Plant Services

SPECIAL REPORT

The Industrial Internet of Things for Maintenance

Photo by Brice Milleson, Cinematographer, ABB Service

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RxM: What is prescriptive maintenance, and how soon will you need it?

Early adopters are exploring how outcome-focused approaches to maintenance can enhance asset management.

By Sheila Kennedy, contributing editor

Don't just predict problems – prescribe a solution. That's the premise behind prescriptive maintenance, which as a concept goes hand-in-hand with prescriptive analytics. Odds are you'll be hearing these new buzzwords a lot more often in the coming months and years. But what is prescriptive maintenance, really? How does it work? And maybe of most importance, what can it achieve that other models can't?

First, to better differentiate the words prescriptive and predictive, the word "prescriptive" here will be used interchangeably with "Rx."

Rx maintenance is unique in that instead of just predicting impending failure, as predictive maintenance (PdM) does, it strives to produce outcome-focused recommendations for operations and maintenance from the Rx analytics. Though RxM is still in its infancy, many thought leaders are considering its potential to become the next level of reliability and maintenance best practice.

ANALYSTS DEFINE RX STRATEGIES

One of the earlier voices on prescriptive maintenance was Dan Miklovic, principal analyst at LNS Research (www.lnsresearch.com). "No longer will you need an ensemble of experts to tell you how and when to maintain your assets, as the assets themselves will tell you what they need if they are unable to fix themselves," wrote Miklovic in a May 2016 blog post, "What Comes After Predictive Maintenance?"

He suggested the acronym RxM at that time, and he continues to research the topic (see Figure 1). Better and more data, coupled with Big Data tools that can interpret things such as the content of repair manuals, is the key to unlocking the concept of RxM, Miklovic says today.

It starts with prescriptive analytics, which not only tells you that a problem is likely to emerge, but also it gives you multiple response scenarios from which to choose. "Let's say a piece of equipment is showing increasing bearing temperature," Miklovic explains. "Predictive analytics looks at the temperature profile and tells you it is likely to fail in X amount of time. On the other hand, prescriptive analytics tells you that if you slow the equipment down by Y%, the time to failure can be doubled, putting you within the already scheduled maintenance window and revealing whether you can still meet planned production requirements."

Another early follower of this trend is Ralph Rio, vice president of en-

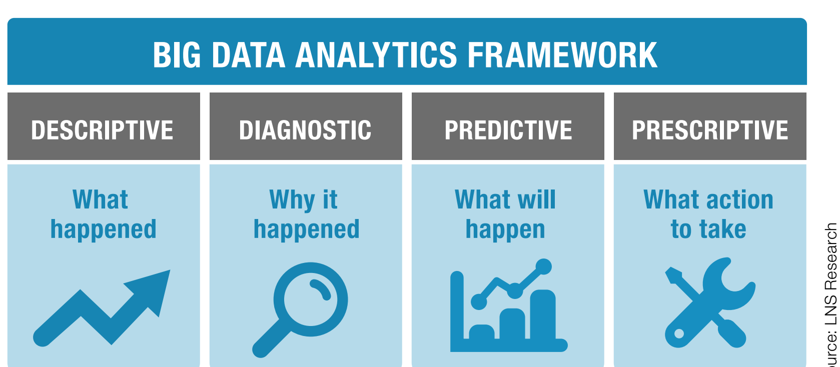


Figure 1. Better and more data, coupled with the use of Big Data tools, is the key to unlocking RxM.

terprise software at ARC Advisory Group (www.arcweb.com). "From my experience with clients from both the user and supplier side, the dominant application right now is PdM – prescriptive maintenance is beyond that; it's new thought leadership," he says. "But the goals of PdM and prescriptive maintenance are similar: to reduce unplanned downtime, which causes lost revenues, materials, and labor."

To help clients better differentiate the newer approaches from conventional maintenance strategies, Rio developed the Asset Performance Management Maturity Model (see Figure 2). The upper tiers of maintenance maturity – predictive and prescriptive maintenance – are both multivariate approaches. The current in a pump's motor drive, the fluid going into the pump, its temperature, and the pressure going in and out can all be combined to better assess the health of the pump and motor, so you get longer advance warning of a failure and can make changes during a planned shutdown, he explains. The industrial internet of things (IIoT) provides the data, and analytics generate the alerts.

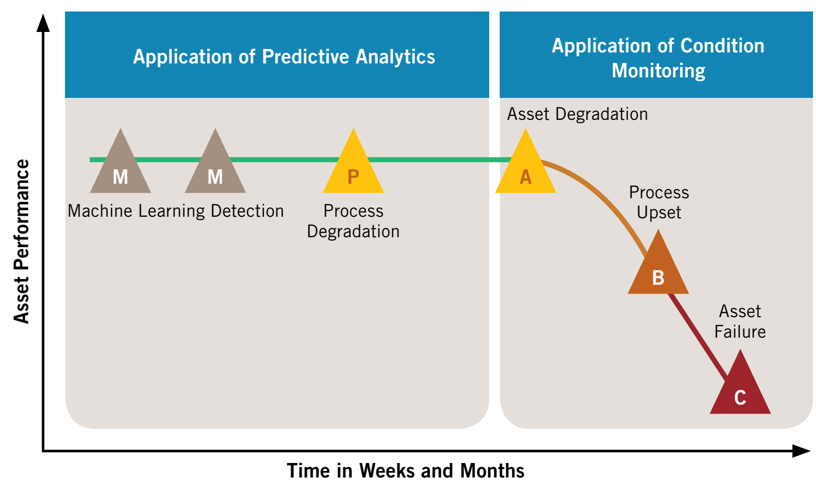
Prescriptive maintenance adds the ability to give advice to the technician on what to do and how to do the repair by taking advantage of artificial intelligence (AI)

Higher

Strategy	Car Analogy
Prescriptive	Dealership-level diagnostic equipment
Predictive	Battery Management System in electric cars
Condition Based	Oil pressure, coolant temp. indicators
Preventive	Replace engine oil every 5,000 miles
Reactive	Radio

Source: ARC Advisory Group

Figure 2. Asset Performance Management Maturity Model with IIoT



Source: ARC Advisory Group

Figure 3. Machine learning is integral to the way data is processed that allows algorithms to find looming failures.

and machine learning. The math algorithms are more detailed, and there's some intelligence added to give the technician some direction.

The three lower tiers of Rio's model include single-variable condition-based maintenance, which provides less advance notice of failure; time- or cycle-based preventive maintenance, which is inefficient compared with higher-level models; and reactive maintenance, which occurs after failure. There is still a place for each of these approaches for certain assets that are not critical to operations or safety, Rio notes.

Peter Reynolds, contributing analyst at ARC Advisory Group, notes that organizations that shift critical assets to prescriptive approaches are seeing significant improvements in maintenance costs, service costs, plant availability, and worker efficiency.

The unique abilities of analytics platforms make them capable of ingesting multiple data sources and storing, processing, contextualizing, and visualizing the predictions, he says. Machine learning is integral to the way data is processed, allowing algorithms to find looming failures (see Figure 3).

"Machine learning detection occurs by using automated collection of historical multivariate data and analysis with equipment-specific algorithms," Reynolds explains. "Pattern identification points to an explicit diagnosis of root cause and indicates a precise action to change an outcome. Prescriptive advice would include altering the process operation to avoid a future failure of the asset."

COMMON DRIVERS OF PRESCRIPTIVE APPROACHES

Several key business drivers are spurring interest in Rx strategies and driving solution development.

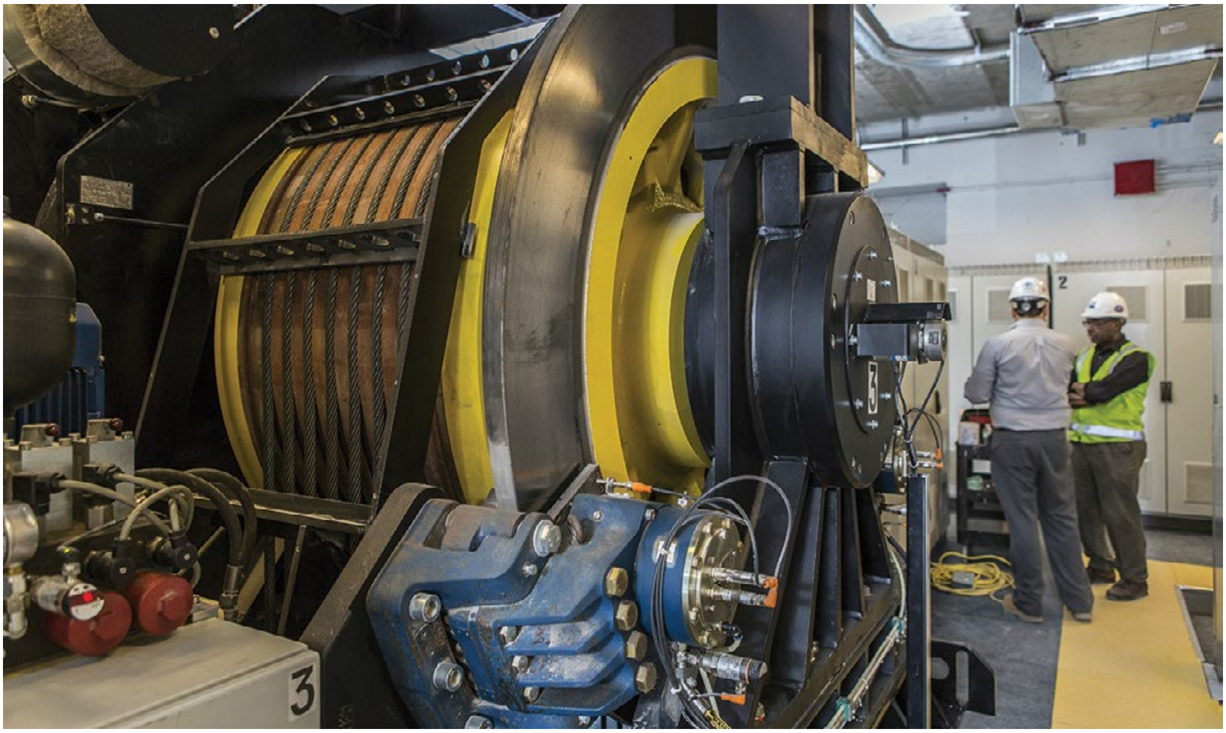
- Automation: As more automation is used in manufacturing, the speed of response required in dealing with maintenance issues is going to get faster, says LNS Research's Miklovic.
- Economics: Decisions as to what's the best option from an economic standpoint are getting more complex. "It just isn't enough to know what can fail or when it might fail," Miklovic says. "It requires having enough information to understand the options for maintenance as well as the financial implications of each option."
- Workforce changes: Older workers are retiring, and newer, younger workers expect smart, assistive tools to help them do their job. Miklovic observes that the value in Google Directions is it gives users options and predicts times based on current conditions. He believes maintenance activities should be the same: For instance, to service a piece of equipment with an overheating bearing, you could either (a) take 20 minutes and grease it, and the repair would probably last two days, or (b) replace the bearing, which would take three hours but last for two years.
- Operating conditions: Assets not only fail by their own means, but also by the manner in which they are operated, notes ARC Advisory Group's Reynolds. For example, a pump manufacturer will recommend specific operating design conditions such as discharge pressure and temperature, but there is a lot of variability in process operating conditions and also in the composition of the fluids. Prescriptive analytics can consider these conditions and make recommendations accordingly.
- Asset performance: Reynolds believes a higher level of sophistication is required in the way asset and process data are organized. "The traditional plant historian and analysis tools have not been adequate for ensuring asset performance," he says. "IIoT and analytics platforms are unique in their ability to ingest years of operational data and massive quantities of unconventional data scattered through different systems of record."

EARLY ADOPTERS ARE ASSESSING THE VALUE

Elevator OEM and maintenance service provider thyssenkrupp Elevator (www.thyssenkruppelevator.com) favors cutting-edge maintenance strategies. Rory Smith, director of strategic development for the Americas at the company, says that at its core, prescriptive maintenance allows thyssenkrupp Elevator to focus on servicing elevators in the most efficient ways possible to increase uptime. Machine learning allows the use of data from the company's vast network of elevators to better identify the service tasks most critical to maintaining a safe and reliable elevator.

"thyssenkrupp Elevator has a team of data scientists and domain experts working in unison to develop predictive models," says Smith. "These models inform our service program, and paired with our network of skilled service technicians, are ultimately responsible for maintaining elevator uptime for our customers."

The company's predictive model continues to evolve thanks to machine learning, but it can already predict five days in advance when an elevator will shut down because of a door problem (see Figure 4).



Source: thyssenkrupp Elevator

Figure 4. Machine learning allows algorithms to find looming failures in assets like this elevator motor.

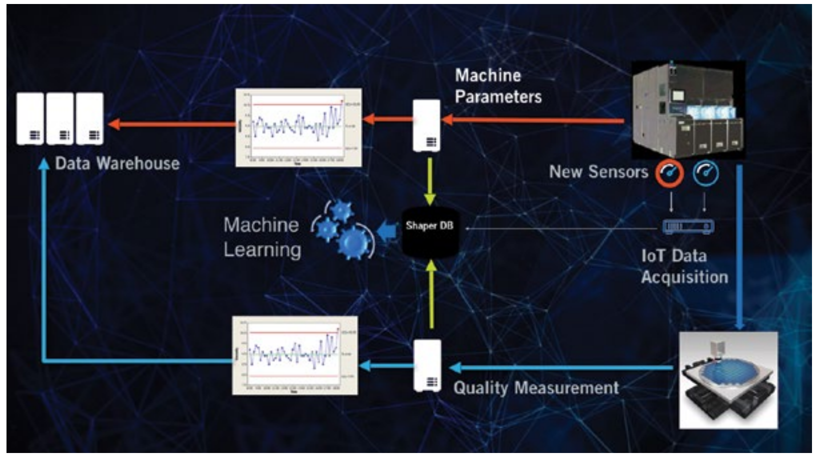
This early warning has proved to be highly accurate with no false positives, making it therefore invaluable to thyssenkrupp customers, Smith says.

"With MAX, our PdM IoT solution, our computing power takes this a step further," he adds. "Even before a service technician arrives on site, the expert system we refer to as 'The Coach' advises the technician on the four most likely causes of the problem, based on the data, with 90% accuracy. This means thyssenkrupp technicians can fix an issue on the first visit more than 90% of the time. The industry average for initial diagnosing is about half that," he says.

Intel prides itself on being at the forefront of research, development, and deployment of advanced technology for manufacturing, including frameworks to support prescriptive analytics (see Figure 5). Often, proofs of concepts are deployed in Intel Fabs (fabrication plants) to help meet the demands of a manufacturing environment that requires precision manufacturing to atomic-level specifications in a completely sanitary environment.

"Intel made the journey to PdM decades ago," explains Mary Bunzel, general manager, manufacturing and industrial solutions at Intel (www.intel.com). "There are many examples of solutions we've developed with our partners being deployed in both our facilities and in our partners' customer sites." She adds, "Evolving to prescriptive maintenance, where probable cause and automated maintenance are implemented, is a necessary next step in the Industry 4.0 journey in order to keep up with the demands of fast-paced change in our market."

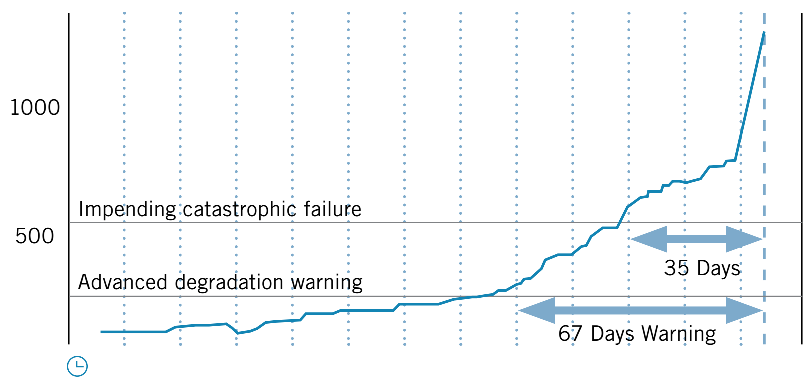
A specific example of one such case study is a project recently implemented in Intel's Ireland Fab plant, which addressed conservation of energy used to cool water for the production facilities. "By integrating sensed data from the outside ambient temperatures for areas the pipelines travel through, with the water temperature, the amount of energy used to cool the water has been reduced by as much as 40%," says Bunzel. Energy conservation is a key imperative for Intel, so the return on investment (ROI) is far greater than just monetary savings alone, she adds.



Source: Intel

Figure 5. Evolving to prescriptive maintenance is a necessary next step in the Industry 4.0 journey.

AI technology specialist Spark-Cognition is helping a wind turbine operator incorporate prescriptive analytics into its maintenance routine. "Because of the thin margins facing the wind industry today, turbines must be running at maximum capacity to get a full payback, and any amount of downtime cuts significantly into profits," says Stuart Gillen, a senior director at SparkCognition (www.sparkcognition.com).



Source: SparkCognition

Figure 6. A wind turbine operator is incorporating prescriptive analytics into its maintenance routine.

SparkCognition and its customers leverage data that is already available yet in many cases unused. Utilizing AI techniques, SparkCognition's system is able to find patterns in large data sets that point to eventual failure. These identifying patterns can then be tracked and/or monitored and provide early warning evidence to subject matter experts, operators, management, etc., for work planning.

These systems are also able to incorporate unstructured data, such as work orders, parts databases, and operational and technical manuals, to provide a true prescriptive view. "Not only is the user now able to understand something is going to fail, but they are provided with evidence about how to address the problem. This provides dramatic savings to operators," explains Gillen.

For example, for a single component on a single wind turbine, SparkCognition conservatively estimates the following annual cost savings from AI:

- Downtime savings: $1,000
- O&M savings: $2,500
- Total savings: $3,500

The wind turbine operator's savings are expected to rise significantly from continued machine learning and also from the identification of more components for monitoring over time (see Figure 6).

RECOMMENDATIONS TO ASSET USERS AND SUPPLIERS

The market will determine whether Rx maintenance will become the ultimate best practice for reliability and maintenance, but those following the model closely are encouraging its adoption.

"Start now," says Gillen. "What we are seeing across many industries is with very few sensors, which are typically already installed, information can be discovered leading to dramatic cost savings."

RxM isn't needed for every asset. It should be used where it makes sense, i.e. where the asset is critical to production (volume, quality, etc.) or to safety, suggests LNS Research's Miklovic.

ARC Advisory Group's Rio recommends using PdM on all of your critical assets because the predictive approach's ROI has already been proved, and PdM has become less expensive and more sustainable with IIoT. He also encourages the supplier and user communities to do pilot programs to flesh out prescriptive technology.

"There is not a barrier to prescriptive from the technology viewpoint," says Rio. "The next step is really to understand how the technology would be melded into products and designed in a fashion that can be applied by end users and deliver ROI."

Rio advises that to facilitate this effort, organizations should engage with a global service provider that already has all of the necessary IIoT technology skills available to it, in particular those pertaining to industrial automation, DCS and PLC systems, data historians, networking, the cloud, and security. ◻

Why the new automation revolution is different – and how to profit from it

A Q&A with ABB's Richard Windis-chhofer

☐ The smart data-collection technologies that are facilitating predictive and now prescriptive maintenance are compelling, to be sure. The ability to integrate real-time data from multiple sources, including both inanimate and human assets around a facility, and add in context gleaned from historical data, can pave the way for significant savings by avoiding unplanned downtime and safety incidents. But these technologies are worth little to a plant unless it has a collaborative team of personnel, supported by a well-designed interface, dedicated to implementing and supporting these technologies. So says Richard Windischhofer, a senior vice president in ABB's industrial automation division.

"It is a lot more about people than about technology," Windischhofer said in a recent interview with Plant Services. Windischhofer, who spent the past five years working on the digital transformation of ABB's marine business unit, talked with Plant Services, about what he sees as key factors for success in the digitization of industrial businesses.

PS: What were some of the things you learned in the marine transformation that you're applying as you work on the other sectors?

First, you have to really believe in this, because digital transformation of an industrial business, in which you actually digitize the core of the company, is not about building an app that you can load on your phone. It's not that easy. It requires the really heavy lifting of change management. That's why you can only do it if you never give up, if you understand the business, if you're close to customers, and you just keep going.

PS: Would you say it is as much a people issue as a technology issue?

RW: Absolutely. Technology companies such as ours usually lead technology development from the technology management perspective. One of the changes from the marine business unit was that we created a business-led technology development approach. We had the people who manage the business, who work with the customer every day, say what needs to be developed. That's a big cultural change, since technology always has been the higher authority in companies such as ours.

PS: Digital transformation is the way the industry is going. Sometimes there's still a sense that it's an all-or-nothing proposition or that IoT is too big or vague of a concept to grasp. How do you sell people on the value proposition of digital transformation, and what do you tell people about how to get started?

RW: Let's look at it this way: If you are already running a plant, 10 or 20 years ago, you invested in automation. You automated how your plant operates. Then after that, you bought yourself an ERP system, and you started to manage and digitize a lot of your administrative processes. Both of these investments are tactical. You do this once, you implement it, and then you're running with it.

The big change that's happening now is when you invested in automation in your plant, you suddenly got 20% or 50% more out of the plant. And then when you invested in the SAP, you got 10%, 20% more out of your administration, and you could run a bigger company. But now the next change, digitalization, is not that easy.

It's not about collecting the maximum amount of data to make you better. You have to realize that today's digitalization investment is a piggy bank. You now collect all of the information that's important from your automation systems that you invested in 20 years ago. You're going to take some information from your ERP system that you implemented 10 years ago. You're going to combine that data, and you're going to find things you need to fix in your facility. You're going to find a lot of things you need to fix, and then you will prioritize what you need to fix. What are your low-hanging fruits that are going to pay back within three months? This is easier to do, compared to a $10 million capital investment that has a much longer payback, or may not even pay back.

That's what I mean by piggy bank. It's many small things that if you do them, it makes you a lot better, and at the end of the year, you're going to have $20 million saved that has been $200,000 here, $100,000 there, $300,000 over there. This is a big change, because companies have believed for a long time that we just buy, we invest, and then we're going to be better, like in the old days. It's not like that anymore. You have to be very focused with the data you collect, how you analyze it, and then you have to work together with the experts to really make something happen.

PS: Have you seen any kind of "ah-ha" moments where people suddenly "get it" or see how their company's efforts and investments are paying off?

Quite many, actually. I'll give you one example. We had been working for a couple of years with one of the largest shipping companies in the maritime industry, and they had installed software on their ships that monitors the captain and how fast the captain goes with the ship. And then they would say, "Hey, you have to go slower," or, "You have to stop because there's a storm coming." The captains wouldn't listen, because in the office there was someone sitting with an IT background, perhaps, telling a proud captain, "Hey, stop the vessel." The captain doesn't want to listen.

So they said, "OK, let's change this." They made a rotation where they took a different captain every month from the fleet to sit in the control center, and then he's telling his colleagues, his peers, "A storm's coming; you've got to stop." Or, "You need to go faster; you're coming into heavy weather." And with this rotation, because the person telling them this was another captain, suddenly, they really got the change happening.

When we talk about software and services, we actually talk about change and implementation. And for that, you have to try new things. And if it doesn't work, you have to try another solution, to see if it works. Eventually, you will find the solution that works, but it's all about change management – being willing to change the old ways of doing things. □

Value-based predictive notification improves production and performance.

How predictive notification keeps production on track.

By Dave Biros, Kevin Starr, and Patrik Boo

☐ Notifications are ubiquitous. Our smartphones receive notifications from apps informing us about appointments, software up-dates or even stock performances. We clearly think that notifications make our lives better. Why, then, aren't notifications used routinely to improve industrial processes? Because notifications tell us what has already happened. In an industrial setting, that could be a costly equipment failure. What if we could accurately predict what will happen and send notification with enough time to act to avoid negative events and exploit positive ones?

At ABB, technology-enabled services use predictive notification in a value-based service strategy for industrial producers. Our experts evaluate predictive notifications, identify problems and develop predictive maintenance programs based on value to deliver optimal advanced services in real-life industrial settings. Predictive notification with the right people in the right place protects and enhances production, equipment availability, process performance and product quality.

HISTORICAL PERSPECTIVE ON PREDICTIVE STRATEGIES

At ABB, we recognize that proactive service strategies with predictive notifications would be valuable to producers. Not only can failure be avoided and equipment maintenance improved, the addition of a value-based predictive notification program improves industrial processes. ABB experts have evaluated the problems with predictive in the past.

Indicative strategies developed in the 1950s and '60s are still used today, such as when bolt-on machinery and software measure properties online to enable more and better products to be produced faster.

The earliest predictive control algorithms were developed during the 1970s and '80s, setting the stage for software to eliminate the need for physical measurements. The resulting capabilities translate to a level of sophistication and sensitivity impractical for use beyond academia.

A practical yet expensive predictive method, condition monitoring, developed in the 1980s and '90s, detects impending equipment failures and notifies personnel to act. This is, however, expensive to deploy.

Today, industrial producers contract with companies to regularly come on-site, make measurements and ensure that mechanics operate within set ranges. Although cost-effective, this strategy does not eliminate catastrophic failures, which occur between service visits.

Suppliers also face the problem of a loss of talent. Cost pressures lead producers to reduce process engineering staff. In advanced economies, many experts are approaching retirement. For service strategies to be successful, expertise must be maintained.

A final roadblock to predictive notification is the reluctance to use remote-enabled technologies in industrial settings. Producers, fearing that someone could induce failure, are hesitant to allow remote connection to process control systems. Improvements in secure communications and cyber-security safeguards reduce apprehension, yet industrial producers remain reluctant.

THE PATH TO PREDICTIVE

At ABB, we developed a stepwise approach to achieve effective application of predictive notification with these challenges in mind. First, choose the equipment or processes for which you want to predict conditions. Secondly, expedite expertise through identification, sorting and prioritizing of problems to provide guidance. Finally, evaluate the value of digital services, which maximizes ease and value of improving equipment services and processes.

- Choose what to predict: A producer must select the specific facility's equipment and processes for which to receive predictive notifications. A criticality analysis of equipment and processes will determine what could happen if something went wrong and how that would adversely affect plant performance. A criticality ranking is applied to equipment or processes, varying from biggest safety impact, production or cost to those with the least.

- Expedite expertise: Many producers contract for condition monitoring, which means expertise depends on the person providing the service. Knowing how to capture experts' knowledge and deploy it in easy, repeatable ways leads to effective completion of time-consuming elements of the job.

- Evaluate the value: Primary value areas were identified in a sample of 111 industrial producers located in North America, South America, Europe, Asia, The Middle East, and Australia and comprising a variety of processes (cement, chemicals, mining, metals, gas and oil). ABB identified and measured the value delivered by digital services, including predictive notification.

DIGITAL SERVICES VALUES

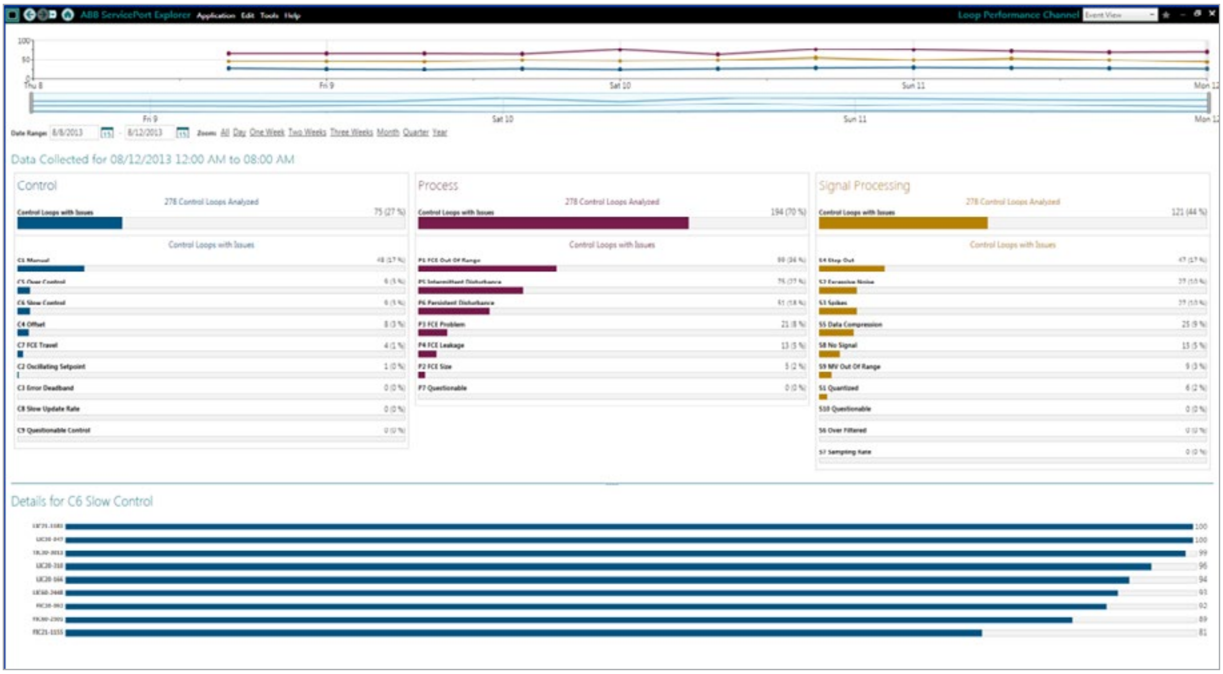
Engineering efficiency: The goal is to reduce diagnostic troubleshooting time by gathering and processing high volumes of production data. Value is reached by performing diagnostics faster. The value is easily understood by producers, yet returns are lower than those of other values.

Incident identification: Rapid identification of incidents such as equipment failures through automatic analysis of high volumes of data. Producers easily recognize the value of this service, characterized by a moderate return, and yet it is more difficult to achieve than other values. ABB collects and categorizes the data into key performance indicators (KPIs). The KPIs are tracked using main indicator bars that increase as the subset bars increase, representing prioritized collections of discrete events that need attention.

Focused implementation on equipment: Values are obtained from improving equipment performance to identify an improvement opportunity, then performing an enhancement quickly and efficiently, resulting in a high return. Delivery of this value can be complex, but original equipment manufacturers (OEMs) can usually achieve this value relatively easily.

Focused implementation on the process: The aim is to optimize production, quality, or cost to produce results. The value derives from using services to identify improvement opportunities and assigning the right skill to deliver services to improve performance. The value can be complex to deliver yet has a high return. This is the hardest value to achieve and is realized by a smaller population of producers.

Predictive notification: The goal is to expeditiously analyze, identify and categorize discrete events to produce



Prioritized display of KPIs to guide corrective actions

patterns that predict failures, then alert personnel to take action rapidly. This value has moderate complexity and yields a high return.

Focused implementation on equipment and focused implementation on processes rely on information delivered through predictive notification. These three service strategies address the overall equipment or process design, or maintenance path, to avoid repetition of negative events, optimizing equipment and process availability.

ABB's assessment shows that providing a predictive notification to personnel, with a recommended action, results in an action taken. The beauty of implementing these service strategies together is that the response will likely produce a high value.

CASE STUDY

A plant in the United States manufactures products for food and beverage consumption, relying on quality. The plant uses Quality Control Systems (QCS) to operate machines and advanced digital services for early detection of potential QCS issues. Predictive notifications are provided to help the plant identify and mitigate problems that could cost millions of dollars in production.

Application

The digital services utilized by this plant automatically gather and analyze data from the QCS, present views of KPIs that help identify variables that impede productivity, and provide recommendations for action. These services identify, categorize and prioritize opportunities to improve equipment availability, process performance and product quality through visualization and analysis of instrument stability, control utilization and process variability. Service engineers address problems on-site and remotely.

Users view, analyze and scan data to produce a summary of KPIs ranked by severity; events are tracked, by setting parameters for KPIs that create customized

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Channel: QCS Sensor Performance Channel
Rule Trigger Time: 2/10/2015 4:16:17 AM
Rule Priority: High
Number of times rule triggered: 2
Rule Name: Precoater Gap Status
Rule Description: Status_Out of Range on AirColumn_Hourly_KPI/ was above 0 (actual value was 50)

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Rule Trigger Time: 2/10/2015 4:16:16 AM
Rule Priority: High
Number of times rule triggered: 2
Rule Name: Innercoat Moisture Status
Rule Description: Status_Out of Range on Moisture_Hourly_KPI/ was above 0 (actual value was 50)

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Rule Priority: High
Number of times rule triggered: 73
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Example of predictive notification

displays of occurrences that fall outside parameters. KPIs that track outside predetermined parameters trigger predictive notifications.

Notification

Service engineers track KPIs by setting predictive notification parameters that notify if an instrument reading exceeds parameters. An engineer at this site received a predictive notification before arriving at work one day, alerting him that the threshold for an instrument had been exceeded.

Once at the plant, the engineer investigated the issue using data views. A large bar in a Pareto chart on the display confirmed that instrument limits had been exceeded. The engineer studied the raw data view and the severity levels to verify the extent of the problem and determined the necessary action to avoid downtime. The replacement of an instrument was scheduled during a planned outage.

Mitigation

An emergency instrument replacement would have led to lost production, a costly event. The action taken by the engineer after receiving the predictive notification mitigated quality losses and unscheduled downtime of more than $100,000. The plant continued to have high equipment availability, stable processes and good quality.

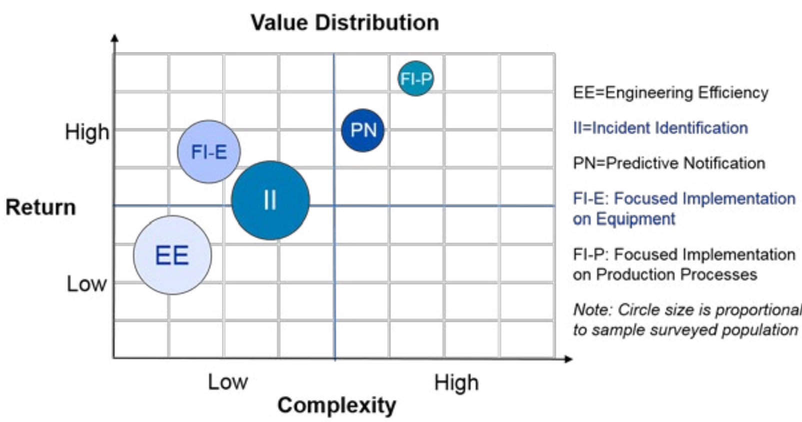
PREPARING A PREDICTIVE PROGRAM

ABB established a technology-enabled predictive notification step-wise program to successfully deliver advanced services that improve equipment availability, plant performance and product quality:

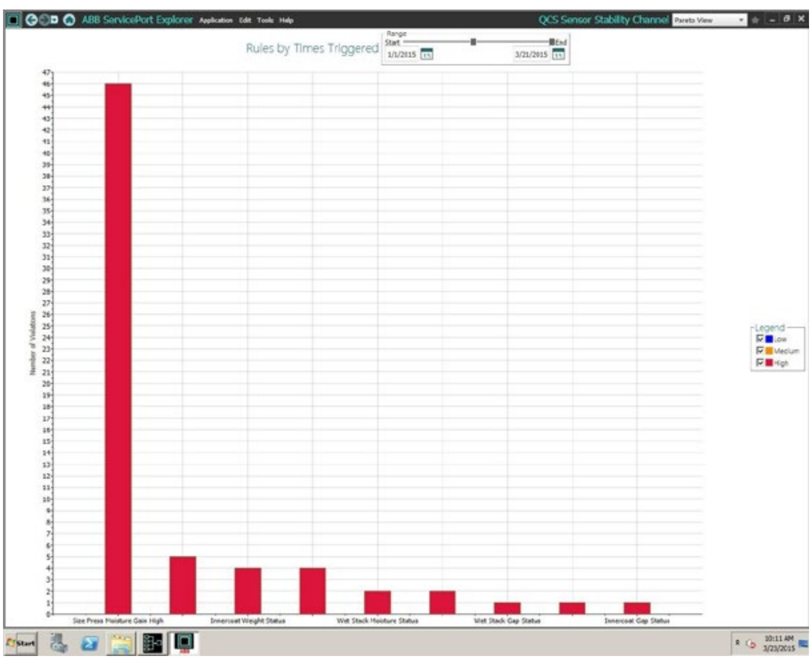
- Agree that equipment or process issues can be avoided or exploited accurately and cost-effectively with digital services. No value can be achieved if a producer does not believe problems can be mitigated through digital services.

- Use best-in-class technology to effectively identify, categorize and prioritize issues. Suppliers have different capabilities and specializations such as equipment areas, production or business processes, and industry equipment. Producers must identify suppliers who can provide the best technology and applications for the plant's equipment and business processes.

- Involve an expert to review findings to ensure that preparation is on track. Producers should have access to experts who are knowledgeable and experienced. They ensure that value-added KPIs are used to develop effective predictive notifications. For many, this knowledge can be found among OEMs.



Predictive notification represents high value opportunity



Predictive Notification prompted immediate action on serious issue noted in Pareto

- Agree on actionable items using the technology and technician. Once the best available technology and the most value-added KPIs are chosen, agree on actions to take when parameters are exceeded. Producers should collaborate with those who will take actions to ensure commonalities.
- Create an action plan to address the agreed-upon actions that can be taken quickly and efficiently when parameters are exceeded and predictive notification is sent. Determine who will act, what will be done, where it will be done, where the tools and/or parts are, and when the action will occur. The action will be taken.
- Set up predictive notification rules. Use the analyses, issues, processes, and KPIs, and establish thresholds that will drive the action.

Digital services are the most effective form of delivering advanced expertise in today's production environments. Predictive notification of impending issues provides producers with the primary value opportunity to improve equipment availability, process performance and product quality. Nonetheless, even the best digital services and predictive notification are only meaningful if the right people in the right place receive the notifications and act. Only then can digital services and predictive notifications truly make our lives better. □

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