# Why Preventive Maintenance is Holding You Back

ENGINEERING YOUR SUCCESS.

## About the Authors

*David Shannon*

Specializing in strategic business development for organizations including Savi Technology and IBM, David Shannon has more than 25 years' experience in product development and supply chain management. As Business Unit Manager for Parker Hannifin, Shannon oversees the development and production of Parker's Internet of Things (IoT) solutions. The team is currently exploring the use of sensor technologies across applications to monitor conditions remotely and provide predictive maintenance insights.

*Tad Orstad*

Tad Orstad is Applications Engineer with Parker's Quick Couplings Division focusing on Internet of Things (IoT) solutions. Since joining Parker Hannifin in 2007, Orstad has helped manufacturers integrate diagnostic and condition monitoring solutions into their machines and processes. He currently leads product development for Parker's SensoControl and SensoNODE solutions and is a member of the company's IoT Solutions Team investigating innovative applications for IoT products on the plant floor.

**Learn how condition monitoring tools allow manufacturers to predict the future, reduce their costs, and do much more with less.**

Overheated machines. Inconsistent chemistries. Conditions out of tolerance. Just about every manufacturing operation has problems like these. They are the characteristics of each production process that keep maintenance engineers up at night worrying or ruin their mornings when systems have failed.

Sometimes they're continuously running processes with the tendency to create production backlogs when processing stops. Other times they could be simple checkpoints that, when not maintained at certain levels, lead to faulty products, rework or worse, the shipment of faulty products.

For example, varying chemistries can affect product quality, and fuel or compressed air supplies can run out at unpredictable times. Temperatures can exceed parameters set for critical inputs or processes. Humidity levels can affect equipment sensitivity. Even the vibration levels of critical pumps, motors and bearings can be an indication of problems on the horizon.

While virtually every factory has pain points like these, not every company has adopted systems to deal with them in quite the same way.

Many still use the traditionally accepted methods — such as manually measuring critical parameters and employing maintenance efforts that are reactive or preventive in nature. With approaches like these, maintenance teams are assured of attending to known problem areas — eventually.

But there are downsides to these methods, too. Taking manual measurements is time- and labor-intensive, poses safety issues and tends to be limited in scope. Manual assessments also may be misinterpreted and can create production slowdowns if processes must be interrupted to get to them.

Meanwhile, unplanned downtime, as in the case of reactive maintenance, is downright costly, and it can have a collateral effect on overall productive output.

While preventive maintenance is more cost-effective than reacting to actual failures, it has its disadvantages. Servicing, monitoring or retooling processes after so many hours of run time, parts made or resources used, can be unnecessary or wasteful. Preventive maintenance also often requires scheduled downtime: Machines must be shut down, locked out for safety and serviced and/or monitored before returning to operational condition. Though these planned outages can extend the life of the machines while ensuring operator and maintenance engineer safety, they also fall short against today's demands to do more with less.

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on a high number of manual methods to achieve these results.

Even more effective options are condition monitoring tools that build on the preventive model to make it predictive. In this way, the newest tools increase productive uptime while decreasing maintenance costs, which impacts profitability. Condition monitoring tools also help facilities produce higher quality products more consistently.

Parker's Voice of the Machine™ Software and SensoNODE condition monitoring are essential tools that help MRO professionals realize the tremendous benefits from a well-executed predictive maintenance program. Assessing machine and process health is the core of Parker's Voice of the Machine software and SensoNODE sensors. The Internet of Things (IoT) enabled wireless sensor system allows plant managers to set up baseline performance levels and seamlessly monitor process parameters to reveal changes in machine health as they develop; giving them the time and the information needed to prevent failures.

Sensors take readings automatically, contributing to higher productivity and allowing better decision making. With access to more automated measurements, managers now have access to process histories and trends that will help them visualize and understand upcoming issues. Trending measurements are communicated via notifications and dashboards; alerting maintenance engineers of the need to attend to developing problems before a full stop failure condition occurs.

**Why conditions are right for condition monitoring**

Even in 2018, many manufacturing facilities are comfortable with the status quo afforded by reactive and preventive maintenance tasks. However, in today's leaner manufacturing environments, conditions are right, and the technology is available, to help companies be more proactive about maintenance and more predictive about pain points. That is where Parker's Voice of the Machine Software and SensoNODE technologies can help companies take advantage of the power of machine learning and the analytical skills of their maintenance professionals.

There is a new basis of competition emerging in global manufacturing in which IoT technologies and predictive maintenance programs imply the world's next Industrial Revolution. Those who adapt it successfully will enjoy substantial and valuable competitive advantage that will set the stage for their future profitability and growth.

There's a changing of the guard underway in the labor force of many industrial facilities. In years past, before the advent of widespread automation, maintenance staffs were larger and many workloads were narrower. These days fewer workers are expected to handle their predecessors' duties and then some. Companies intent on doing more with less are employing fewer individuals to do the work their predecessors did.

At the same time, as more members of the baby-boom generation retire, companies are facing a significant loss of

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their knowledge base. Since many companies now employ fewer people in maintenance and operations departments, they can be challenged to complete all the manual checks their processes require. But, if certain parameters aren't checked, factories can end up with lost productivity, quality problems and costly rework.

Today's maintenance technicians, manufacturing engineers and assembly line workers, whose job it is to keep equipment and processes calibrated and running, benefit from more automated yet affordable solutions that help them to do more of these things, more often.

Another gap preventive efforts don't address is the increasing need for more frequent, faster status- and process-based information. Today's newer generation of hyper-connected workers increasingly expect the machines, processes and equipment they oversee to be connected and "smart." It's further evidenced by the fact that maintenance technicians overwhelmingly say it would be useful to them if they could receive notifications in advance of faults and early warnings of impending issues.

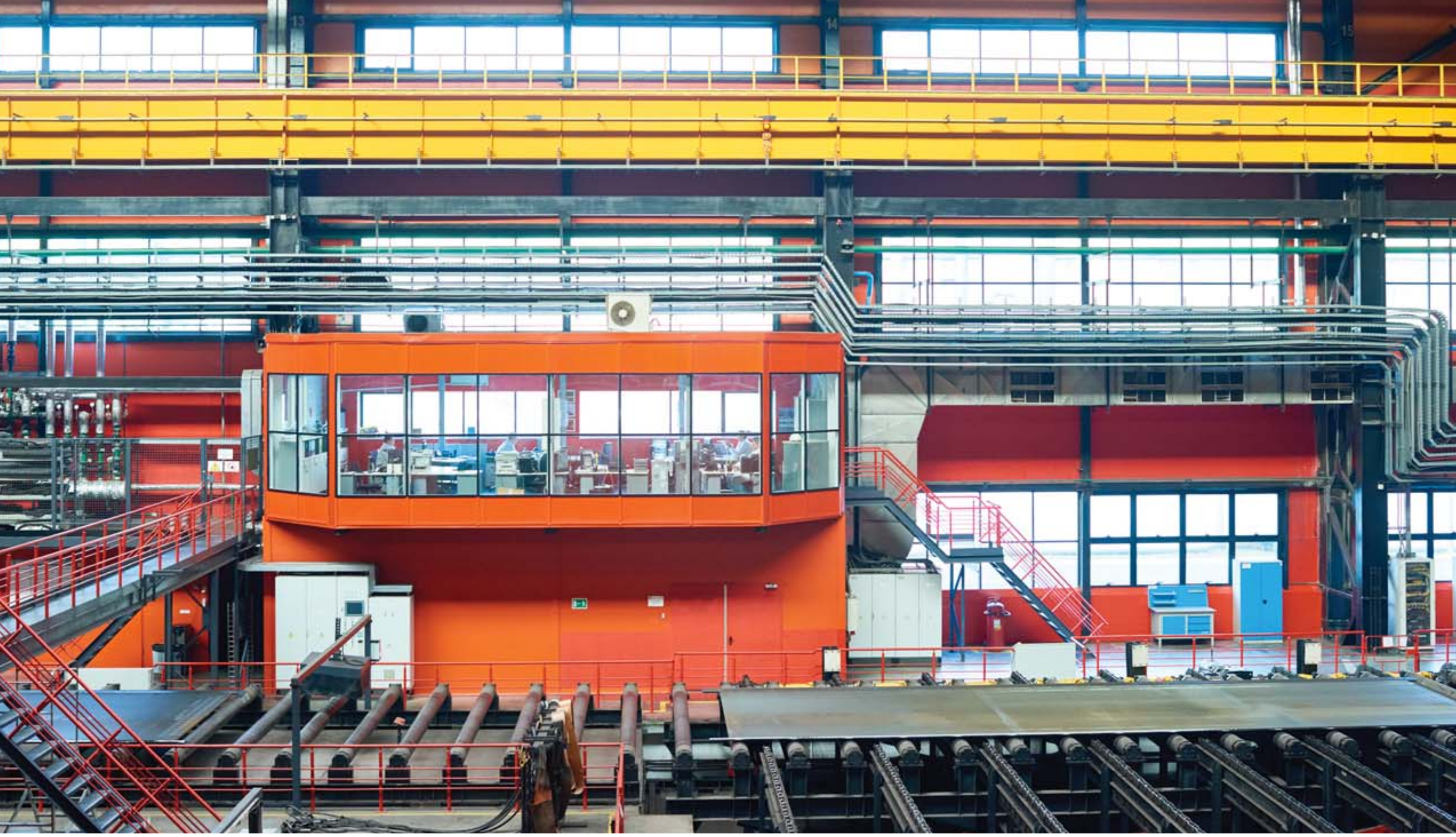
Preventive maintenance can't prevent catastrophic failures, nor does it prevent an operation from having to do rework, take returns or to scrap its work, because faulty processes continued unabated. What's more, preventive maintenance adds the potential for incidental damage to components while work is being performed. Replacement parts can be faulty, components can be assembled incorrectly, bolts can break and screws can be cross-threaded. This means the facility could have even more downtime in the long run than expected.

A related issue is that preventive maintenance can promote wasted resources and may cause companies to spend time, effort and money unnecessarily. For example, when changing out parts on a preventive maintenance schedule, maintenance engineers may be uncertain how much utility exists in the parts they're asked to replace. There's also the possibility that parts with useful service life are being thrown away.

**Applying a more predictive approach**

The appeal of condition monitoring only becomes stronger in light of these shortcomings. In today's competitive business environment, most plant managers and their staffs cannot operationally afford to be watching their tools, machines and key process variables 100 percent of the time to ensure they are staying perfectly operational. It would be too expensive and there are too many things to watch."

Yet, this is the sort of visibility condition monitoring tools provide. By automating the monitoring process, condition monitoring tools can eliminate repetitive, manual and time-intensive monitoring of processes and equipment, and shift constant management oversight of pain-inducing processes to management of processes by exception instead. A key distinction of predictive maintenance is that it bases the need for maintenance on the actual condition of the machine, not on a preset schedule, as



does preventive maintenance.

The benefits of this approach are significant. A few of the improvements, according to industry experts and the U.S. Department of Energy,[1] include a 50 percent reduction in maintenance costs and a 40 percent reduction in downtime.

Because it's predictive, condition monitoring ends some of the chaos associated with reactive maintenance and allows for more conscious decision-making ahead of time.

Predictive efforts also allow maintenance engineers to predict changes and perform maintenance tasks when there's evidence they're warranted, and not simply because of a time-based or otherwise arbitrary justification. This is where condition monitoring adds the potential to take away bottlenecks, waste, scrapped parts, production delays, missed deadlines and added costs from rework and scrapped work.

**Predictive Maintenance by the Numbers[2]**

**A 50% reduction in maintenance costs, including labor, overhead and parts**

**A 60% reduction in mean time to repair**

**A 40% reduction in downtime**

**A 55% reduction in machine failures**

**A 30% increase in asset life**

**A 25% increase in production**

**An average return on investment of 10 times**

And, it's a methodology whose time has come: According to a recent article from *Business Insider*[3], the number of connected machines in manufacturing could increase almost 400 percent, from 237 million devices in 2015 to 923 million in 2020.

More and more companies are realizing the benefits of condition monitoring and this new way of maintaining the health of their machines. As manufacturing and maintenance teams run leaner, factories have less tolerance or leeway to deal with unplanned breakdowns nimbly. This means more companies are compelled to seek better ways to manage the care of their assets.

With a lack of manpower in many facilities, managers need to find new and different ways

[1]Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency" US DOE, August 2010.

[2] Mobley, R. Keith. An Introduction to Predictive Maintenance. 2nd ed. Philadelphia: Elsevier Science, 2002. 70-73. Print.; U.S. Department of Energy

[3]Source: Business Insider October 12, 2016

Operators are notified only when conditions are beginning to go awry.

The continual measurements provide an immediate awareness and understanding of whether processes or equipment are running within previously established thresholds. If a process or piece of equipment is running as it should, processes can continue to run. But if measurements indicate that processes or equipment are heading toward a fault condition, operators can have advance notification. This allows them to decide if they should take corrective action, and ideally gives them some time to determine when it should be done.

to monitor their assets. In that sense, condition monitoring is an extension of automation that automates the process of caretaking.

While many companies already use some form of condition monitoring on high-end or marquis-level machines, the real benefit of this tool comes when applying it to day-to-day operations viewed as part and parcel to a process.

That means instrumenting ancillary, but still critical, pieces of equipment or processes that are often thought of as the "balance of plant." In many cases, these are supporting operations that, if allowed to fail, would bring production to a standstill.

For example, it might be the $50,000 feed pump motor driving pulp onto a paper platen at a paper mill. Should the motor fail, the entire mill shuts down, even though the larger mill is probably outfitted with multiple sensors of its own. Its viability can rest on the health of a feed pump designed to ensure that pulp gets fed to the paper machine properly.

In that sense, condition monitoring tools for balance of plant equipment or processes focus on current and future system health by taking critical measurements automatically via sensors. Examples include key process variables like machine vibration, air and hydraulic pressures, pH levels, temperatures, flow rates, current and liquid level. These measurements can be indicative of machine health as well as changes to proper machine function.

By placing sensors, receivers and dashboards in facilities to serve as the eyes and ears to a process and/or equipment, operations can continually monitor the state of processes and equipment in the background.

Determining the preset thresholds for each process or application is obviously a critical piece of the puzzle. What makes the methodology particularly valuable is when threshold levels establishing what's good and what isn't are set using the experienced, seasoned insights of maintenance engineers and operations staff. These individuals often are attuned to critical conditions like vibration patterns, temperatures, pressure ranges and other windows of suitable measurements. In most cases, they also can quantify these things. In this way, establishing thresholds based on "tribal knowledge" gives manufacturers an opportunity to leverage their earned insights in a whole new way.

A related capability is being able to track and then predict how

processes and equipment will behave by studying historical patterns in the measurements. Manufacturers already know that critical parameters can serve as leading indicators showing whether equipment or processes are beginning to break down. Condition monitoring illustrates those predictive insights because users have access to process histories and ongoing measurements as they accrue.

Exploiting this trending data in real time to manage processes is the essence of predictive maintenance because the changes in measurements or trends over time are actionable. Informed comparisons can show maintenance engineers exactly when a process begins to move from a level of concern to a hard failure.

For example, increasing vibration often can be the precursor to such events as a bearing starting to fail or a shaft that is progressively moving out of alignment. Therefore, vibration sensors can be deployed to create electronic signatures illustrating machine health. Maintenance engineers might know, for example, that every time vibration reaches a certain threshold, it signifies that the operation is two weeks away from needing to replace a key bearing. Incidentally, that's the sort of knowledge it might have taken the maintenance supervisor 20 years of experience to gain.

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Besides being able to predict failures and the upcoming need for maintenance, having the ability to manage and maintain processes by exception also allows factories to preserve resources, by predicting impending failures with time to spare. Having the ability to schedule service ahead of time versus calling in emergency service when a problem arises is much more cost effective.

Since there's a significant reduction in the need for preventive maintenance activities, facilities can allocate their resources and staff more efficiently. No longer must machines or processes be shut down and serviced, or parts replaced simply based upon so many hours having passed. This means productive uptime will increase, and system components can be used for more of their useful lives.

Condition monitoring also contributes improvements to environmental health and safety. Since condition monitoring is an automated process, it eliminates the need for technicians to take and record manual measurements in what may be hazardous, confined or hard-to-reach areas of an operation or process.

Finally, condition monitoring also can improve product quality and consistency from part to part. The use of windows of operation means fewer products are likely to be manufactured when conditions are out of tolerance. This not only eliminates rework, returns and dissatisfied customers, but also helps ensure that manufacturing output is right the first time, leading to greater productivity.

**Potential financial and cultural impacts of condition monitoring**

Facilities that implement condition monitoring will find many financial benefits from the process, beginning with reduced cost of goods sold. Being able to reduce the number of events in which a manufacturing process was allowed to run when it shouldn't have, reduces the need to scrap parts, perform rework and waste time and labor manufacturing defective parts. It also allows facilities to gain back countless hours of productive uptime, which translates to higher outputs.

One facility that experienced these gains first-hand was Parker's Chetek, Wisconsin, manufacturing facility, where the company manufacturers a few thousand different varieties of quick couplings.

Randy Larson, plant manager of the facility, said the operation realized productivity gains, reduced costs and increased peace of mind after adding condition monitoring in three separate areas of the plant: electroplating,machining and quality assurance.

In the electroplating process, sensors were installed to automatically measure the pH and conductivity of three plating baths every 15 minutes, rather than once or twice per shift as was the previous routine.

"The continuous remote condition monitoring tools provide the staff a real-time understanding of how the electroplating chemistry changes throughout the process, and operators are notified when measured values drop above or below control limits, giving them time to correct chemistries when it makes sense," Larson said.

The sensor readings are displayed on a large screen in the plating area, indicating real-time health of the plating process. Alarms sound and appear on the screen if one of the inputs begins to creep out of control.

Larson said the more frequent readings help to improve product quality and consistency, leading to increased productivity and peace of mind for the facility. Additionally, production operations can continue as sensor readings are being obtained and shared.

"We see value from a predictive point of view, where we can position this technology at key inputs of our process, and we are getting a better understanding of the process," he said. "The more we understand those inputs and keep them in control, the better the quality of the process."

*"We can take action before we experience downtime or have a larger failure."*

**— Randy Larson, Plant Manager**

Larson said the sensors and condition monitoring have helped reduce production scrap while increasing product quality and consistency.

"We can take action before we experience downtime or have a larger failure," he said.

Another benefit, Larson reported, is the productivity gains from not having to take plating bath measurements manually.

"Those people are working, instead of taking a half-hour to walk the entire line and take measurements," he said.

Ultimately, condition monitoring helped the facility significantly reduce its need to perform rework and to increase its first-pass yield from 60 percent before condition monitoring, to an impressive 99 percent today.

A related benefit has been significantly increased productivity overall. By eliminating excess rework, process engineers improved the productivity of the process by some 240 percent.

The Chetek facility also added condition monitoring to its machining operation, adding temperature sensors to one of six CNC machines.

"The machines would overheat and the machinist would notice it was impacting the quality of the parts, leading to faults and downtime," Larson said. "We needed to figure out what was causing this."

Previously, machine temperatures were not being monitored, so adding the sensor helped machinists to understand, predict and prevent machine overheating, Larson explained.

"It gives us an opportunity to plan when we need to address the problem, other than just waiting for it to go down. It adds a planning piece into our predictive maintenance program," Larson said.

The Chetek facility also added condition monitoring to a third area. Humidity sensors were installed on compressed air lines supplying the plant's sensitive testing equipment. In the past, moisture in the lines had impaired functionality of the testing equipment, to the point of causing damage. This problem is reduced significantly with the humidity sensor, Larson said.

Overall, productivity savings of condition monitoring have been significant.

"It's allowed us to grow with the amount of people we have, too," Larson said. "We can take on more work and we have productivity gains to offset that need."

At another Parker facility, operators found that using a few connected sensors in a clean room operation eliminated the need for time-intensive manual checks, which ultimately returned 26 hours of productive manufacturing capacity to the process over a year's time, resulting in operative gains that exceeded the cost of the sensors by a factor of ten.

Both are powerful examples which demonstrate that by employing condition monitoring tools, operations team members

can focus more on their core function, and less on the maintenance of their operations. Taking care of processes only when they need attention prevents wasted time, effort and materials.

An ancillary benefit of condition monitoring is eliminating the need for manual monitoring processes. This allows workers to be reallocated to more productive value-added activities. That could be worth thousands of dollars to a company if it means they can conduct more training, make process improvements or simply produce more products.

Using condition monitoring also allows factories to produce more parts without any increase in materials cost for the associated inventory. Because systems don't have to be shut down for maintenance or for manual record-taking, productive uptime is increased. The half-hour that used to be spent taking and recording measurements can now be spent on more productive activity.

Added up over a week, a month and a year, those gains can translate into significant numbers.

Companies that adopt condition monitoring also can expect increased morale, peace of mind and job satisfaction from their team members, as they deal with fewer pain points, fewer significant events and reduced stress when situations do arise. All levels of the plant benefit from better running operations, including those with responsibility for output, for maintenance operations, the manufacturing engineers who designed the processes, and front-line workers on the production floor.

In this way, condition monitoring ultimately helps manufacturing facilities improve the return on their operational business investments in the form of more productive output, lower maintenance costs, higher productivity and higher quality outputs.

For more information on how to implement predictive maintenance tools in your operation, visit **parker.com/conditionmonitoring**




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