



Driving Growth with Prescriptive Maintenance in Food and Beverage Processing

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Introduction

Historically, equipment maintenance has been a cost sinkhole, an unwanted necessity that was primarily reactive, with predictive aspirations that were asserted but never really met. At AspenTech, we believe that the new frontiers of Asset Performance Management (APM) are transformative for maintenance and can create great value over and above maintenance cost savings.

This paper focuses largely on the role APM technology, predictive and prescriptive analytics, and artificial intelligence (AI) can play for the food and beverage processing industry, one of the most important sectors within industrials. No other industry is better suited for an approach that provides more lead time for critical maintenance decisions.

McKinsey reported in its March 2018 report, [McKinsey on Food Processing & Handling Ripe for Disruption](#) that the food and beverage processing industry had demonstrated exceptional performance, citing several key measurements including EBITA margin expansion from 5.5 percent in 2002-07 to 10.2 percent in 2011-16; efficient use of capital, with 2.7x capital turns in 2011-16 compared with 2x capital turns for industrials; and a return to growth after the financial crisis, evidenced by 4.3 percent CAGR revenue growth 2011-16 versus 0.6 percent for wider industrials.¹

With this encouraging data, APM solutions are well-positioned to drive positive results and sustained growth for food and beverage manufacturers.

APM Technologies for Food and Beverage Processing

The use of AI in food and beverage processing is not new and falls under the Industry 4.0 or fourth manufacturing revolution. Past efforts to integrate AI focused primarily on opportunities in supply chain, hygiene/safety and ensuring incoming raw material quality. The ability to digitize and proactively monitor assets via sensors has steadily evolved so that technology is now ready to revolutionize asset maintenance for all industries. Today's asset performance management technology delivers advanced warning of failures through a combination of predictive and prescriptive analytics, enabled by integrated software that incorporates AI and machine learning.²

Historical inspection, diagnostic and monitoring efforts could generally be coupled with other tasks when running intermittent product or packaging changeovers. However, this often leads to over-maintenance of equipment and typically does not prevent catastrophic failure.³

APM solutions provide the time to plan for predicted downtime with a comprehensive view of the operation; enabling plant personnel to see exactly how downtime financially affects the entire organization. Digital transformation exposes the data hidden in silos and delivers tools to extract and make sense of them. The results are new ways to run the business and create value.

Predictive and prescriptive maintenance have moved 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 the ability to rapidly deliver value at enterprise scale.

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The Objectives of Asset Performance Management

Equipment failures and process disruptions are the main drivers of unplanned downtime that costs organizations billions of dollars in lost revenue and profit every year. This financial loss can be the result of production slowdowns or stoppages, unfulfilled customer orders, and overtime to name a few. Factories generally lose between 5 and 20 percent of production to equipment downtime.⁴ This can translate to as much as \$260,000 per hour of downtime for some producers.⁵ These costs translate directly to lost margin in a globally competitive market.

Identifying equipment failures is an area where corporate initiatives crop up around APM and risk management. Companies are searching for ways to improve the accuracy of detection and increase the notification period of asset downtime events. With more warning, more options become available, including the opportunities to mitigate the negative impact of those events. And providing prescriptive advice could mean avoiding downtime altogether.

Improved Safety and Protection for Workers, Increased Profitability for Businesses

APM solutions deliver improved levels of asset availability and reliability, and can result in several important benefits, such as improving worker safety, reducing carbon emissions and protecting profitability. It's well documented that the rate of accidents increases significantly during unplanned equipment downtime, as operators and engineers are trying to make repairs quickly.

By avoiding unexpected equipment failures, the level of protection is improved—especially for maintenance workers—as earlier warnings from APM solutions help manufacturers move from emergency maintenance to planned maintenance.



With Aspen Mtell[®], it's now possible to extract value from decades of design and operations data to perform prescriptive maintenance and optimize asset performance.

More Proactive Sustainability Efforts Needed by the Industry

Unfortunately, food and beverage manufacturers' history of proactive carbon reduction and environmental compliance efforts is less than exceptional, at least according to the EPA. The industry was the sixth largest contributor to the EPA's Toxic Release Inventory (TRI), accounting for over 120 million pounds of releases in 2014. On average, packaging accounts for about 5 percent of the energy used in the life cycle of a food product making it a significant source of greenhouse gas emissions.

Unexpected downtime can cause readily understood environmental impact from spills and leaks. However, resulting ingredient and product spoilage is also problematic. Approximately 50 percent of food waste occurs during the production stage, contributing to the overall estimated carbon footprint (of all food waste) of 3.3B Tonnes of CO2 equivalent per year.⁶

This figure includes waste created during production and any greenhouse gases emitted from the food itself. While all food and beverage processing emissions cannot be linked directly to unplanned downtime, reducing or preventing downtime can certainly help reduce the negative impact.

New Technologies and a New Approach

Traditional preventive maintenance alone cannot solve the problems of unexpected breakdowns. With APM technology, like the Aspen Mtell[®] solution from AspenTech, it's now possible to extract value from decades of design and operations data to perform prescriptive maintenance and optimize asset performance.



New APM technology deploys precise failure pattern recognition across the entire process with very high accuracy to predict equipment breakdowns weeks or even months in advance. Use cases could include:

- Equipment that regularly plugs (ex: separators, homogenizers) where cleanings are regularly scheduled, however, the frequency is based on history, and often do not fully prevent blockage from occurring
- Management of water treatment efficiency and other critical systems to prevent energy waste and production slowdowns
- Ventilation stacks which are prone to build up, becoming combustible safety hazards, such as those for snack food fryer stacks
- Other critical equipment that is prone to downtime such as pumps, valve clusters, blow molders, separators, dryers, grinders, chillers, extruders, cookers, slicers, mixers, warmers, cooling tunnels, packers, fillers and palletizers

Earlier Warnings—Finding the Subtle Patterns Humans Can't See

The new approach to asset performance management and predictive analytics exposes problems sooner, with a more precise prediction to failure time than competing technologies, and enables more thoughtful action to correct the problems.

The ability to correct a problem once detected and time to failure highlight another significant difference to the new approach to APM: the accuracy of failure signatures over anomaly detection. For example, unexplained compressor failure at industrial facilities can have major cost implications, as compressed air is often viewed as the 'fifth utility.'

The staff at one particular customer was mature in its implementation of reliability-centered maintenance methodologies and used state-of-the-art vibration systems, but still the breakdowns occurred. Frustrated, the company turned to Aspen Mtell®. In a rapid implementation spanning just five days, Aspen Mtell 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 plant for over a decade.

In a similar “save,” one Failure Agent alerted, with eight weeks’ warning, to a failure in the third-stage valve of a multi-stage compressor. The operations staff chose to continue unheeded. Seven weeks later, the vibration system announced excursions, and the condition deteriorated rapidly. In three days, the compressor was shut down for maintenance. The tear-down proved that Aspen Mtell had correctly announced the impending failure a full seven weeks before the state-of-the-art vibration system.

For example, an Anomaly Agent might ask, “Is this normal behavior?” to uncover either a new unknown operating condition or a potential failure that an inspection might uncover. On the other hand, a Failure Agents might ask, “Am I seeing the precise (Machine Learning) pattern in the process data that led to a specific failure?” This might even lead to a specific

root cause, such as a seal failure. Bottom line: Failure Agents are more accurate than Anomaly Agents, often predicting days or weeks ahead of anomaly detection. Aspen Mtell is the only asset performance management solution that utilizes both, providing fewer false positives and more precise time-to-failure than other options.

Automating the Data Science: Better Data Beats Fancier Algorithms

One of the most time-intensive tasks associated with any analysis is preparing the data. Aspen Mtell provides a machine learning approach that eliminates much of the manual effort involved in “data cleaning.” With contemporary approaches, users report that identifying, selecting and preparing data can consume a significant fraction of the time spent just in preparing to analyze a problem. Aspen Mtell tackles that challenge, automating much of the data preparation workflow by:

- Using the sensors already installed to avoid new data collection and preparation
- Automatically validating and cleansing data sets
- Determining which set of the existing process sensors have the strongest correlation to particular failure modes



- Identifying data regions for machine learning training and testing
- Automating the tuning of parameters
- Determining the optimum data sample frequency for analysis

Data cleansing is often one of the most valuable tasks one can do to improve pattern recognition performance, for three important reasons:

1. Isolate and highlight key information, which helps the application “focus” on what’s important.
2. Enable better application performance by bringing in your own domain expertise.
3. Bring in other people’s domain expertise.


Together, these capabilities result in the creation of predictive 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

The competence embedded with the Autonomous Agents of Aspen Mtell represents a breakthrough in automating data collection, cleansing and analysis to provide superior and more accurate detection of deviations from normal for monitored equipment. Anomaly Agents also tune themselves automatically to keep abreast of process changes without false alarms.

In one real-world application, the solution was built by an engineer with less than five years industry 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. Aspen Mtell was designed not for the data scientist, but for reliability technicians and process engineers.





Successful Applications of Prescriptive Analytics

The Agent methodology approach of Aspen Mtell is proving itself every day in projects across the energy, chemicals, mining and food and beverage industries, among others. By modeling asset failures rather than asset behavior, Aspen Mtell provides the most scalable approach.

Unlike other approaches, failure signatures developed on one asset can often be used as identical assets across different sites, further protecting the customer from degradation and failure.

Here are some examples of Aspen Mtell in action:

- Aspen Mtell Agents have detected vibrations in pumps that led to the replacement of mechanical seals before failure. The Agents also identified signatures that led to the replacement of a high-pressure pump with 39 days of lead time. In the same plant, problems with a wash oil pump were detected 48 days in advance.
- One facility, where fouling was of particular concern had been seeking better notification of fouling for better planning of critical equipment usage.
- Drawing on data from the previous year, Aspen Mtell Agents provided an alert with a 125-day lead time of fouling. Unfortunately, the company took no action and eventually had to shut down a quench oil tower due to fouling.
- Vacuum bottom pumps can be critical to operation, but also repeatedly affected by 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. The staff ignored the warnings and was later forced to replace seals and bearings after the failures occurred.
- One Aspen Mtell customer saw firsthand how advanced technology can increase safety. Aspen Mtell alerted the user to a particular failure mode that would have resulted in a major fire. Instead, the user had nine days of advance warning and was able to take action to avoid any fire.



Solution Scalability: An Asset per Day

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

The Aspen Mtell solution utilizes machine learning, AI and automation to prepare data and 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. A key feature of Aspen Mtell is that it's designed to fit precisely with the work processes already in place at food and beverage facilities, using existing data and work skills and experience of staff already in place.

Another Aspen Mtell feature that helps enable scalability is the software's ability to transfer failure signatures across assets. In general, other model types are not transferable across similar assets, so the work to create and maintain the models must be repeated for each asset. But this is not the case with Aspen Mtell, where it is not uncommon to see deployment numbers like 30 assets in 30 days.

Conclusion

As the food and beverage processing industry evolves into the digital transformation age, asset monitoring is paramount. Among the APM technologies in the marketplace today, Aspen Mtell stands out for its distinct ability to provide earlier prediction of asset failures while reducing or eliminating false positives. Aspen Mtell was also recognized by the hydrocarbon processing industry in 2019 for its ability to recognize leading indicators of asset failure and alert plant staff weeks prior to breakdown, allowing time to plan maintenance and reschedule production to minimize financial impact.

About Aspen Technology

Aspen Technology (AspenTech) is a leading software supplier for optimizing asset performance. Our products thrive in 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 machine learning. Our 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 faster, safer, longer and greener.

Visit www.aspentech.com to find out more.

Sources:

¹ Mckinsey.com

² Foodindustryexecutive.com

³ Advancedtech.com

⁴ Foodqualityandsafety.com

⁵ Machinemetrics.com

⁶ Climatecollaborative.com

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