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Five case studies show how predictive tools can bring greater clarity to machine health

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September | October Content

VOLUME 44 | ISSUE 5

FEATURE

Ask The Experts: Compressed Air Challenge

What are the best strategies to reduce the energy consumption of your compressed air system?

COVER STORY

Michael Annino | Shutterstock-AI

The Many Facets Of PdM

Five case studies show how predictive tools can bring greater clarity to machine health

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THOMAS WILK
From the Editor

ONE WORD: DATA

Readers of a certain age will pick up on the headline of this month's editors note, as will many Millennials and Zoomers. It's a paraphrase of the advice given to Dustin Hoffman's recent college grad in the 1967 movie "The Graduate" by one of his parents' friends.

The movie follows Hoffman's character, Benjamin Braddock, as a sort of case study of the next generation as he takes his first steps into an uncertain post-education future. Not every choice he makes is perfect, but by the end of the movie Braddock has navigated a few mis-steps and is starting to chart his own course.

This issue of Plant Services features our annual roundup of compelling predictive maintenance case studies from contributing editor Sheila Kennedy. She's been writing up this annual summary for five years now, and each year includes a theme that ties the case studies together. You guessed it, this year's theme is "data" – specifically, what to do with it once you've collected it.

There are a lot of maintenance programs that identify their critical assets, then identify the data required to better understand machine health, and finally invest in the tools (both hardware and software) to collect those data. This year's cover story features case studies from organizations that made it through these steps, but then made good use of their data to drive proactive maintenance decisions. These organizations:

- **deployed AI predictive analytics across multiple critical subsystems to predict impending failures**
- **automated manual processes and streamlined data exchange between operations and maintenance**
- **solved data fragmentation with a dashboard presenting a single source of truth to streamline maintenance service cases**
- **used their CMMS to standardize and centralize maintenance workflows, policies, and procedures.**

The message of these case studies is reinforced by this month's column from Jeff Shiver, who offers his own single word for us to remember: "implementation." Shiver urges everyone to do what each of these companies did – once the work of identifying the problems and developing solutions is done, make sure that those solutions are implemented. Δ

Thomas Wilk, Editor in Chief
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JOE KUHN
Leadership in Action

HOW TO GET THE ATTENTION OF THE PLANT MANAGER

Build reliability credibility as an organization by observing and eliminating waste

Everyone at your plant is trying to get time, money, and resources from the plant manager. As a plant manager I would get five new requests a week to sponsor. Typical pleas were: *we need to hire more production workers*, *we must have this quality improvement project*, or *we need to replace this obsolete control system*. Resources are always limited, and lack of focus will lead to poor results. How does the plant manager decide what to sponsor?

How do you make decisions? How do you decide which contractor to use to put in a new pool? How do you select a financial advisor? How do you choose which headphones to purchase from Amazon? In a word: Creditability. You ask for references to give firsthand testimony and with Amazon, you look at the online reviews. It is no different with your plant's leadership team, they look at your track record of delivering results. How effectively are you using the resources already provided? What is your creditability?

As a plant manager deciding what to sponsor, I had "needs" and "wants." Needs included: fast results (the business expects quarter over quarter improvement), high confidence in the outcome, meaningful impact, and alignment with company and personal values. Wants included: Scalable sustainable results and engaging for the workforce.

As the reliability leader for your site, you propose to begin a reliability journey, which you estimate will deliver $3 million per year from increased uptime, improved quality, and lower costs. But the results will not come until year four. You need to invest $1 million per year for three years to get best practices in place through training, hiring new roles, buying spare parts, and getting the equipment in a maintainable state. Looks reasonable: $3 million invested with $3 million per year returned. Where do I sign?

Joe Kuhn, CMRP, former plant manager, engineer, and global reliability consultant, is now president of Lean Driven Reliability LLC. His YouTube Channel offers content on creating a reliability culture as well as financial independence to help you retire early. Contact Joe Kuhn at *joekuhn1964@gmail.com*.

Not so fast. Let's take a look at current state creditability of the maintenance organization. Imagine this describes your plant:

- **90% unplanned work**
- **15% PM compliance**
- **0% condition monitoring techniques employed**
- **wrench time is under 15%**
- **15% increased costs per year**
- **a blaming culture between operations, maintenance, and engineering.**

How creditable is your organization? How believable is the pitch to deploy best practices for $3 million dollars with a return of $3 million per year? Pretty low on both accounts, right? Any wonder why your plant manager cut costs, implements a hiring freeze, and cancels overtime when the business is stressed and needs better numbers?

Waste is everywhere in every plant; however, you must stop what you are doing and look for it. It is one thing to see waste for five minutes and "write it off" as an anomaly; it is quite a different experience to wallow in the inefficiency for four, eight or 12 hours. Examples:

- **Over scheduling manpower: A planned job to replace a vacuum tube on an overhead crane can be performed by two people in four hours. The planner plans the job with four people for eight hours in case the crew runs into problems or gets pulled off to execute emergency work. *Result*: wrench time is dramatically lower (32 hours actual versus 8 possible). Secondly, assuming emergency work will pull the work crew from the planned job is hiding wastes. *Action*: A best practice is to separate**

planned work crews from unplanned crews.

- **Full job kitting:** You observe two mechanics just driving around on their scooter. They appear to be wasting time. However, you discover they are looking for key stock that is needed on a new pump installation. The planned job kit only consisted of the new pump. *Result:* The craftsmen were predestined to search out a new coupling, key stock, shims and anything else needed to execute the work. The plan was doomed to fail. Consequently, the planner doubled the time to complete the job from two hours to four hours based on past performance. *Action:* This waste can easily be eliminated for zero cost by doing "full kitting and staging." With full kitting and staging, the expectation is to have every part, tool, and piece of equipment needed waiting at the job site before the work begins. Kits are verified correct and complete before work is scheduled.
- **Production failure to release equipment on time:** You observe a crane wire rope change. The work was scheduled to begin at 7:00 a.m., but production was still using the crane. Production informed the crew they would call on the radio when they can have the crane. Management sees the maintenance crew in the lunchroom at 8:00 a.m. and concludes the crew is lazy. The crane is finally turned over to maintenance at 9:30 a.m. *Result:* Work is completed by noon; three hours longer than expected. The planner then revises the time to complete this job to five hours, in effect hiding the waste. *Action:* Production must be committed to maintenance efficiency and become partners. Begin by tracking the number of events per day where equipment is not ready for planned work. From this data, ask for a 90-day trial of commitment to the maintenance schedule. After the 90 days discuss the results. Expect to be amazed.

These three examples were real in my plant. All were free and rapidly implemented. Imagine the impact of finding and fixing one of these a week for a year. It will be huge! Further, this will deliver all the plant manager "needs": fast, high confidence in the outcome, meaningful impact, and alignment with company and personal values; and all her "wants". Creditability has been earned.

Implementing reliability and maintenance best practices is optional for the plant manager. Appropriately proving and selling best practices as a waste elimination machine changes everything. Δ

SHEILA KENNEDY
Technology Toolbox

THE CMMS/EAM TRANSFORMATION CONTINUES

Innovative upgrades and advancements add intelligence and efficiency to asset management solutions

How industrial assets and infrastructure are managed can make or break business goals. Uptime, performance, safety, compliance, and costs are just some of the factors impacted by maintenance processes. It is why enterprise asset management (EAM) and computerized maintenance management systems (CMMS) are continually undergoing improvement. Advanced technologies, strategic integrations, and enhanced user experiences are represented in some of the latest enhancements.

ADVANCED INTELLIGENCE

Artificial intelligence (AI) is fueling significant gains in equipment reliability and uptime. Asset Risk Predictor, an AI-powered predictive maintenance software solution from Fiix by Rockwell Automation, now also has generative AI (GenAI) capabilities for prescriptive work orders. Fiix Prescriptive Maintenance turns failure predictions into actionable work orders that can be integrated with a Fiix CMMS or any other CMMS or EAM solution.

"Fiix GenAI utilizes unique datasets for maintenance, including maintenance manuals, historical work orders, other AI analysis results, and human-generated data, each uniquely created and managed by automated algorithms and customers for their assets," says Mohammad Esmalifalak, lead data scientist for Fiix by Rockwell Automation.

The newly announced HxGN SDx2 by Hexagon supports the company's Smart Digital Reality vision with a platform that integrates project and asset operational data, creating a digital twin that improves the comprehensive management of industrial facilities and infrastructure. The scalable, data-agnostic solution also incorporates advanced visualization, AI, and machine learning capabilities.

Sheila Kennedy, CMRP, is a professional freelance writer specializing in industrial and technical topics. She established Additive Communications in 2003 to serve software, technology, and service providers in industry. She can be reached at *sheila@addcomm.com* or *www.linkedin.com/in/kennedysheila.*

"This cloud-native SaaS solution connects and contextualizes industrial asset data from both Hexagon and third-party sources to enrich and optimize engineering, operations, and maintenance work processes and drive innovation," observes Simon Jones, principal strategy and enablement consulting lead at Hexagon's Asset Lifecycle Intelligence division.

The Maintenance Technician Workbench, a new AI-powered Smart Operations capability within Oracle Fusion Cloud Maintenance, provides a single mobile user interface for all technician work execution. Customers can combine maintenance, asset, workforce, and supply chain data to enable continuous monitoring and predictive maintenance. Based on their assignment or skill, technicians can quickly access relevant work and service histories, document their work, and collaborate with other workers through the workbench.

Oracle also offers Smart Operations capabilities for manufacturing. "The new smart manufacturing and maintenance capabilities can help our customers reduce inefficient manual recording and monitoring processes, increase safety, improve quality, and optimize operations," notes Chris Leone, executive vice president of applications development at Oracle.

BENEFICIAL INTEGRATIONS

A partnership integrating the industrial AI-based Machine Health platform from Augury with IFS Ultimo, a cloud-based EAM solution that is part of IFS, is designed to improve the connection between machine health and asset management.

With the integration, Augury and IFS Ultimo "catalyze a shift from manual, time-consuming machine maintenance to data-driven, real-time machine

optimization. Now, Augury not only predicts manufacturers' machine failures long before they turn catastrophic, but also its AI-based alerts and notifications flow seamlessly into the IFS Ultimo platform, which then automates a manufacturer's maintenance scheduling and planning," explains Chris Dobbrow, VP of partner development at Augury.

Three solutions from Accurent, including its Maintenance Connection CMMS, Meridian engineering document management system (EDMS), and Observe IoT platform, are now integrated to improve efficiency, safety, and regulatory compliance. Rather than toggling between systems to access pertinent information, maintenance teams now have big-picture insights from a centralized, comprehensive solution that streamlines asset management, document access, and real-time IoT remote monitoring and energy management.

Technicians on the go need solutions like the new Fluke Mobile release for eMaint. The mobile app from Fluke Reliability empowers teams to manage work orders, access asset details, and even operate offline while in the field.

"Users of eMaint Mobile benefit from a powerful combination: leveraging native mobile app capabilities (offline access, camera integration, quick access icons, and links) and the flexibility to configure, extend, and administer the CMMS centrally via the web application," says Navin Kulkarni, director of product management at Fluke Reliability. "By enabling teams to connect and share crucial industrial data, the app plays a pivotal role in maximizing uptime and reliability." Δ

VIDEO REFERENCES

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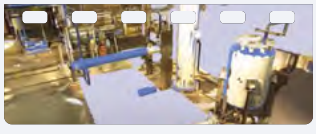
↗ https://www.youtube.com/embed/SQ1R-Hoxq2I?si=5RW32RVRGvyz1WFO



Hexagon
↗ https://www.youtube.com/watch?v=Q0H6UR6p-P30&t=2s

DOC PALMER
Palmer's Planning Corner

SHOW THE LABOR ESTIMATE ON THE WORK ORDER!

Don't compromise your craftspersons by withholding trust regarding time estimates

Work orders, electronic or paper, should show the labor time estimate to the assigned craftspersons. However, industry has two schools of thought on this topic. One school holds that we should not tell the craftsperson the time estimate primarily to avoid lingering if the estimate is excessive. The other school holds that we should give the craftsperson as much knowledge as possible for a number of reasons. Because this whole issue affects both productivity and quality, it certainly merits discussion.

Let's say a planner estimates that a certain job should take a craftsperson 5 hours of labor, but the particular assigned craftsperson can finish the job in only 2 hours. In this example, some managers fear that if the work order shows the estimate, the craftsperson will take all 5 hours on the job, killing productivity. (Parkinson's Law says that, indeed, the work assigned expands to fill the time available.) Worst case: If every job could be done in only 40% of its estimate, perhaps the entire workforce is grossly oversized. On the other hand, perhaps another craftsperson would really need 8 hours to do that same job correctly; in this case, managers fear that this craftsperson will cut corners, killing quality, to do the job in 5 hours. Wouldn't it be better not to show the estimate and let craftspersons simply work at a determined pace and complete jobs in a quality manner without worrying about the estimate?

THE PROBLEMS WITH NOT SHOWING TIME ESTIMATES

In my experience, there are a number of problems with not showing time estimates including Parkinson's Law itself, not having "typical" humans, and factors involving estimating itself and knowing exact job scopes. Another problem is one of treating professional craftspersons as children.

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A final problem is not considering the rest of the maintenance system when dealing with time estimates.

First, Parkinson's Law affects our productivity whether or not we show the estimates to craftspersons. If we assign work, how much should we assign? If we assign a craftsperson two jobs (without visible estimates) for the day, aren't we saying that this is a full day's work and thus the two jobs should take all day? The worst case would be assigning a single job at a time saying, "Come back when you are finished." Doesn't that imply it might be acceptable to take all day?

Second, if we assign a single job at a time, an additional human factor comes in – i.e., there is no "typical" human. Some craftspersons are naturally faster and some are naturally slower than others. We worry about super-fast craftspersons, but we do not want to slow them down if they are competently completing assignments. And to protect quality, we hesitate to speed up the naturally slower craftspersons. Real life experience with assigning a single job at a time shows that some persons come back for more work continually throughout the day, some persons seem to never come back for more work, and the persons in the middle wonder if they came back enough times and how that affects their reputation.

Furthermore, planners do not know the exact scope for many corrective maintenance jobs and even for some preventive maintenance jobs. Exactly what needs to be done to stop the leak on that pump? Will the PM technician find a few extra things to remedy along the route? Should the planners put extra time on all these jobs just in case we find something else or assign a slower craftsperson? If planners do add extra time on all the work estimates, Parkinson's Law kills our productivity. Another factor is that a visible time estimate

> If the craftsperson needs longer to do a job right, we need to take longer.

itself also helps clarify the job scope. The time allotted for a cleaning job sort of helps tell "how clean." A short time for a sparkplug change helps clarify that we are not changing all the engine filters and hoses.

THE BENEFITS OF ADDING TIME ESTIMATES

We must also consider Douglas McGregor's "Theory X and Theory Y." Theory X says that if you treat people like children, they tend to act like children; whereas Theory Y says that if you treat people like adults, they tend to act like adults. Isn't it demeaning to not tell an adult craftsperson the time expected on a task? Doesn't that imply we do not trust them? Accordingly, visible estimates show that each crew is getting a full week's worth of work and each craftsperson is getting a full day's worth of work. If the craftsperson needs longer to do a job right, we need to take longer. Quality is king. Management must NEVER downgrade a craftsperson for taking longer on work simply by comparing actual versus planned times.

Finally, time estimates are not "the silver bullet." We need to assign enough work for the week and each day using the not-so-accurate times. We still need supervisors in the field. Fully loading crews with work for the week and supervisors being in the field together defeats Parkinson's Law to take care of productivity. We need to generate proactive work. We need skilled craftspersons. We need planners making plans better over the years, especially with adult craftsperson feedback. Skilled craftspersons allowed to take their time and planners continually upgrading plans takes care of quality. We also programs generating proactive work and reliability persons doing root cause analysis and developing projects for upgrading inherently unreliable assets. And we need managers maturely leading all these efforts. We have to do all this stuff.

Don't compromise your craftspersons by withholding trust regarding time estimates. We must work together to make our facilities great. Treat craftspersons as the adults they are and provide them with the information to complete the work assigned as best they can. Don't settle for good. Be great! Δ

JEFF SHIVER

From the Plant Floor

IMPLEMENTATION—THE MISSING LINK TO REAL RESULTS

Knowing how to solve a problem or write a job plan is only half the battle

Why is it in the maintenance and reliability world that we constantly find ourselves facing the same challenges repeatedly? Often, I find the answer is not in the problem-solving approach but in the implementation – or rather, the lack thereof.

From million-dollar FMEA exercises to gearbox debacles. A utility pays consulting groups upwards of a million dollars to do asset-specific Failure Modes and Effects Analyses (FMEAs) every few years. Despite the detailed efforts, the same failures occur, and maintenance costs continue to rise. While the analyses were thorough, the implementation was poor. Sometimes, the findings and suggested actions sat on a shelf, collecting dust. And there was little ownership from the maintenance personnel.

Consider another recent event – a planner developed a comprehensive job plan to repair a large gearbox in a large facility. The plan specified everything: the correct location, the necessary tools, the right parts, and the steps to follow. However, the technicians decided that they knew better. They tossed the job plan in the trash and set about their work. However, they changed the wrong gearbox and damaged its motor. To make matters worse, no critical spares were available for the repair, resulting in two process lines being idled. And no, you can't make this stuff up; it was real. The best-laid plans are useless if they aren't followed or there's a lack of ownership over the process.

RCA and RCM analysis without implementation is a missed opportunity. Our team recently visited a plant to facilitate a Reliability-Centered Maintenance (RCM) analysis on a troublesome asset. While there, the site complained about failures on another two assets. It turns out that the RCM analyses of those assets were completed a few years prior. In the CMMS, it was evident that nothing from the analysis was ever implemented. The plant had invested in the analysis but, without follow-through, they gained nothing from their investment.

In another instance, a manufacturing company implemented a structured Root Cause Analysis (RCA) process across all its sites globally. It was a massive undertaking involving years of effort. When we visited one of their sites, we discovered that while they had completed numerous RCA events, few findings had been implemented. The U.S. corporate group measured the number of completed RCA events as a key performance indicator. The corporate focus on counting events rather than implementing actions and business results meant that the real issues continued to fester.

Bridging the gap between analysis and action. The key lies in ownership and accountability. Realize that plant managers aren't just looking for results two years down the line – they need to see improvements this quarter or the next that impact the bottom line. Focus on implementing actions that deliver short-term wins while setting the stage for long-term gains.

One practical approach we leverage is investing in your operators and technicians, not just with tools but with the responsibility for outcomes. Implementation action is key. With the hard work of identifying the problems and developing solutions, it's time to ensure that those solutions are implemented. Encourage your teams to take ownership of the process, and don't let the findings from your RCAs, RCMs, and other analyses fall through the cracks.

When your team takes ownership of the entire process – from analysis to implementation – the results will follow, and the investment in your personnel will pay off in reduced failures, lower costs, and improved asset performance. It's time to break the cycle. It's time to implement for real business results. Δ

Jeff Shiver, CMRP, is a founder and managing principal at People and Processes, Inc. Jeff guides people to achieve success in maintenance and reliability practices using common sense approaches. Visit *www.PeopleandProcesses.com* or email *JShiver@PeopleandProcesses.com*.

The TRUTH About COMPRESSED AIR!

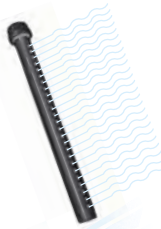
If you think compressed air is too expensive and noisy - read this. The facts will surprise you!

Compare These Blowoffs

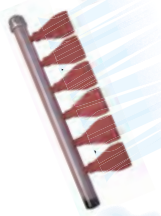
There are a variety of ways to dry, clean or cool products and surfaces, but which method is best? To decide, we ran a comparison test on the same application using four different blowoff methods: drilled pipe, flat air nozzles, Super Air Knife (each using compressed air as a power source), and a blower supplied air knife (using an electric motor as a power source). Each system consisted of two twelve inch long air knives.

The following comparison proves that the EXAIR Super Air Knife is the best choice for your blowoff, cooling or drying application.

The goal for each of the blowoff choices was to use the least amount of air possible to get the job done (lowest energy and noise level). The compressed air pressure required was 60 PSIG. The blower used had a ten horsepower motor and was a centrifugal type blower at 18,000 RPM. The table below summarizes the overall performance.



Drilled Pipe This common blowoff is very inexpensive and easy to make. For this test, we used (2) drilled pipes, each with (25) 1/16" diameter holes on 1/2" centers. The drilled pipe performed poorly. The initial cost of the drilled pipe is overshadowed by its high energy use. The holes are easily blocked and the noise level is excessive. Velocity across the entire length was very inconsistent with spikes of air and numerous dead spots.



Flat Air Nozzles This inexpensive air nozzle was the worst performer. It is available in plastic, aluminum and stainless steel from several manufacturers. The flat air nozzle provides some entrainment, but suffers from many of the same problems as the drilled pipe. Operating cost and noise level are high. For some flat air nozzles the holes can be blocked - an OSHA violation. Velocity was inconsistent with spikes of air.

Blower Air Knife The blower proved to be an expensive, noisy option. As noted below, the purchase price is high. Operating cost was considerably lower than the drilled pipe and flat air nozzle, but was comparable to EXAIR's Super Air Knife. The large blower with its two 3" (8cm) diameter hoses requires significant mounting space. Noise level was high at 90 dBA. There was no option for cycling it on and off to conserve energy. Costly bearing and filter maintenance along with downtime were also negative factors.

EXAIR Super Air Knife The Super Air Knife did an exceptional job of removing moisture on one pass due to the uniformity of the laminar airflow. The sound level was very low. For this application, energy use was slightly higher than the blower but can be less than the blower if cycling on and off is possible. Safe operation is not an issue since the Super Air Knife can not be dead-ended. Maintenance costs are low with no moving parts to wear out.

SEE THE AIR KNIFE IN ACTION!

https://exair.co/85_akv_ad

The Super Air Knife is the low cost way to blowoff, dry, clean and cool.

Blowoff Comparison

Type of blowoff	PSIG	BAR	Comp. Air		Horsepower Required	Sound Level dBA	Purchase Price	Annual Electrical Cost*	Approx. Annual Maintenance Cost	First Year Cost
			SCFM	SLPM						
Drilled Pipes	60	4.1	174	4,924	35	91	$50	$4,508	$920	$5,478
Flat Air Nozzles	60	4.1	257	7,273	51	102	$300	$6,569	$1,450	$8,319
Blower Air Knife	3	0.2	N/A	N/A	10	90	$7,000	$1,288	$1,500	$9,788
Super Air Knife	**60**	**4.1**	**55**	**1,557**	**11**	**69**	**$842**	**$1,417**	**$300**	**$2,559**

*Based on national average electricity cost of 8.3 cents per kWh. Annual cost reflects 40 hours per week, 52 weeks per year.

Facts about Blowers

Energy conscious plants might think a blower to be a better choice due to its slightly lower electrical consumption compared to a compressor. In reality, a blower is an expensive capital expenditure that requires frequent down-time and costly maintenance of filters, belts and bearings.

Here are some important facts:

Filters must be replaced every one to three months.

Belts must be replaced every three to six months.

Typical bearing replacement is at least once a year at a cost near $1000.

- Blower bearings wear out quickly due to the high speeds (17-20,000 RPM) required to generate effective airflows.
- Poorly designed seals that allow dirt and moisture infiltration and environments above 125°F decrease the one year bearing life.
- Many bearings can not be replaced in the field, resulting in downtime to send the assembly back to the manufacturer.

Blowers take up a lot of space and often produce sound levels that exceed OSHA noise level exposure requirements. Air volume and velocity are often difficult to control since mechanical adjustments are required.

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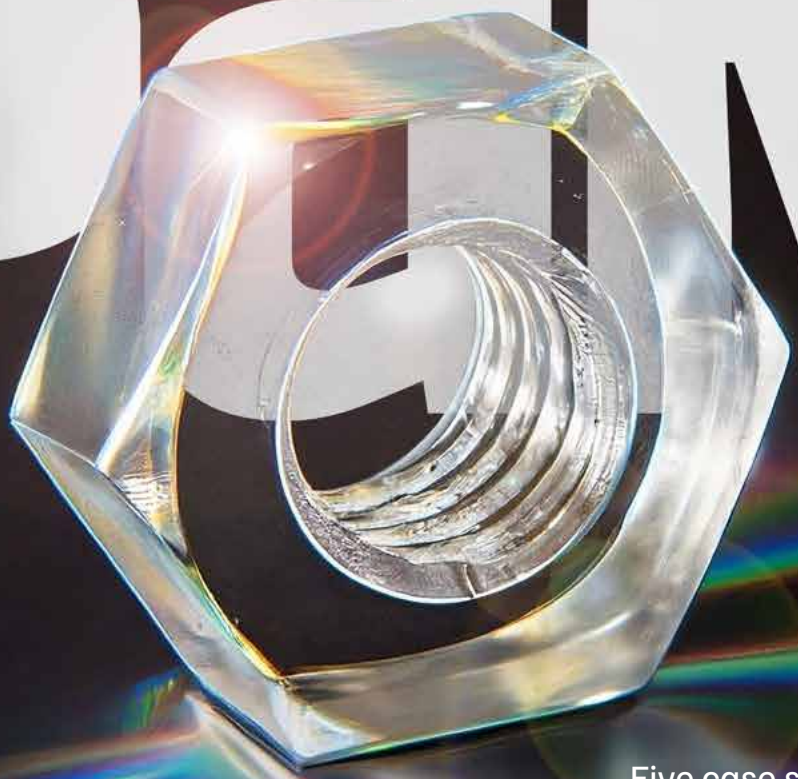
THE MANY FACETS OF PdM



Five case studies show how predictive tools can bring greater clarity to machine health

Michael Annino | Shutterstock-AI

The medley of predictive maintenance (PdM) strategies for improving machine health is growing larger and more powerful. Leaders going on record by documenting improvements gained from predictive maintenance initiatives provide a window into the immense potential of today's enabling technologies.

This article presents several published case studies to illustrate some of the many PdM methods and applications employed today to increase uptime and efficiency, reduce costs, extend asset life, and more broadly improve operational performance.

THE EVOLUTION OF PdM

Maintenance and reliability professionals have long relied on condition monitoring to detect early signs of asset degradation and prevent unexpected failures of critical equipment. Tried and true methods such as vibration and temperature monitoring, oil analysis, infrared thermography, and ultrasound inspection enable predictive maintenance during scheduled outages to avoid unplanned downtime.

But the early applications typically involved time-consuming inspection rounds and data gathering, often in spreadsheets, for manual analysis. Fortunately, vast technological improvements are helping to eliminate the data silos, integrate and automate data collection and analysis, and better predict and prevent failures.

Inderpreet Shoker, director of research at ARC Advisory Group, notes the industrial world has made tremendous improvements when it comes to maintenance strategies. "The next big change in asset management is brought by technologies like artificial intelligence (AI), analytics, and machine learning (ML). These technologies are helping us improve PdM models," she explains.

PdM approaches employ near real-time equipment and process data analysis to predict failure. Applying continuously improving technology to PdM enables a higher degree of confidence and low false positives. "The next level that progressive end-users are looking to achieve is prescriptive maintenance, whereby leveraging AI and ML technology, users get recommended steps to better maintain assets. As the industry is facing a shortage of skilled workers, these technologies will be instrumental in addressing the skills gap," adds Shoker.

In fact, the most impactful technologies in the next five years, according to the ARC Digital Transformation, Sustainability and Technology Survey conducted by ARC Advisory Group in Q4 2023, include AI with a significant lead and industrial analytics, cloud, and industrial internet of things (IIoT) technologies also prominent. Each of these is already playing a role in improving PdM and prescriptive maintenance approaches.

OIL AND GAS SUPERMAJOR USES AI PREDICTIVE ANALYTICS

Challenge: An oil and gas supermajor needed to maximize its production potential and improve the efficiency, availability, and overall safety of its offshore platforms. Thanks to previously completed digital transformation initiatives, its maintenance programs were already being operated with high digital competence and its assets were well instrumented and monitored. Its next target was adding predictive AI modeling capabilities.

Solution: An initial evaluation of Industrial AI Suite from SparkCognition, using a blind set of historical subsystem data from a key platform, exceeded expectations. AI models built for a separator system prone to unexpected failures predicted 75% of historical failures with an average of nine days advance warning. The

FIGURE 1. Integrating its CMMS and control systems helped Red Cedar Gathering's treatment facility increase its uptime above 99%.

(Source: Llumin)

models were then operationalized at scale at that platform and another. Industrial AI Suite was deployed in the supermajor's remote onshore control center, providing alerting, 10-minute diagnostics, and a significant increase in overall operational visibility. AI predictive analytics were deployed across multiple critical subsystems to predict impending failures and optimize maintenance activities.

Results: The solution delivered a 4% increase in availability by avoiding net deferral events on both platforms. For instance, at least $10 million worth of deferred production was avoided when an alert enabled troubleshooting and scheduled maintenance of a critical export compressor with a faulty temperature sensor, which otherwise would have required up to two days to stage the asset to determine the root cause. The projected economic impact of Industrial AI Suite's full deployment across the entire fleet of offshore platforms is roughly $800M annually.

MIDSTREAM ENERGY COMPANY USES IIoT STRATEGY WITH INTEGRATED CMMS

Challenge: Red Cedar Gathering Company gathers, treats, and compresses natural gas from more than 1,200 wells within the Southern Ute Reservation boundary before delivering it to interstate transportation pipelines. A new asset management solution was desired to help automate manual processes, improve machine uptime, streamline data exchange between operations and maintenance, and expedite diagnoses and the mean time to repair (MTTR).

Solution: The Colorado-based company chose to implement CMMS+ asset management software from Llumin and integrate it with their Rockwell Automation PlantPAx control system, data historian, and IIoT sensors (see **Figure 1**). The solution enables predictive and proactive maintenance by monitoring and analyzing historical and real-time data such as temperatures and pressures, and triggering notifications and actions.

Results: With the added insights gained from CMMS+, the energy firm increased its uptime above 99%, resulting in plant throughput of 100% per year. Additionally, its MTTR cycles were significantly reduced. "We require less labor hours due to fewer callouts with equipment going down," explains Coy Bryant, chief operating officer at Red Cedar Gathering Company. "There is less downtime due to automatic, proactive actions triggered based on equipment condition alerts. We paid for our investment in Llumin in just over two years."

CONSUMER PRODUCTS MANUFACTURER USES AI AND ML MODELS

Challenge: Frequent HVAC failures at a critical Amway facility in India drove the need to create a single system of record to improve transparency into daily building operations, streamline maintenance service cases, and balance indoor air comfort against energy consumption.

Solution: Leveraging its long-term partnership with Honeywell, Amway chose to deploy Honeywell Forge Performance+ Predictive Maintenance to modernize its facility management capabilities with a data-based strategy. Close collaboration between the partners enabled the Amway team to identify underutilized and fragmented official data across their current systems, and aided Honeywell in quickly modeling analytical rules that fit Amway's operational conditions.

Results: Performance+ Predictive Maintenance helped to solve data fragmentation with a dashboard presenting a single source of truth, and allowed Amway to realize a 15% increase in "excellent" rated comfort performance zones over a three-month period. AI and ML models can forecast trends, detect anomalies, and enable root cause analysis, while also learning and adapting to changes in the HVAC systems. The advanced algorithms and automated workflows allow users to quickly identify service cases and proactively address HVAC issues to reduce downtime and extend asset life.

(Source: Kyoto Group)

FIGURE 2. Heatcube's use of Generative AI from Cognite Data Fusion makes it easier for decision makers to access and understand complex industrial data.

SELF-DRIVING TRUCK COMPANY USES CMMS, BI TOOLING, AND MOBILE APP

Challenge: Torc Robotics, an autonomous self-driving truck pioneer, wanted a customizable CMMS with out-of-the-box features to help address growing operational complexities while maintaining efficiency and reliability. An operational framework was needed to standardize and centralize its maintenance workflows, policies, and procedures for maintaining equipment in its fleet.

Solution: The eMaint X5 CMMS from Fluke Reliability was selected, extensively tailored to the truck company's needs, and connected to its different systems with eMaint's application interface (API). Using the CMMS's features, including a business intelligence (BI) tooling integration and mobile app, Torc standardized its maintenance processes and centralized all asset management.

Results: By improving its workflows, monitoring asset conditions, and addressing issues early with the new solution, the company cut downtime by 50% most months. "Thanks to our API, we can pinpoint patterns of failure and set up triggers that automatically generate a work order, add the assets involved, and provide a duty procedure for technicians to follow," says Brenton Papenfuse, autonomous service program manager at Torc Robotics. Technicians using the X5 mobile app can report and document asset issues in real time. BI analytics help to identify root causes of downtime.

THERMAL BATTERY MANUFACTURER USES GenAI-DRIVEN DATA OPERATIONS PLATFORM

Challenge: A thermal energy storage solution from Kyoto Group called the Heatcube (see **Figure 2**) is designed to help reduce the CO_2 footprint for industrial process heat by capturing and storing energy from solar and wind sources. Kyoto needed a solution to power its data operations and enable its customers to optimize the operation and maintenance of Heatcube.

Solution: The company chose to integrate its cloud-based DataOps platform with the Cognite Data Fusion industrial DataOps platform. Data Fusion's use of Generative AI makes it easier for decision makers to access and understand complex industrial data. Kyoto's DataOps implementation also integrates real-time operational data from the Heatcube Battery Management System with various engineering data sources, facilitating product improvements by its engineering team.

Results: The first iteration of Kyoto's DataOps platform is "designed, tailored, and tested" to oversee operations of Heatcube installations at multiple locations. "The integration will empower our customers to streamline data management and cost optimize operations, enabled by a foundation of best-in-class preventive and predictive maintenance," observes Gustavo Zaera, head of digital acceleration at Kyoto Group.

IN CONCLUSION

These diverse case studies are just a sample of how the latest PdM technologies are advancing reliability and asset management. Whether using classic portable tools for non-critical asset inspection rounds and on-site problem verification and troubleshooting, or advanced technologies such as the IIoT, cloud, and AI and ML algorithms, the value of preventing failures and increasing uptime with predictive and prescriptive maintenance solutions is indisputable. Δ

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ASK THE EXPERTS:

STRATEGIES TO REDUCE COMPRESSED AIR ENERGY CONSUMPTION

Michael Annino | Shutterstock AI

In this Ask the Experts feature, expert instructors from the Compressed Air Challenge (CAC) tackle your questions on compressed air systems and associated technology.

The Compressed Air Challenge is a voluntary collaboration of industrial end-users; manufacturers, distributors, and their associations; trade organizations; consultants; state research and development agencies; energy efficiency organizations; and utilities. The CAC has one purpose in mind—helping facilities enjoy the benefits of improved performance of your compressed air system.

This month's question: **"What are the best strategies to reduce the energy consumption of my compressed air system?"**

Paul Maguire (Natick MA, L1 Trainer): Reducing energy consumption in a compressed air system is crucial for both cost savings and environmental sustainability. Here are the most effective strategies to minimize energy consumption:

1. Lowering System Pressure: Compressed air systems typically operate at pressures higher than necessary, leading to excessive energy consumption. Reducing the operating pressure by just 2 psi can result in a 1% reduction in energy use. According to the U.S. DOE, lowering system pressure from 120 psi to 100 psi can decrease energy costs by approximately 10%. The key is to balance the pressure requirements for various tools and equipment with the minimum pressure needed, thereby reducing the workload on compressors and saving energy.

2. Implement Leak Detection and Repair Programs: The DOE estimates that air leaks can account for up to 20-30% of the total system output. Regular leak detection and repair programs are essential for maintaining system efficiency. Using tools such as ultrasonic leak detectors or even simple soapy water solutions can help identify leaks.

For example, a single ⅛-inch leak can waste approximately 37,000 cubic feet of air per day (26 cfm), leading to substantial energy costs over time.

3. Upgrade to More Efficient Equipment: Upgrading to more energy-efficient equipment can have a substantial impact on overall energy consumption. Modern, high-efficiency compressors and variable speed drive (VSD) technology can significantly reduce energy usage compared to older models. VSD compressors adjust their speed based on demand, which avoids the inefficiencies of running at full speed constantly. According to a study by the Compressed Air and Gas Institute (CAGI), upgrading to a VSD compressor can yield energy savings of up to 35% compared to a fixed-speed compressor. Additionally, investing in high-efficiency air dryers and filters can further enhance system performance and reduce energy consumption. Though initial costs may be higher, the long-term savings and performance improvements often justify the investment.

Chris Beals (Denver CO, L1 Trainer): In order to save energy the compressors in the compressor station(s) have to be coordinated so they can reduce energy when demand side work reduces demand. Therefore, the first place to start is with the compressors in the compressor station.

There are two types of compressors – rotary screw and centrifugal. For rotary screw compressors, set the compressors' pressure set points so all but one is fully loaded. The compressor that isn't fully loaded is called the trim compressor. If the trim compressor is a constant speed rotary screw then it should operate in load/unload mode with sufficient storage so it doesn't short cycle, as short cycling can damage a rotary screw compressor.

If the trim compressor is a VSD compressor then it needs to be sized either so its turndown covers the entire variation in demand or so its turndown range covers the standard cubic feet per minute (SCFM) capacity largest constant speed rotary screw compressor that will unload during the variation in demand. VSD compressors also require sufficient storage to reduce hunting that can reduce the life of its variable frequency drive. Installing compressor automation can further improve the system efficiency.

Blow off must be eliminated to save energy with centrifugal compressors. Given multiple centrifugal compressors, the best way to eliminate blow off is to install automation that allows load sharing across all the compressors. While tuning the control valves on a centrifugal compressor can help it react better to system events, large storage is often required, particularly between the compressor and a desiccant air dryer.

Gopalakrishnan Bhaskaran (Morgantown, WV, L1 Trainer): The best strategy to start examining energy saving potential in compressed air system would be to do effective concurrent data logging to determine the power draw from each compressor. If a plant has multiple air compressors, with or without a sequencer, then this collected data will provide significant insight and knowledge into the effectiveness of compressed air system operation.

For example, in a plant with four screw type air compressors all providing air to the same header, the power and/or current draw will indicate the unload/load status of each compressor over time. This information will help to ascertain if multiple air compressors are being loaded and unloaded in a manner that results in an overall low kW and air capacity loads, which would signify a significant energy conservation opportunity. The use of the DOE MEASUR tool (www.energy.gov/eere/iedo/measur) for modeling the compressed air system can then be attempted to analyze the energy saving opportunities, in more effective sequencing of the compressors operation based on target pressure or cascading pressure bands.

The collected data in this regard will also reveal rapid load/unload cycling of the compressors; and, if any compressor is operated by VFD, it will reveal if the VFD is actually providing benefits as it intended. The effectiveness of the VFD controls on an air compressor is only as good as the effective integration of the supply and demand side.

I recommend also collecting short interval data on the compressed air pressures at various locations in the plant and superimposing them on the current/power profiles of the compressor operation to determine the changes in pressures with respect to time and with respect to compressor operations. Such efforts will lead to closer examination of the end uses and their air use patterns and examine their correlation with the power draw from various compressors at the same time periods.

Paul Shaw (Berlin, CT, L1&2 Trainer): Very often plant pressure is much higher than required, causing the plant extra operating costs. For the system pressure the operator should investigate what the REAL pressure needs are for the plant – they may find that the perceived operating pressure is much more than the required or needed pressure. I have frequently been in plants where the operating pressure is 125 psig or higher and by the time we are done with a study and implementation that has addressed the issues, we are able to reduce the plant's operating pressure to 85 or 90 psig and hold it there. Some examples of the issues we uncover that require the higher pressure are an inadequate header sizing, inadequate pipe looping, high filter pressure drop, storage and lack of pressure control to provide a couple of examples. Implementing this provides a real energy benefit as a 2 psig

decrease in system pressure realizes a 1% energy savings plus additional savings in the leak load if that portion has not been addressed.

Also, the operator needs to look at the supply side of the system and specifically the air compressors. How many compressors are on, are they required, are they integrated correctly, do they shut off automatically when they are not required? Also, is there one compressor in the system that provides excellent part load turndown being used as the trim compressor in a multi-compressor system, or is the primary compressor in a single compressor system? A compressed air system specialist can help with this along with datalogging to understand where the issues are, if any.

Ron Marshall (Winnipeg, MB, L1&2 Trainer): A lot of study typically takes place inside the compressor room, but often the largest potential cost savings benefit results if you poke your nose outside the door and look at how the air is used (or abused). Very seasoned auditors estimate that if aggressive and thorough investigations of the compressed air demand is done you can double the savings gained in the compressor room, often with little to no cost involved.

If you really want to optimize your system, purchase an ultrasonic leak detector or an acoustical imager to help you find compressed air uses and leaks hidden in your production equipment. You will soon be amazed at all the innovative ways your compressed air users can think of the waste compressed air. Considering it takes about 10 units of energy to produce one unit of energy output on a compressed air device like an air motor, considerable energy can be saved by reducing or eliminating wasteful end uses. And for plants that have been ignoring their leakage, it is very common to see leakage levels approaching or above 50 percent of the total compressed air system output. Your compressors need a rest – start an aggressive leak detection and repair program and reduce your load!

Want help in finding out what to do? Compressed Air Challenge's Fundamentals and Advanced training can help you formulate a plan (www.compressedairchallenge.org). Δ

The mission of **Compressed Air Challenge** is to promote energy and operational efficiency in compressed air systems for industry through information and training, leading end users to adopt efficient practices and technologies while leveraging collaborative cooperation among key stakeholders. To carry out its mission, CAC maintains a group of 20 highly qualified and experienced instructors who are available to deliver its various product-neutral training offerings through in person or online training delivery. To learn more about upcoming training opportunities visit the CAC calendar at *https://www.compressedairchallenge.org/calendar.*

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THE CAPTAIN
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THE JOY OF SETTING UP A LUBE PROGRAM

Forget standards and best practices—your equipment will appreciate the element of surprise

So, you've decided that your equipment needs a lubrication program. Congratulations! Get ready for a wild ride as you navigate the thrilling world of grease, oil, and maintenance schedules. Here's a handy guide to help you on your fantastic journey to lubrication program success.

First things first, ignore all those boring industry standards and best practices. Who needs 'em, right? Just grab the nearest bottle of oil and start slathering it on everything that moves. More is always better, so don't be shy with that grease gun. The best thing you can do for your equipment is to hand the "noobs" a grease gun and turn them loose, creating thousands of defects in all of your equipment.

Next, make sure to completely overlook any sort of training or education for your maintenance team. They'll figure it out as they go along. After all, how hard can it be to lubricate equipment? It's just like putting sunscreen on at the beach, right?

Now, when it comes to selecting lubricants, always go for the cheapest option. Quality is overrated, and your equipment won't mind a bit of low-grade sludge. Besides, who wants to spend all that money on fancy oils when you could be investing in more important things, like office snacks?

When it comes to scheduling lubrication tasks, just do it whenever you feel like it. Who needs a consistent schedule? Your equipment will appreciate the element of surprise. Plus, it keeps your maintenance team on their toes.

Oh, and don't bother with any sort of documentation or record-keeping. That stuff is for nerds. Just trust your memory to keep track of when you last lubricated each piece of equipment. What could possibly go wrong?

As your lubrication program evolves, be sure to never, ever ask for feedback from your maintenance team. Their opinions are irrelevant. Just keep doing things your way, no matter how much they complain.

Oh, and the joys of managing oil in your lubrication practices while also considering the environment. It's like walking a tightrope, except the tightrope is made of oil-soaked rags and the safety net is a bunch of angry environmentalists. But fear not, brave maintenance warrior, for I am here to guide you through this treacherous terrain.

Remember to ignore all those pesky environmental regulations and guidelines. Who needs clean air and water anyway? Just dump your used oil wherever is most convenient. Storm drain? Sure, why not? Nature will figure it out, it came out of the ground, didn't it?

When it comes to selecting lubricants, always go for the most toxic option available. Forget about biodegradability and eco-friendliness. You want your lubricants to be as harmful to the environment as possible. After all, what's a little pollution between friends?

When handling and storing oil, be sure to be as careless as possible. Spills happen, right? Just leave them for someone else to clean up. And who needs proper containment measures? That is also what the ground is for.

When disposing of used oil, make sure to do so in the most irresponsible way possible. Pour it down the drain, bury it in the backyard, whatever works for you, just make sure it's as damaging to the environment as possible.

And finally, always remember to blame the equipment when things go wrong. It couldn't possibly be your fault for neglecting proper lubrication practices. Nope, it's definitely the fault of those pesky machines.

So there you have it, a foolproof guide to setting up an excellent lubrication program. Follow these steps, and you'll be well on your way to ... well, probably a lot of equipment failures, costly repairs, probably a hefty fine from the EPA, and a tarnished reputation. But hey, at least you'll have saved a few bucks in the short term and you'll have a good story to tell at the next maintenance conference! Δ

Captain Unreliability is a satire of the state of manufacturing in 'Merica, USA, by an industry professional known for using humor to get the point across. Email him at *Captain.Unreliability@ReliabilityX.com*, or follow him on Twitter: @CUnreliability.

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