Delivering on the Promise of Prescriptive Maintenance

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Introduction

Asset maintenance has historically been thought of as something preventive—and in many cases reactive, unpredictable and done out of pure necessity. Maintenance in this mindset is a cost center, and not something that creates measurable value. However, with the ever-increasing need for overall asset reliability and optimization, all businesses should be looking to proactively address asset maintenance. The ability to digitalize and proactively monitor assets via sensors has steadily evolved to where technology is now ready to revolutionize asset maintenance. Leveraging that capability, today's asset performance management (APM) technology can blanket an existing maintenance strategy to accurately predict failures. An innovative approach combines predictive and prescriptive analytics and is enabled by incorporating artificial intelligence (AI) and machine learning.

This type of solution provides the time to plan around predicted downtime and a holistic view of the operation, enabling personnel to see exactly how downtime financially affects the entire organization. The ability to see wide and deep creates value by enabling the development of new ways to run the business. Digital transformation is knocking down the data silos and delivering the tools necessary to make sense of the data readily available.

Today, predictive and prescriptive maintenance is moving from the early focus on proof-of-concept pilots to broader rollouts. The market has learned over the last few years that, while everyone claims to be using machine learning and AI, not all APM solutions are created equal. Success is ultimately defined by ease of adoption and the ability to rapidly deliver at enterprise scale.

Reducing Maintenance Spend

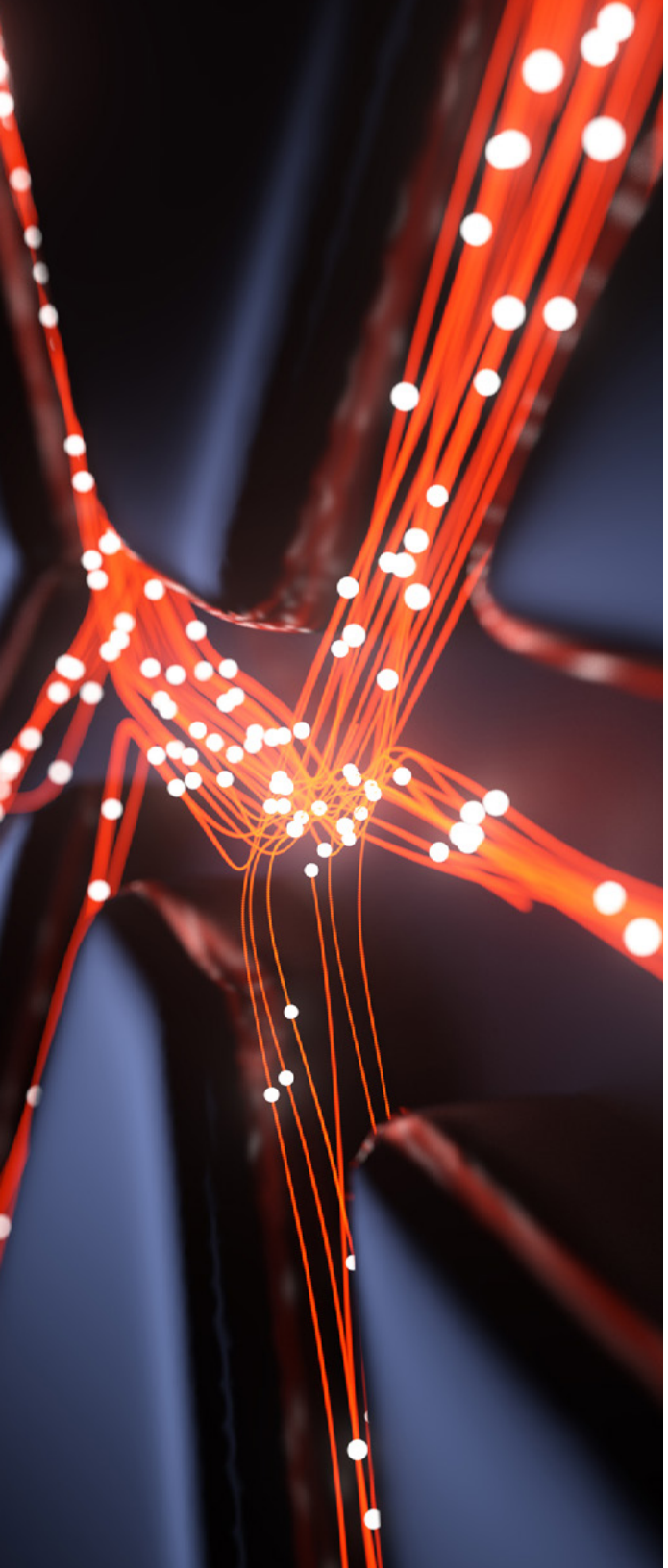
Equipment failures and process disruptions are the main drivers of unplanned downtime, resulting in billions of dollars in lost revenue and profit every year. In fact, one study found that unplanned downtime costs industrial manufacturers an estimated $50B USD each year. For petrochemical companies, refiners and other asset-intensive industrial organizations, unplanned downtime can be devastating, costing between $10K USD to $250K USD per hour.[1]

This is an area where we commonly see corporate initiatives cropping up around APM. What these companies are searching for are ways to improve the accuracy of failure detection, increase the advance notification period of asset downtime events and reduce maintenance spend. With more warning, more options become available—and with options comes the opportunity to mitigate the negative impact of those events while reducing related costs.

Safety and Environmental Benefits

APM solutions are delivering improved levels of asset availability and reliability, but there are other important benefits as well. It's well-documented that the rate of accidents increases significantly during transitory operations like shutdowns and startups. By avoiding unexpected failures, safety is improved—especially for maintenance workers—as companies gain the ability to move from emergency maintenance to planned maintenance made possible by earlier warnings.

Those transitory operational periods can also produce excessive levels of greenhouse gas emissions, particularly from flaring, or the combustion of excess product that is typically released when a plant experiences over-pressuring operation. So reducing unexpected failures can have a significant environmental impact, as flared natural gas alone produces more than 300 million tons of CO_2 emissions globally every year (the equivalent of approximately 77 million cars).[2] Much of that could be avoided by eliminating unplanned shutdowns.



Driving Improvement Through New Technology

Traditional preventive maintenance alone cannot solve the problems of unexpected breakdowns.

Asset performance management provides the plant with an extra layer of protection with early and more accurate warnings. APM can complement your current maintenance strategy by extracting value from decades of design and operations data to offer critical insights necessary to optimize asset performance.

This technology deploys precise failure pattern recognition with very high accuracy to predict equipment breakdowns weeks or even months in advance.

Here are just a few examples of it in action:

- LG Chem deployed a prescriptive analytics solution as a part of its digitalization program to increase reliability and avoid unplanned shutdowns. Thanks to the ease and speed of technology adoption, they realized $3.6M USD benefits in a year by avoiding production loss.

- A large Asia-based refinery with 250,000 barrels per day capacity has been able to predict failures with significant lead time—and has done so without false positives. These capabilities are expected to reduce unplanned shutdowns by up to 10 days, increase revenue by 1-3 percent, reduce refinery maintenance costs and cut operating expenses by 1-5 percent.

- A pulp and paper company implemented solutions to predict failures with nearly 69 days of lead time, capturing $11M USD in value on the first three assets. They were able to reduce unplanned downtime and the risk associated with incidents.

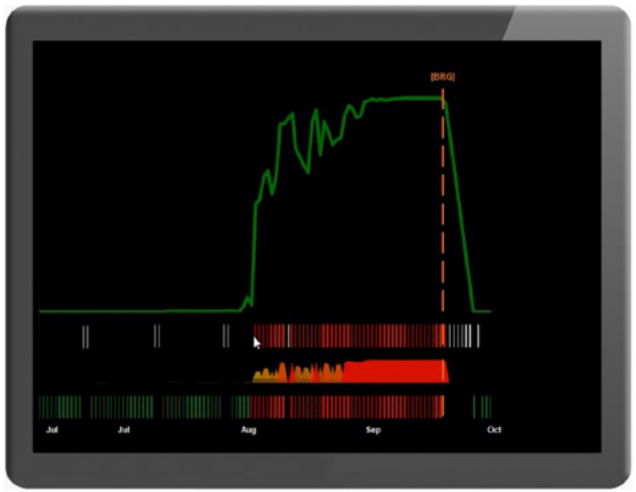
- Bluestar, part of ChemChina, has seen how advanced technology improves safety and reduces environmental impact as its predictive analytics solution alerted site staff to an unplanned shutdown with more than 50 days of advance warning.

- A metals and mining company has deployed a leading-edge predictive analytics solution across more than 300 of its assets. Managed by essentially one person, the company has improved availability enough to get full return on investment in less than six months.

Earlier Warnings—Better Visibility, Better Decisions

This new approach to asset performance management and predictive analytics has two important capabilities: It finds problems sooner than competing technologies, and it's easy to deploy and sustain.

These improvements highlight another significant difference, the accuracy of failure signatures over anomaly detection. For example, a major oil and gas company was experiencing recurring, unexplained breakdowns of compressors at one of its refineries. The staff was a mature implementer of reliability centered maintenance methodologies and used state-of-the-art vibration systems, yet still the breakdowns occurred.



Frustrated and looking for a solution, the refiner selected AspenTech's Aspen Mtell® prescriptive maintenance software. Aspen Mtell's autonomous agents were deployed to protect three major compressors and pumps. On the third day of implementation, one anomaly agent alerted and exposed the cause of a compressor failure that had plagued the refinery for over a decade.

In a similar "save," Aspen Mtell's failure agent notified Pan American Energy (PAE) 60 days in advance of an axial displacement failure of a steam turbine in a fluidized catalytic cracking unit's main air blower. Early warning by Aspen Mtell provided PAE with crucial time for maintenance and engineering crews to plan for an on-stream replacement of the complex 60 km3/hr. main air blower at the Campana Refinery. This was a big win for PAE. Aspen Mtell provided its team the confidence to accelerate rollout to other assets.

Augmenting Data Science: Better Data vs. Fancy Algorithms

One of the most time-intensive tasks associated with any transformative program is sifting through data and preparing the data for meaningful insights. Aspen Mtell provides a low-touch machine learning approach that eliminates much of the manual effort involved in "data cleaning." Users report that identifying, selecting and preparing data can consume a significant amount of the time spent analyzing a problem. Aspen Mtell tackles that challenge, automating much of the data preparation workflow by:

- Determining the minimum important set of sensors
- Defining the key derived transforms of the sensors
- Identifying data regions for machine learning training and testing
- Automating the tuning of most parameters
- Determining the frequency of data needed for analysis

The second major area of automation is in "feature engineering," or creating new input features from existing ones. In general, you can think of data cleaning as a process of subtraction, and feature engineering as a process of addition. This is often one of the most valuable tasks one can do to improve model performance, for three important reasons:

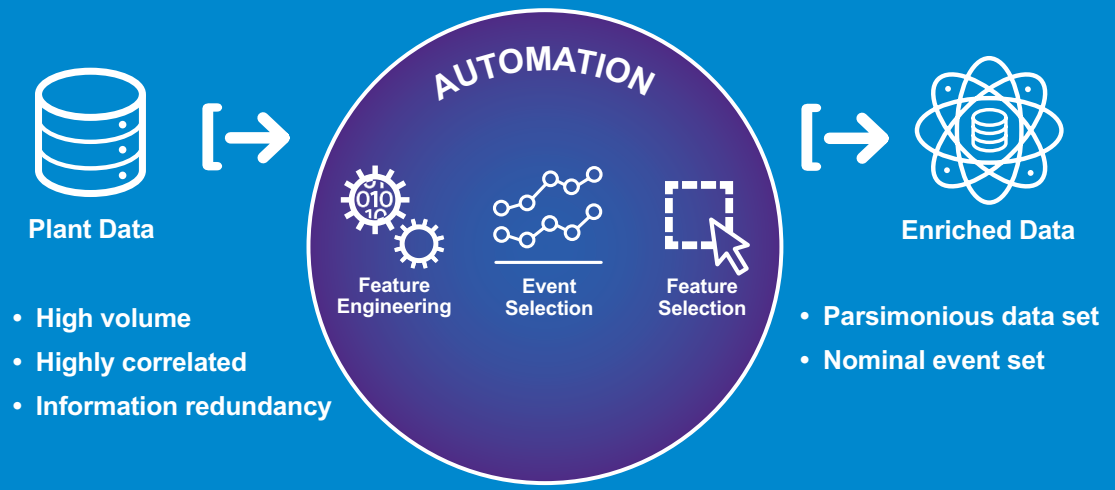
1. You can isolate and highlight key information, which helps your algorithms "focus" on what's important.
2. You can bring in your own domain expertise.
3. You can bring in other people's domain expertise.

Together, these capabilities result in the creation of AI-powered autonomous agents that can tackle a range of difficult problems, such as:

- Multiple failure modes that share causes
- Multiple operating states that result in similar outcomes
- Cascading failure modes (i.e., one failure causes other failures)
- Failure modes that can be explained using domain expertise
- Failures that take months to evolve (no sudden onset)

The competence embedded in the autonomous agents of Aspen Mtell represents a breakthrough in automating data collection, cleansing and analysis to provide prescriptive maintenance protection for equipment.

In one real-world application, the solution was built by an engineer with less than five years of experience. With just a few hours of instruction, he completed the development of a new Aspen Mtell agent—including the work to access, extract, clean, organize and prepare data for analysis.



Successful Applications of Prescriptive Maintenance

The low-touch machine learning approach of Aspen Mtell is proving itself every day across the energy, chemicals, mining, pharmaceutical and pulp and paper industries, among others. By modeling asset failures rather than asset behavior, Aspen Mtell provides a more scalable approach. And unlike other approaches, failure signatures developed on one asset can often be used to inoculate identical assets.

Here are some examples of other recent applications:

- In a drilling operation, autonomous agents correctly detected calibration errors on drilling joystick operations that had gone unnoticed. Aspen Mtell provided two to four weeks' warning of impending failures on top-drive, mud pump and draw works components.

- A multinational mining company implemented Aspen Mtell and significantly improved production uptime while reducing the high costs of failure. The company blanketed its metals refining process with autonomous agents for early warning of equipment degradation. Aspen Mtell provided 60 days of lead time, helping the company avoid a very expensive repair of its rotary scrubber and production losses.

- In a European refinery, vacuum bottom pumps had been affected by repeated seal and bearing failures. Aspen Mtell learned the failure history, which included more than a dozen different failure signatures. The agents provided lead times of 28 and 31 days for future seal failures on the pumps, as well as lead times of 10 and 28 days for future bearing failures. Although the refinery didn't act on advance warnings, the accuracy of Aspen Mtell was confirmed when the seals and bearings failed. Ultimately, the refinery implemented a new alert management and review process.

- A multinational chemical manufacturer experienced high failure rate of a pump in a batch process. Even with a low number of sensors, Aspen Mtell provided early warnings to reduce downtime by 80 percent, avoid potential safety incidents and reduce maintenance costs significantly.

- A large pulp and paper company avoided catastrophic tube failure in a recovery boiler using Aspen Mtell. Failure agents provided 30 days lead time that prevented an entire mill shutdown and saved approximately $10M USD.

- A global pharmaceutical company, which typically suffered seven days of lost production from a purified water plant outage, saw quick results as Aspen Mtell provided 35 days of early warning of deionizer failure. This saved an estimated 15 product batches worth $3M USD. From this experience, Aspen Mtell was rapidly deployed across the enterprise, taking advantage of the "transfer learning" feature.

- Driven by positive results from the Aspen Mtell implementation at its parent company Saras Refinery, Sardeolica deployed Aspen Mtell with a focus on gearbox and generator failures. Mtell alerted of potential issues 6 months in advance, reduced maintenance costs up to 10% while increasing overall power generation.

Delivering Financial Gains Across the Enterprise

With customers commonly having thousands of assets on a single site, success ultimately becomes a question of how fast the solution can be rolled out and its financial impact. If the solution doesn't scale appropriately, a project could take several years to complete. Two big constraints on scaling predictive analytics solutions are preparing good data and developing the underlying models.

The Aspen Mtell solution utilizes machine learning, AI and automation to prepare data and to create the failure signature models. The ability to assist in cleaning and preparing data and the cloud-based automation to build agents combine to deliver the scalability needed to support enterprise-level rollouts.

Physical models are not scalable, require a lot of resources to create and maintain, and must be repeated for every single asset. Aspen Mtell sets itself apart in a number of key ways, including its ability to transfer failure signatures across similar assets with the potential for enterprise-wide scalability.

As an example, the oil driller referenced earlier transferred failure signatures for key assets to more than 200 drilling rigs around the world. And in another facility, agents that were trained to identify casing leaks on electric submersible pumps in one facility have been transferred to 18 other pumps.

The adoption of Aspen Mtell is now at a point where companies are complementing their current maintenance strategy through improved workflows and rolling out the solution enterprise wide.

Here are some examples of Aspen Mtell at work:

- In 60-90 days, Equinox and Aditya Birla Group deployed Aspen Mtell across 3 sites and 40 assets.
- In one year, LG Chem rolled out Aspen Mtell to protect 47 assets.
- An integrated energy company went from an initial rollout of 10 assets in 2019 to more than 250 assets in 2020.
- Another energy company has Aspen Mtell deployed in 12 refineries and on multiple pipelines.
- Sardeolica extended its initial rollout; in one year, the company covered 48 assets focused on gearbox and transformer failures.
- A pharmaceutical company has rolled Aspen Mtell out across 10 key assets at 3 sites.
- A large chemicals manufacturer in the Middle East deployed Aspen Mtell across 200+ assets covering 8 different asset categories in just 6 months.
- A large mining company has deployed Aspen Mtell across 6 facilities; 124 assets in one year including trucks.

1. Aberdeen, Asset Performance Management: Blazing a Better Path to Operational Excellence. Nov. 2017
2. The IoT Transformation of Gas Flaring Operations, Lana Ginns, Flow Control, Oct. 4, 2016

Conclusion

Asset-intensive companies across the globe are successfully using Aspen Mtell to predict asset failures earlier and with more accuracy. As a result, these organizations are seeing greater throughput, more efficient, profitable production, and fewer safety and environmental risks. Organizations adopting Aspen Mtell comment on its demonstrated ease of implementation, rapid integration with current maintenance strategies and ability to deploy at speed with existing resources. Aspen Mtell is driving operational excellence by prioritizing maintenance spend on the highest ROI activities.

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About AspenTechnology

Aspen Technology (AspenTech) is a global leader in asset optimization software. Its solutions address complex, industrial environments where it is critical to optimize the asset design, operation and maintenance lifecycle. AspenTech uniquely combines decades of process modeling expertise with artificial intelligence. Its purpose-built software platform automates knowledge work and builds sustainable competitive advantage by delivering high returns over the entire asset lifecycle. As a result, companies in capital-intensive industries can maximize uptime and push the limits of performance, running their assets safer, greener, longer and faster.

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