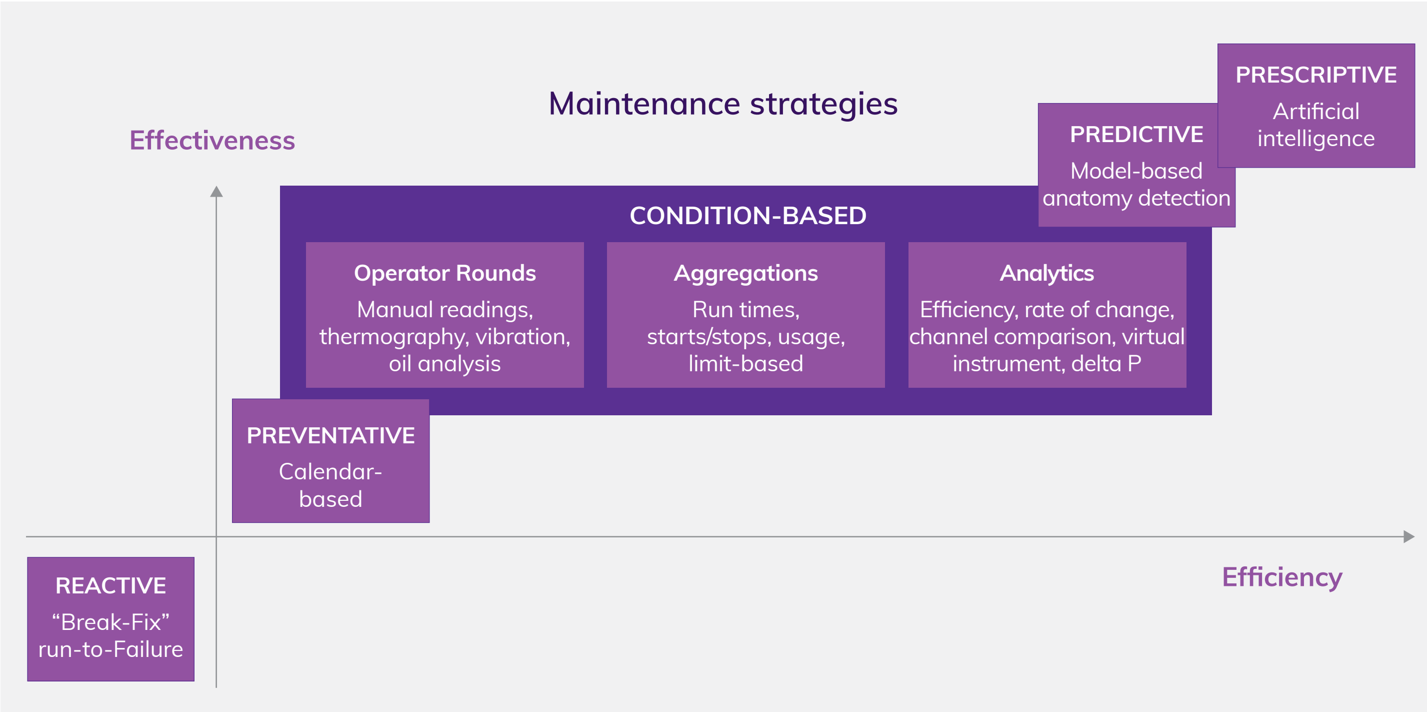
Executive summary:

The path to interoperability – the pinnacle of the smart plant – is paved with real-time operations data and analytics.

Data analytics is a virtual gold mine for smelter and mill operations, with initial cost reduction and productivity gains of an estimated 10% to 20%.[1] Moreover, the McKinsey Global Institute projects that in an accelerated technology-adoption scenario – involving the deployment of data analytics, robotics, and other technologies – an aluminum smelter or steel mill can reduce its costs by up to 40%.[2] This white paper discusses how a metals company can benefit from actionable data, particularly in its approach to maintenance and asset management. This paper provides an overview of maintenance strategies and outlines the rewards of a real-time predictive-maintenance approach. Importantly, it also reveals how metals companies can adopt a four-step plan to implement predictive maintenance and become Industry 4.0-ready.

The evolution of maintenance

When it comes to asset management, companies can apply five common maintenance approaches to plant assets: reactive, preventative, condition-based, predictive, and prescriptive.



Reactive maintenance is necessary when equipment breaks down but can be a costly process, leading to downtime, which affects productivity. Preventative maintenance will help improve asset reliability, but there will still be unplanned downtime and costly repairs that could have been avoided with a more efficient method. Even regularly scheduled preventative maintenance is inefficient because 82% of machine failures occur at random intervals.[3]

Condition-based monitoring is the first step toward adopting a future-facing maintenance strategy. Data can be collected while machines are running either through network connectivity to sensors, or through operator rounds or other offline means. Predictive maintenance advances the condition-based approach further by using model-based anomaly detection. This strategy relies on the online collation of sensor data and uses data analytics to predict machine reliability.

The ultimate level of maintenance, prescriptive maintenance, involves the integration of big data, analytics, machine learning, and artificial intelligence. Prescriptive maintenance takes predictive maintenance a step further by automatically implementing an action to solve an impending issue, rather than recommending an action that is then carried out by operators. For example, prescriptive maintenance could be deployed to automatically reduce the speed of an automated guided vehicle for anode transportation in order to increase its life expectancy. A prescriptive maintenance system will be a cognitive system; it will have the ability to “think” and can perform at this level only when there is interoperability between analytic systems and assets. This is the maintenance system of the future: the heady end goal of Industry 4.0.

The digital transformation: a four-step plan

The most important factor in improving plant and asset efficiency is access to real-time operations data. The application of advanced analytics in maintenance enables the fourth level of maintenance strategy: predictive maintenance, or predictive maintenance 4.0 (or PdM 4.0).[4] This level of maintenance can reduce the time required to plan maintenance by 20% to 50%, increase equipment uptime by 10% to 20%, and reduce overall maintenance costs by 5% to 10%.[5] Companies can begin using a predictive-maintenance strategy by following a four-step implementation process.

Step 1

Establish an operations-data infrastructure

The first step in implementing a predictive-maintenance strategy is to start using an enterprise operations-data infrastructure. For example, the PI System™ is a data infrastructure that captures real-time operations data coming from sensors, manufacturing equipment, and other devices and transforms it into rich, real-time insights, connecting sensor-based data to systems and people. Setting up a system like the PI System to gather and organize operations data is fundamental to providing insights for later analysis. A real-time operations-data infrastructure will help improve not only asset reliability but also process productivity, energy and water management, environmental impact, health and safety of staff, and product quality, as well as KPIs and reporting. Real-time operations data is the base for all digital-transformation initiatives, such as implementing a PdM 4.0 approach.

Step 2

Enhance and contextualize data

The next step on the road to predictive maintenance is to make sure data is being not only collected but also properly enhanced so that it can become valuable information. One way to enhance data is to provide context. For example, sensors may collect data that indicates a machine has stopped running. But that data does not automatically include the context of events – did the equipment stop running due to failure, or due to the activation of an emergency stop button? This kind of context makes data meaningful. Context can help an analyst decide whether to treat that data point as part of a pattern predicting machine failure or as an extraneous event. Recognizing what data is important and relevant to an organization or goal is vital. The PI System provides businesses with contextualized data – the type that enables smarter operations.

Step 3

Implement condition-based maintenance

The third step toward predictive maintenance is to start with a condition-based maintenance (CBM) approach using contextualized data.

CBM involves identifying the conditions that lead to an eventual failure in an individual asset and automating maintenance plans and schedules based on the current condition of that asset. For example, when a bearing temperature starts increasing outside of its normal range, it often means the bearing will eventually fail. As the temperature begins to climb, the real-time operations-data infrastructure can alert technicians that this element is approaching failure in time to fix the machine before it truly breaks down.

Real-time CBM supported by the PI System can also be enhanced with basic analytics. For example, identifying a performance pattern – such as an increase in bearing temperature by more than 20% in the last seven days – would allow the algorithm governing the maintenance strategy for this asset to become more and more predictive. Reliability engineers already know a lot of those failure patterns, which are often found through reliability-centered maintenance analysis following a failure. All those known patterns can be implemented as CBM inside a real-time enterprise operations-data infrastructure.

Step 4

Implement predictive maintenance 4.0

The final step is to implement PdM 4.0. The PI System – in conjunction with advanced analytics and pattern-recognition tools – provides real-time, actionable data that empowers businesses to optimize their operations. Used together, these tools can identify the patterns that indicate an approaching failure. In the bearing example above, data could be used to identify the pattern that causes the bearing temperature to start increasing beyond its normal operating range. Once implemented, this approach can significantly boost productivity and reduce maintenance costs.

Case studies

Liberty Ostrava: 25 years of PI System

Liberty Ostrava (formerly ArcelorMittal Ostrava) is a steel-manufacturing company located in the Czech Republic. Liberty Ostrava operates a complete industrial plant, creating and running everything required in the steel-manufacturing process, from the power needed to run the plant to milling and refining. The company's systems were disparate and disconnected, making it difficult to manage its complex data needs. The first step to creating a unified data architecture was to implement Asset Framework (AF), the contextualization layer of the PI System, to organize data from all equipment into a single hierarchy of assets. Once Liberty Ostrava had structured its data using AF, the company turned to PI Processbook™ and PI Vision™ to create blast furnace displays. Using operations data to predict failures and implement preventative maintenance for the furnace resulted in a 10% savings from avoided losses. Liberty Ostrava also relies on the PI System's event-monitoring capabilities to monitor inaccessible parts of the blast furnace and avoid dangerous accidents like molten-metal leaks. Product quality rose 15% after employees began applying PI System-based analytics. The PI System's ability to archive years of complex and varied data also allows users to perform long-term trend analysis and maintain an impartial record of events. After a disaster at one of the plants, the company's insurance provider didn't believe that proper procedures and regulations for safety had been followed and threatened to not pay the claim. Liberty Ostrava would have been forced to take a huge loss, but using historical data from the PI System the company proved there had been no wrongdoing, saving Liberty Ostrava over €4 million in damages.[6]

Case studies

ArcelorMittal Dofasco: Maximizing asset reliability

Having reliable data is just the first step. Having a system of record, or a single source for reliable operations data, which can inform any number of workers, applications, and initiatives, is an even better first step.

Dofasco supplies the automotive, manufacturing, construction, and packaging industries with steel products. Responding to globalization, inflation, and shareholder erosion, Dofasco conducted research into best practices regarding predictive maintenance and reliability strategies and found that there was an overarching culture of equipment replacement instead of investment in asset reliability. By integrating its data with the PI System, Dofasco discovered six data patterns that indicated impending equipment failures and was able to track and predict equipment life and maintenance more accurately than before.

By investing in reliability-driven maintenance, Dofasco decreased reactive maintenance from 70% to 20% of its maintenance hours and increased proactive maintenance from 20% to 80%. Average equipment unavailability dropped from 22% to 7%, and quality increased from 76% yield to 91%. As the maintenance workload shrank, the company found it had less of a need to hire new maintenance workers when people left the company, leading to even greater savings.[7]

Alcoa: Real-time predictive maintenance

Operating across ten countries, Alcoa is the largest refiner of alumina, the second-largest bauxite miner, and one of the largest smelters of aluminum in the world. Alcoa was already using the PI System to collect and store its data. The company hired Senseye™, the makers of a leading automated predictive-maintenance product, to take sensor data from Alcoa's machines in its aluminum smelters and use that data to help Alcoa predict maintenance needs and avoid machine downtime. "We believe that predictive maintenance is a key part of our strategy to evolve and become a more stable, more profitable organization," said Árni Páll Einarsson, reliability-implementation manager at Alcoa. With the PI System storing data and Asset Framework creating a structure for Senseye's analytical tools, Alcoa decided to implement its new strategy at the Fjardaal aluminum smelter as a test case before rolling it out to its other assets and smelters. The company detected two invisible machine errors before they became serious problems, saving 15 hours of downtime. Within six months, Alcoa had received a full return on investment for its predictive-maintenance project, with maintenance costs down across the board, a 10% reduction in maintenance person-hours, and a 20% reduction in unplanned downtime.[8]

Summary

Predictive maintenance, the use of advanced analytics in maintenance, can provide impressive benefits for an aluminum smelter or steel mill. For example, a metals company can not only predict equipment failure before it happens but also use historical data to track what happened during an incident and save thousands of dollars in damages. To implement PdM 4.0, companies need real-time operations-data infrastructure to collect, analyze, and implement data analytics. This is achievable with the PI System. Companies can benefit from reduced costs as well as open new revenue streams, extend equipment life, and increase production throughput with the PI System.

References

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