OSIsoft®

The Digital Mine

A Four-step Approach to Predictive Maintenance 4.0

Overview

The path to interoperability—the pinnacle of the smart mine—is paved with real-time operational data and analytics.

Data analytics is a virtual goldmine for mining operations, with initial cost reduction and productivity gains of an estimated 10 to 20 percent[1]. Moreover, it is projected that in an accelerated technology adoption scenario—involving the deployment of data analytics, robotics and other technologies—a mining operation can reduce its costs by up to 40 percent[2]. This white paper discusses how a mining company can benefit from actionable data, namely in an operation's approach to maintenance and asset management. It provides an overview of maintenance strategies and outlines the rewards of a future forward, real-time maintenance approach. Importantly, it reveals how mining companies can adopt a four-step implementation plan to predictive maintenance and become Industry 4.0-ready.

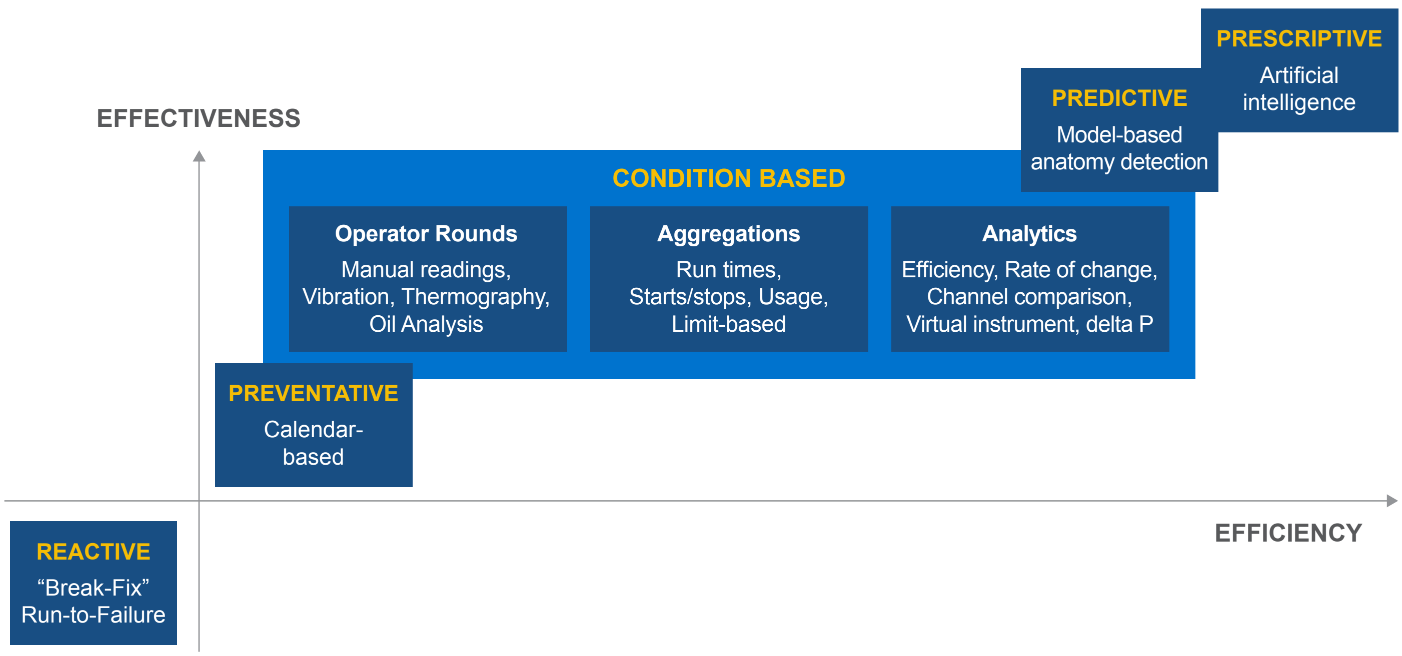
The Evolution of Maintenance

When it comes to asset management, there are five common maintenance approaches that can be applied to mine assets: reactive, preventative, condition based, predictive and prescriptive. For critical assets, reactive maintenance is not strategic when a machine has already broken down. Equipment breakdowns are often costly on many levels—downtime means productivity is affected, parts can be expensive and then there are the wasted outlays on labor and energy. For this reason, preventative maintenance will help improve asset reliability, but it might not be effective, as there will still be unplanned downtime and costly repairs that could have been avoided. Calendar-based or scheduled maintenance is inefficient because 82 percent of machine failures occur at random patterns[3].

Condition-based monitoring is the first step towards adopting a future forward maintenance strategy. Condition-based maintenance is defined by its name—it's the monitoring of machines while they are still running. Data can be collected online through network connectivity to sensors or offline through operator rounds or other means, depending on the criticality of the machine. Predictive maintenance advances the condition-based approach further by using model-based anomaly detection. It relies on the online collation of sensing 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. It takes predictive maintenance a step further by implementing an action to solve an impending issue, rather than recommending an action. For example, prescriptive maintenance could be deployed to automatically reduce the speed of an autonomous haul truck 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 only perform at this level when there is interoperability. 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 achieving efficiency is access to real-time operational data. The application of advanced analytics in maintenance represents the fourth level of maintenance strategy: predictive maintenance. This has been dubbed as 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 percent, increase equipment uptime by 10 to 20 percent and reduce overall maintenance costs by 5 to 10 percent[5]. Reaching this level of maintenance is achievable now, through a four-step implementation process.

Step 1: Establish an Operational Data Infrastructure

The first step is establishing an enterprise operational data infrastructure. For example, OSIsoft's flagship product, the PI System™, is an enterprise infrastructure that captures real-time 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. This first step is fundamental to providing insights for later analysis. Not only will a real-time operational data infrastructure help improve asset reliability, but having a single infrastructure in place will improve process productivity, energy and water management, environment, health and safety, quality as well as KPI and reporting—all of them taking advantage of the same operational data. This is the base for all digital transformation strategy initiatives such as implementing a PdM 4.0 approach.

Step 2: Enhance and Contextualize Data

This is how data is stored and enhanced to become information. Enhancing data means providing context to the data. For example, even though data is collected from a sensor, analysts need to know if the equipment is running or has stopped either due to a failure or activation of an emergency stop button. Such context provides data with meaning. Without context, data doesn't have much value. Also, recognizing what data is important and relevant to an organization is equally as vital. OSIsoft's PI System provides businesses with contextualized data—the type of data that enables smarter operations.

Step 3: Implement Condition-based Maintenance

This is about implementing condition-based maintenance (CBM) using contextualized data. This involves prioritizing certain assets, identifying the conditions that lead to an eventual failure, and implementing those conditions on specific assets within a real-time operational data infrastructure to automate condition-based monitoring. For example, when a bearing temperature starts increasing outside of its normal operating temperature, it means the bearing will eventually fail.

Real-time CBM implemented with the PI System can also take into consideration some basic analytics. For example, identifying a performance pattern, such as an increase of bearing temperature by more than 20% in the last seven days, would allow 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 of those known patterns should then be implemented as CBM inside a real-time enterprise operational data infrastructure.

Step 4: Implement Predictive Maintenance 4.0

This is the final step, the implementation of PdM 4.0. The PI System—in conjunction with advanced analytics and pattern recognition tools—will provide real-time, actionable intelligence that empowers businesses to optimize their operations. Used together, these tools will automatically determine the patterns that lead to an eventual failure. Using the bearing example above, the question could be asked, what pattern causes the bearing temperature to start increasing out of its normal operating range? Once implemented, this approach can significantly boost productivity and reduce maintenance costs.

Case Studies

Syncrude: Mining Equipment Event Synthesis

Syncrude is one of the world's largest producers of synthetic crude oil from oil sands and operates two largescale surface mines using truck and shovel techniques. The company wanted to apply event synthesis on their mining equipment for early intervention and to reduce costs. This was a particularly challenging exercise as they run a 136-unit heavy hauler fleet with supporting equipment such as shovels, graders and dozers. The manual analysis of truck sensor datasets proved too cumbersome for timely analysis and intervention.

They used the PI System to create a solution for the reporting of mechanical events that occur on the mobile equipment at the Syncrude sites. They were able to optimize and streamline calculations and integrate these with notification systems as well as validate and tune performance. This involved collecting data from 6,600 data points on 131 heavy duty trucks and five shovels. The results were impressive. Syncrude calculated that fleet operating expense savings came to US$16.75 per hour per unit, which equates to a US$20 million annual operating cost avoidance, not including lost production hours that would have occurred. Using real time operational data, Syncrude was not only able to save on maintenance costs but also help improve their safety results. From a safety perspective, monitoring dumping procedures improved compliance and reduced non-procedural operator dumping incidents by 85 percent[6].

Barrick Gold: Real-time Haul Truck Health Monitoring

The largest producer of gold in the Caribbean, Barrick Gold Pueblo Viejo wanted to improve the asset health monitoring system of its haul truck fleet to improve maintenance efficiency and reduce costs. The challenge involved providing real-time information of 34 haul trucks using installed systems and at minimum cost. Prior to installing the PI System, reliability and maintenance managers relied on incomplete or delayed information to make decisions. The solution was to deploy the PI System to connect with the truck sensors and extract real-time operational data. "We used to use the in-vehicle sensors to investigate why a truck failure had happened," explained Alejandro Zappa, a Senior Metallurgist for Barrick Gold. "Now we can be one step ahead of a failure and be more proactive."

By using the PI System, Barrick Gold saved US$500,000 in the first half year of implementation by being able to detect and address failures before they occurred. The company also reduced the total number of failures from engine, brake or suspension issues by 30 percent[7].

Barrick Gold: Turning Data into Gold

Headquartered in Toronto, Canada, Barrick Gold is one of the largest gold mining companies in the world. With mines in 11 countries, Barrick creates a wealth of data, tracking roughly 250,000 tags across the enterprise. For over 20 years, Barrick has relied on OSIsoft's PI System to drive insight, action, and substantial cost savings. The mining giant has engaged the PI System to become what it calls a "gold price agnostic" operator by bringing production costs to the point where even large commodity price swings will not cause major disruptions.

One goal the company has accomplished with the help of the PI System: better predictive maintenance at its Cortez mine in Nevada. Extracting and refining that gold is a laborious, mechanically intensive process. The machinery involved in that process is expensive, and so is downtime caused by mechanical failure. Cortez is investing in predictive maintenance through IIoT and data analytics, using sensors and machine learning to detect potential equipment problems before they escalate into failure.

> *"We're collecting more data to be able to see the machine issues coming sooner."*
>
> —Deb Dewald, PI Administrator, Barrick Cortez

To gather information on assets that are not inherently IoT-enabled, Barrick uses sensors and vibration monitoring software from Petasense. Machine learning algorithms use frequently collected sensor data to generate an equipment health score, which can be tracked for declines that might indicate a potential problem. Site engineers use PI System tools to integrate Petasense data with other sources and to provide clear, intuitive access to that data for a variety of users.

"We've reduced unplanned downtime and repair costs, and improved the overall efficiency process," said Deb Dewald, Barrick Cortez's PI Administrator.

Since its inception in 2018, the predictive maintenance project at Cortez has begun to pay off quickly. The first potential defect was identified within a month of the project launch. Since then, more than half a dozen major equipment failures have been avoided. A single early fault detection for one piece of equipment alone saved the company US$600,000[8].

Summary

Predictive maintenance is the use of advanced analytics in maintenance and can provide impressive benefits for a mining operation. For example, a mining equipment supplier is now able to sell predictive maintenance services on the assets it is selling, thus enabling a new business model for the company. To implement PdM 4.0, companies need real-time operational 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 their production throughput with the PI System.

References

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