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Maintaining the IIoT

How the IIoT is delivering on the promise of asset performance management

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Executive summary

The increased complexity of connected assets, as emerging from the advancement of the Industrial Internet of Things (IIoT), presents new challenges to the industrial maintenance organization. At the same time, however, it is providing an unprecedented wealth of operating data that can heighten maintenance productivity and reduce costs. Realizing this potential to optimize assets will require edge control devices with more flexibility, power, and connectivity, as well as the ability to protect themselves against cyber threats.

Logging on

If you had researched the Industrial Internet of Things online in the mid-1990s, there might have been a handful of results. But if you searched on terms like asset performance management, predictive maintenance, and computerized maintenance management, you would have found thousands of entries. While such maintenance automation is finally gaining a foothold in industry, realizing its full potential has been hampered by limited access to the contextual data related to things like system wear and performance degradation. As more industrial devices gain intelligence and Internet connectivity, however, their data histories are increasingly exposed, offering advanced maintenance applications a richer supply of data for analysis. And all indications are that the number of digitally-enabled industrial devices is growing dramatically.

CISCO,[1] projects that more than 50 billion things will be connected to the internet by 2020, resulting in more traffic, more data, more storage, and more energy consumption. Looking at this from and industrial perspective, IHS reports that only 9.1 percent of the more than 23.8 billion process and discrete automation elements are currently networked, but the compound annual growth rate of such deployments will increase to 24.1 percent in 2019.[2]

As an example of how increasing digitization might improve plant operations, Schneider Electric senior vice president for strategy Greg Conary points to improved communications between drives and pumps: “Pumps are typically dumb assets. They turn based on the amount of electricity supplied to them. But if you can embed the pump operating curve into a drive, when it sends electricity down into the pump, it knows how fast the pump should be turning and if it doesn’t fit the profile it can contact someone to find out why,” he said. Increasing digitization of this sort will impact maintenance at all levels. As defined by ARC Advisory group, (Table 1) these include reactive, preventive, predictive, and prescriptive maintenance practices.[3]

As ARC estimates, unscheduled downtime can approach zero when prescriptive strategies are applied. Predictive strategies can deliver twice the cost benefits of preventive strategies, and, in comparison to preventive strategies, reactive maintenance could increase lifecycle maintenance costs by a factor of 10 when a failure occurs. ARC sees IIoT offering new opportunities for asset performance improvement by combining the growing wealth of data with advance analytics.

Table 1

Approach	Method	Application	Cost/Benefit
Reactive	Run to failure, and then repair	Failure is unlikely, easily fixed and/or non-critical	10X plus when failure occurs
Preventive	Service in a fixed time or cycle interval	Probability of failure increases with asset use	2X maintenance costs
Predictive	Monitor a single process data value for bad trends and alert prior to failure	Assets with random or unpredictable failure pattern	1X maintenance costs
Prescriptive	Multiple variables with engineered algorithms and/or machine learning	Longer range prediction of failure with high confidence	Unscheduled downtime approaches zero

Asset Management Maintenance Strategies

Improving productivity of reactive maintenance

Reactive maintenance, in which things aren't fixed until they break, is probably the most widely applied maintenance strategy. According to ARC, this is especially true for non-critical assets in which the overall impact of failure is minimal. While reactive maintenance does not add costs in the short term, it can potentially contribute to higher lifetime costs, including the cost of diagnosing, fixing, testing, etc., as well as the cost of downtime during the operation. IIoT, however, can improve reactive maintenance by enabling a more efficient, more informed response.

"I've heard estimates that a field operator spends only 2.5 hours of a 10-hour shift on work that adds value to the business, while the rest is taken by looking for information — probably travelling back and forth to a central maintenance office presumably searching filing cabinets looking for service manuals, along with admin work and various other non-value add tasks," says Conary.

In a more connected environment, on the other hand, maintenance engineers or technicians could be sitting in front of their computers when an alarm goes off in the middle of the plant. Instead of taking the time to travel to the plant, they can view a supervisory screen that will alert them to the condition. With a click they can see the documentation and review the code that might be managing a flagged pump without leaving their desks. They could then connect to the PLC that is managing it; see what is going on within the actual program of responses; and determine whether it is a programming issue, a hardware issue, or whatever. If it is a broken pump, for example, they might be able to configure it from their desk. If parts are needed, they would have instant access to spares inventories or a simplified ordering process.

The limitations of preventive maintenance

Preventive maintenance has been shown to reduce maintenance costs over the lifetime of the asset, but has its limitations. Preventive maintenance is based on the assumption that assets deteriorate at predictable rates based on age and utilization, which is valid. But ARC points to U.S. Navy research showing that only 18 percent of equipment failures result from aging equipment. While IIoT may improve tracking scheduling and other aspects of preventive maintenance, it won't necessarily address 82 percent of the other failures which result from seeming random operating events. These require condition monitoring based on analysis of more complex variables, which is what the IIoT promises to enable.

Delivering on the promise of predictive and proactive maintenance

Predictive and prescriptive (sometimes called proactive) maintenance strategies stand to gain the most from IIoT. In both approaches, process data is monitored to identify trends and issue alerts prior to failure. Predictive condition monitoring, as defined by ARC, is most appropriate for simple systems, where single variable math can be used to predict failure. More complex systems involve prescriptive condition monitoring, where multiple variables are analyzed to predict failure. This requires a more contextually driven understanding of operating conditions and providing more accurate diagnosis of the pending issue with fewer false positives.

Envisioning the possibilities is Thorsten Pötter, Ph.D., head of business intelligence and data management for Bayer and leader of the Industry 4.0 caretaker group for NAMUR, a user-driven consortium that provides best maintenance practices guidance for the chemical industry: "The device learns from the past, but also receives information from the current operating environment, such as temperature and humidity. What would happen if the device were to tweet all this information, regardless of who would be the recipient of this information? Could not you go a step further and gather this information and use it to help you evaluate models? This could significantly increase the quality of predictions of imminent faults in field devices and other components in the field," he said at NAMUR's 2013 general meeting.[4]

The advanced data historians and advanced analytical software needed to deliver the potential of IIoT are already in place to help process the deluge of operating data that could be flowing in. Today's enterprise data historians can collect data for analysis and report on asset operations, health, maintenance, and regulatory compliance. They can collect continuously streaming time-series data from critical control, monitoring, and smart devices and then archive this data – increasingly in the cloud using advanced storage and compression technologies.

Ash Grove Cement, of Overland Park, Kansas, for example, uses Schneider Electric's Avantis asset management software to automate maintenance data collection at each of its nine facilities. They have a well-defined enterprise asset management process to support equipment performance reliability, which improves production asset availability and utilization and provides a standardized solution for each production facility. The process and software enabled Ash Grove to reduce its inventory costs by $2 million (USD) in the first year of implementation, while ensuring compliance with the EPA's Portland Cement Maximum Achievable Control Technology regulation, thereby minimizing the potential loss of $3 thousand (USD) per hour for every hour the kiln is offline.[5]

Ash Grove Cement

IIoT makes it possible form more companies to achieve measureable benefits such as those that Ash Grove achieved, while extending the possibilities as well. It enables the real-time collection of data on the system operation, which can extend the lifespan of any asset and reduce capital expenses. Improved operating data helps capture the knowledge of experienced workers, which flattens the learning curve for new hires and helps minimize unplanned downtime.

The following trends are converging around IIoT to help more companies achieve maintenance benefits such as those that Ash Grove Cement has enjoyed:

1. Advances in edge control that enable flexible deployment of control systems with the power and flexibility to handle advanced analytics and the big data needed to support them

2. Expanded use of Ethernet connectivity in controls, making it easier to capture and share data and then analyze it with advanced applications

3. Deeper cybersecurity protection to leverage the value of open standards that are essential to realizing the full potential of IIoT with less vulnerability to cyber attack

4. Advanced object-oriented engineering environment's simplifying, the deployment of strategic asset management models

5. The evolution of asset management models themselves.

The first three trends are evident in the evolution of control technology, in which programmable logic controllers (PLCs) have evolved into more power programmable automation controllers (PACs) capable of implementing preprogrammed application libraries and open, advanced, object-oriented engineering environments. As such, these have gained some market traction, but primarily as low-end alternatives to a distributed control system and addressing multi-asset maintenance challenges. In recent years, PACs have evolved more in the direction of the requirements of the IIoT. For instance, Schneider Electric's Modicon M580 ePAC has adds more processing capability, Ethernet communications and deeper cybersecurity protection.

As an example of the fourth trend the Modicon M580 can be implemented with Schneider Electric's PES process automation system, which is a single, object-oriented software engineering environment that simplifies configuration of architectures involving numerous field devices, control types and applications.

And the fifth trend is the evolution of asset-centric models, which IIoT is making increasingly valuable for continuous, discrete, and hybrid operations. In an asset-centric model, rather than even trying to build a model for maintaining the entire, constantly growing network of intelligent things, the maintenance engineer develops isolated strategies for individual assets, selected on the basis of their contribution to higher-level business objectives. Unlike a process-oriented model, in which asset management challenges are solved across multiple operating levels, asset-based approaches solve individually at the equipment, unit, area, plant, and enterprise levels. They may, however, exchange data as required with other assets across a common network communications bus. This approach makes it easier to balance asset availability and utilization across the equipment, units, and areas that have the most impact on the business without getting bogged down in trying to optimize maintenance for the entire enterprise.

Driving measurable business value

Whether you call them advanced PLCs, IIoT-ready PACs, or ePACs, modern controllers with the characteristics mentioned above are enabling engineers to control their most important risks, whether they are in a process, batch, or hybrid operation: safety/environmental risk (including cybersecurity risk), reliability risk, efficiency risk, and profitability risk.

The measurable business value that can be derived from this new generation of controllers makes upgrading easy to justify, even in times of continuing downward pressure on capital costs. With the right models, companies involved in brownfield or greenfield modernization automation projects may see 100 percent returns on their controller investment in as little as three months. Here are just some of the ways new ePACs equipped for IIoT are already having an impact on operational profitability:

- **Increased productivity.** Using such advanced ePACs, a feed mill in Vietnam, for example, has achieved 3 times faster feed production. And by standardizing on one control products family, it has cut cabling costs significantly. Overall, the mill has increased production by 3 percent, and reduced costs by 30 percent.

- **Increased operational visibility.** Lacking precise data on asset location, process status, etc., can cost up to 3 percent of yearly revenue — and create a significant margin shortfall for the typical discrete/hybrid manufacturing plant, with substantial bottom-line impact. An ePAC automation project with transparent open native networks can bring much-needed operational visibility.

- **Cost-efficient energy management.** Calculations show it's possible to reduce annual energy consumption at an average large facility from $6 million (USD) to about $4.8 million (USD) by making energy usage data more efficient and transparent.

- **Cybersecurity protection.** Manufacturers now have a 32 percent chance of experiencing a hostile cyber-event or cyberattack in any given year.[6] Using advanced ePACs in key roles within comprehensive plantwide cybersecurity strategies can drastically reduce the likelihood of cyberattacks — critical in a world where the total costs of a data breach average more than $3.7 million (USD).[7]

Thus the increases in business value that can be derived from this new generation of controllers make upgrading easy to justify, even in times of continuing downward pressure on capital costs.

Putting IIoT to work

Most maintenance teams already have in place much of the technology they need to take advantage of the IIoT. Industry groups and standards organizations are gearing up to provide guidance. As we have seen above, NAMUR, for example, is beginning to articulate the vision for a new generation of digital maintenance, addressing IIoT in the context of broader Industry 4.0 initiatives and seeking to understand the entire transformation of industry, one that incorporates IIoT, mobile, cloud, digital augmented reality and other advances.

And the FDT organization, a true pioneer driving standards for device diagnostics, has just announced a standards-based, FDT/IIoT Server for mobility, cloud, and enterprise applications. The server features robust layered security leveraging vetted industry standards and utilizing encrypted communications with transport layer security. It also takes advantage of an OPC Unified Architecture (OPC UA) annex enabling sensor-to-cloud, enterprise-wide connectivity for industrial control systems used in the process, hybrid and factory automation markets. Together, FDT and OPC UA allow sensor, network and topology information to permeate the enterprise, including mobile devices, distributed control systems, programmable logic controllers, enterprise resource planning systems, the cloud, and the IIoT and Industry 4.0.

With so much going on, it is easy to become overwhelmed and take a wait-and-see approach. But your operations don't sit still. The good news is that IIoT is not an all or none proposition. Industrial digitization with will increase steadily over time. The most strategic approach is to identify which assets are most vital to your company's profitability today and begin the dialogue about whether better information about their operating histories and performance can help improve their availability and utilization. That should lead to an understanding of what types of control, if any, you might need to achieve those benefits.

About the author

John Boville is a marketing manager for Schneider Electric's marketing and innovation group, where he focuses on the Modicon controller line. He has been with Schneider Electric industrial automation for more than 25 years, including implementing market segment strategies for the automotive industry. Prior to joining Modicon, before it became part of Schneider Electric, he served for 12 years in project engineering for CEGELEC Automation as an industrial system designer, installation specialist, and project leader for large automation migration projects. He holds a B.S. in electrical engineering from the University of Bradford, U.K. Keep up with John's latest insight in his blog: http://blog.schneider-electric.com/author/jboville/

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