Plotting The Quickest Route To Better Asset Maintenance

A variety of research indicates that industry loses 3 percent to 5 percent (and in some cases more) of productivity annually to unplanned shutdowns due to equipment failure. With all the data and connectivity available through today's Industrial Internet of Things (IIoT) technology and SCADA systems, water and wastewater treatment operations can reduce those losses significantly…if management is willing to consider and adopt proven strategic approaches.

What Are The Alternatives?

There are multiple methods to dealing with process equipment maintenance — ranging from benign neglect to proactive, predictive maintenance. Each approach has its own advantages and shortcomings in terms of costs and time-savings, and each can be appropriate in some, but not all, situations. The secret is matching the proper approaches to the right applications (Figure 1). This is especially true for production-critical rotating equipment (pumps and blowers) used in water treatment, water distribution, and wastewater treatment applications.

- **Reactive Maintenance (Run To Failure).** In one industry survey, nearly a quarter of respondents reported using this approach for more than 25 percent of all their assets. Waiting until a light bulb burns out before replacing it will typically have little negative impact on production and will save the high cost of scheduled replacement for bulbs that still have years

Strategy	Description	Asset Attributes	Car Analogy
Reactive	Run to failure, and then repair	Failure is unlikely, easily fixed/replaced, or non-critical	Radio
Preventive	Service in a fixed time or cycle interval	Probability of failure increases with asset use or time	Replace engine oil every 5,000 miles
Condition Monitoring	Alerts for bad trends or other rules-based logic using a single data value	Assets where a component failure cascades into big $ losses	Oil pressure, coolant temperature indicators
Predictive (PdM)	Equipment-specific algorithms or machine learning. Multivariable	Critical assets where unplanned downtime has business impact	Battery Management System in electric cars
Prescriptive	Model and knowledgebase identify an issue and what to do for repair	Complex assets requiring advanced skills	Dealership-level diagnostic equipment

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Figure 1. The availability of IIoT sensors, SCADA systems, and advanced analytical software are making it easier for water utilities to migrate through the maturity hierarchy from reactive maintenance to prescriptive maintenance.

of functional life in them. The same approach does not work with rotating equipment such as critical pumps and blowers whose failure can shut down water utility operations and for which emergency repairs can be prohibitively expensive.

- **Preventive Maintenance (Calendar-Based).** Approximately 45 percent of companies take this traditional calendar-scheduled approach for more than a quarter of their assets — even though research shows the relationship of failure patterns to time-based-degradation patterns only applies in about 18 percent of cases. Scheduled maintenance periods might be determined by average wear conditions, worst-case equipment-failure experiences, some other historic frame of reference, or equipment-manufacturer recommendations. The problem is that using this approach alone can still result in occasional equipment failures and unplanned downtime, even while it wastes significant parts-and-labor expense for planning and carrying out unnecessary 'preventive' maintenance on the majority of equipment. Worse yet, it can even introduce human error as a byproduct of inaccurate inspections or improper disassembly or assembly during unneeded physical interventions.

- **Condition-Based Maintenance.** With the ready availability of sensors and analytic equipment to monitor warning signs such as vibration, elevated operating temperatures, declining flow rates, etc., being able to service equipment only as conditions warrant can save time and money.

- **Predictive Maintenance.**

Predictive maintenance relies on instrument-based observations monitored in real time. By using equipment-specific real-time data instead of estimated averages, the system can track the progression of deterioration as it occurs, compare it to known performance characteristics, and predict the most cost-effective time to perform a maintenance intervention before functional failure (Figure 2). While the concept of predictive maintenance is logical — built on condition-based inputs correlated to historical experience — it is not realistic to expect to switch seamlessly from a long-term scheduled-maintenance approach to a fully automated approach driven by a 'black box.' Making the transition to a predictive-maintenance approach based on analytical feedback from scores of sensors installed throughout the process can raise some concerns (and even resistance) among experienced plant-maintenance

workers accustomed to trusting their own experiences and insights. Consider transitioning to a predictive-maintenance/asset-management approach that can complement historical perspective and allow for human consensus and intervention if needed in exceptional situations.

- **Prescriptive Maintenance.** With the growing availability of machine learning and artificial intelligence (AI), organizations can now implement systems that take this one step further by analyzing the implications of certain equipment conditions and initiating an appropriate course of action based on related impacts and opportunities.

  Successfully changing any strategic approach to equipment maintenance will benefit most from being part of a holistic shift in the organizational cultural and its view of asset management. That can take some time but can be a worthwhile investment
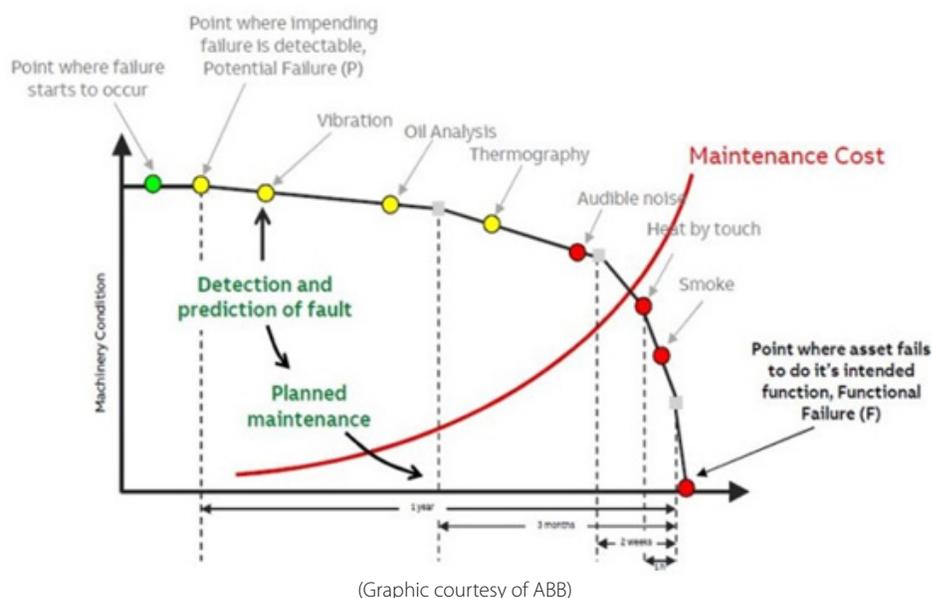

(Graphic courtesy of ABB)

Figure 2. Building on a known progression of equipment deterioration, predictive maintenance can alert maintenance workers before declining operation becomes an emergency — regardless of whether that decline is typical, accelerated, or extended. This helps in preventing unexpected downtime and in optimizing scheduled maintenance and maintenance costs vs. emergency repair or replacement.

in terms of reducing lost productivity and cutting wasted maintenance costs and efforts (Figure 3).

Charting Progress In The Real World

While predictive maintenance is starting to make its way into the water industry, there are many applications with similar rotating equipment requirements that have demonstrated the value of taking a more analytical approach to maintenance cost-effectiveness and downtime prevention:

- **Rotating Equipment Maintenance.** In one example of a public utility making the switch from hours-based maintenance to condition-based predictive maintenance, 33 of their facilities encompassing 100 units of rotating equipment showed success in three major areas:

  1. **Reducing Unplanned Failures**
  2. **Enabling More Efficient Planned-Maintenance Practices**
  3. **Increasing Plant Productivity and Saving On Fleet Maintenance Costs**

  To achieve those results, the organization analyzed more than 190,000 signals from approximately 800 digital asset modules. While this user was a hydroelectric power generation utility, the concepts proven there, the types of work, and the documented savings are relatable to comparable rotating equipment applications for
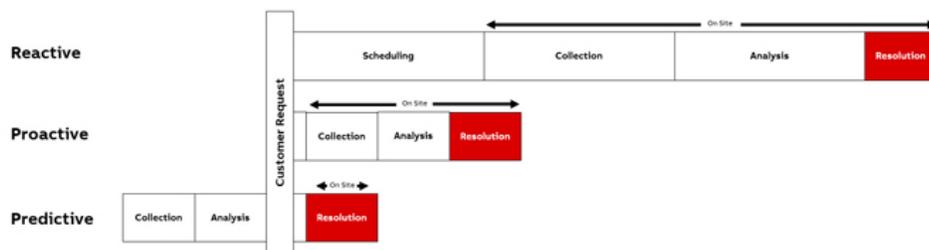
(Graphic courtesy of ABB)

Figure 3. Employing a collaborative approach to predictive maintenance takes advantage of continuously collecting and analyzing data before equipment issues arise, so alarm conditions can be addressed and onsite resolution can be delivered more quickly and cost effectively.

water treatment and distribution or wastewater collection and treatment.

- **Honing Maintenance Effectiveness**. One chemical process industry implemented a predictive-maintenance regime that involved looking at more than 100 different control loops within the plant. They took advantage of a collaborative operations environment with the predictive-maintenance system supplier to use the supplier's experience in analyzing those control loops and to understand how to deploy maintenance based on that data. As a result, they were able to reduce operating expenses (OPEX) by more than 20 percent, improve the speed of problem-solving thanks to 24/7 visualization, and save 35 days of analysis time per year.

  Another chemical company is using wireless sensors on its rotating equipment to optimize a fleet of 60,000 assets at a plant where 80 percent of maintenance issues were historically caused

by that type of equipment. As a result, they have reduced unexpected failures, increased production efficiency, and minimized operational costs.

- **Improving Utility Efficiency.** One multifaceted utility proved that it is possible to employ multiple alarm limits and use them to intervene before the situation becomes critical. As a result, their water operators can prioritize and work more actively with issue prevention — a key to leak detection where losses have been reduced from 33 percent to 20 percent so far as part of a continuous improvement loop. Centralized long-term data storage facilitates support at every level in the organization. Important data is readily available throughout the organization, and improved quality and efficiency are achieved through collaboration. Now, instead of spending time on maintenance, the utility can concentrate on fine-tuning the installation and providing even better and more consistent water quality. ■