

Proactive Asset Management with IIoT and Analytics

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Summary

The Industrial Internet of Things (IIoT) with advanced analytics, offers new opportunities to improve the reliability of industrial assets, enabling owner-

Proactive asset management provides new opportunities to improve uptime, asset longevity, cost control, yield/quality and safety. Studies show that 82 percent of assets have a random failure pattern. Consider a pilot project using analytics to predict failures.

operators to progress toward no unplanned downtime, which many consider to be the ultimate objective for maintenance and operations.

Preventive maintenance assumes a failure pattern that increases with age or use. Unfortunately, this applies to only 18 percent of assets. The other 82 percent of assets display a random failure pattern.

In contrast, predictive maintenance (PdM) approaches employ condition monitoring data to predict failure. Proactive maintenance goes further by combining multiple variables with analytics to predict failure with a higher degree of confidence and fewer false positives.

Typical benefits of proactive maintenance include improved uptime, asset longevity, maintenance cost control, and safety. Industrial organizations should review their asset management strategy and consider increased adoption of condition monitoring and predictive maintenance solutions. ARC Advisory Group recommends that users consider a pilot project for proactive maintenance with analytics - especially for complex assets or a common asset type.

Comparing Maintenance Strategies

Building the case for proactive maintenance requires a review of other maintenance strategies along with strengths and weaknesses.



Preventive Maintenance: Appropriate for Just 18 Percent of Assets

Preventive maintenance schedules inspections and/or repairs are typically based on calendar time, run time, or cycle count. This approach assumes that the probability of equipment failure increases with use. However, data on failure patterns compiled by NASA and the US Navy (see chart on page 3) show that only 18 percent of failures are age related, and 82 percent have a random pattern. Based on these data, preventive maintenance (PM) provides a benefit for just 18 percent of assets. Doing a PM on the other 82 percent may well cause failures by placing the asset at the beginning of the Type B curve for early life failures.

Predictive Maintenance: Simple Math

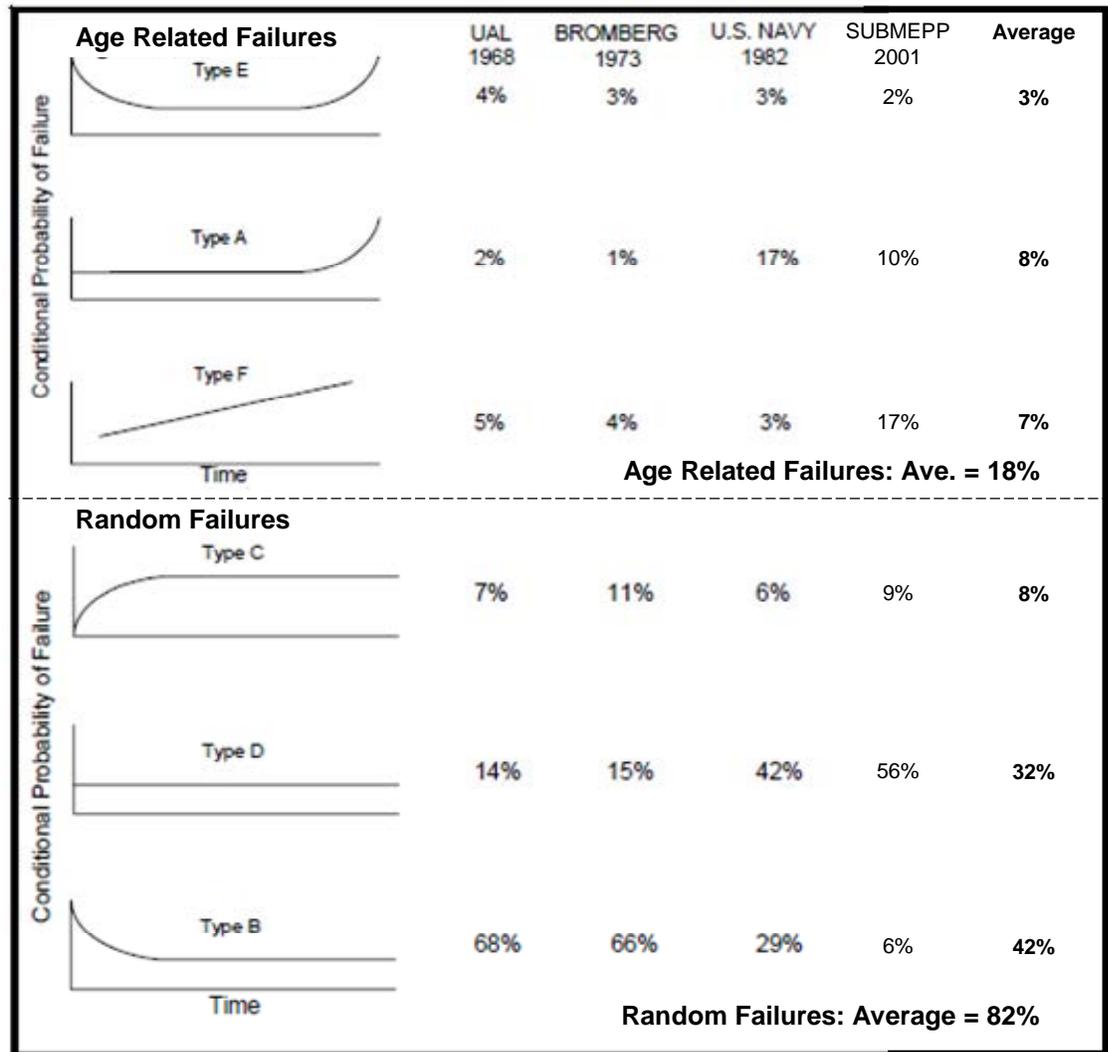
PdM uses condition monitoring to provide advanced notice of a failure so appropriate maintenance can be scheduled and performed to prevent the unplanned downtime. The three common approaches for the condition monitoring include:

1. Monitoring a process data value associated with the asset from the plant historian with trend charts and/or a mathematical calculation
2. A plant asset management (PAM) system with sensors (commonly vibration) typically applied to rotating equipment
3. Periodic inspections and evaluation involving infrared, ultrasonic, oil analysis or corrosion typically used for stationary plant equipment such as steam boilers, piping and heat exchangers

Approach	Method	Applicability	Comparison
Reactive	Run to failure and then repair	Non-critical assets with low impact from failure	10X plus when failure occurs
Preventive	Service in a fixed time or cycle interval	Failures increase with age or usage	2X maintenance costs
Predictive (condition monitoring)	Monitor process data, identify bad trends, & alert prior to failure	Simple systems where single variable math predicts a failure	1X maintenance costs
Proactive (analytics & multiple variables)	Equipment-specific data acquisition with algorithms, analytics, and/or a model	Complex systems where multiple variables and analytics can predict failure	Unscheduled downtime approaches zero

Equipment Maintenance Strategies

Particularly when using historian data or a PAM system, the underlying math is often based on a single variable. A heat exchanger provides a use case: when the pressure difference between the inlet and outlet increases beyond an upper limit, the tubes need to be cleaned. This form of PdM is an improvement over periodic preventive maintenance where the process is shut down and the exchanger opened for inspection, often resulting in unneeded downtime and maintenance costs. While an improvement over preventive maintenance, PdM uses basic math and typically applies to correspondingly simple assets.



Failure Patterns of Simple and Complex Items
 Sources: RCM Guide, NASA, Sept. 2008, and
 U.S. Navy Analysis of Submarine Maintenance Data 2006

Proactive Asset Management

Technology changes often provide the underpinnings for business process improvements that enable more effective deployment of resources. IIoT and advanced analytics provide the basis for a shift from predictive to proactive maintenance – appropriate particularly for critical assets. IIoT provides access to more data and process variables. Multi-variant analytics can help identify anticipated failures earlier and provide more accurate diagnosis of the pending issue with fewer false positives.

Industrial IoT with Intelligent Devices

IIoT connects intelligent physical entities (sensors, devices, machines, assets, and products) to each other, to internet services, and to applications. The IIoT architecture builds on current and emerging technologies such as intelligent equipment with an IP address, machine-to-machine (M2M) communications, mobility, cloud computing, analytics, and visualization tools. No substantial technological breakthrough is needed for industrial solutions to utilize IIoT technologies.

Analytics Combined with Focused, Structured Data

With the growing adoption of device networking, more assets have the capability to provide data for proactive asset management. The more focused, structured data coming from a particular machine or class of assets can be combined with advanced analytics to offer new opportunities for improving asset reliability, uptime, and longevity. The device data, combined with algorithms designed for that specific type of equipment, provide a means to assess condition with higher fidelity (identify specific components and failure modes with longer advanced notice) and reliability (detect a higher portion of pending failures with fewer false alarms). The combination can significantly improve uptime and reduce maintenance costs by recognizing a problem long before it can cascade into a catastrophic failure with a much larger impact on business performance.

Advanced Pattern Recognition

One approach for proactive asset management involves engineering and designing condition monitoring using custom analytics or algorithms. This approach works well for equipment OEMs that can spread the cost of developing the algorithm over many machines. For owner-operators, the limited availability of engineering resources often makes this approach dif-

difficult to implement and sustain. An emerging, more automated approach uses Advanced Pattern-Recognition (APR).

APR technology generates an empirical model by “learning” from an asset’s unique operating history during various stable and dynamic process conditions. This model becomes the baseline profile for normal operations for a specific piece of installed equipment or system. The APR system automatically compares an asset’s model with real-time operating data to detect meaningful changes – some of which could be subtle, interrelated and beyond normal human recognition using visualization tools. APR provides advanced warning of an impending equipment failure before they reach alarm levels or an unplanned shutdown.

Current implementations of APR typically use data from existing sensors. The Industrial Internet of Things (IIoT) offers a richer set of equipment data for a higher fidelity model and improved condition monitoring. The combination of these two emerging trends - IIoT with structured data and APR - offers an opportunity to take proactive maintenance to a new level with broad adoption across critical assets.

Virtual Equipment for Many Similar Assets

After an APR system learns and has a proven track record with its associated equipment, it becomes a virtual model for that particular type of equipment. A key benefit of this “virtual equipment” is the ability to replicate the model (somewhat like a template) across many similar devices in a large network. Examples could include pumps in a refinery, transformers for power transmission lines, or stamping machines at an automotive supplier. This approach helps make the best use of the often limited technical resources available, and offers the opportunity to have condition monitoring coverage for a much larger portion of critical and complex assets.

Business Process Automation

As these technologies enable longer advanced notice of a pending failure, business process automation (BPA) becomes more critical. Unfortunately humans tend to overlook or forget long-term issues; alerts get lost in the flurry of daily activities. Manual processes for transferring an alert from a condition monitoring application to the EAM system for managing the response become problematic and can contribute to overall business process failure. Integration with the EAM system enables more automated genera-

tion of a work order for review and approval by a maintenance planner, which can help assure resolution prior to failure.

Schneider Electric Avantis APM Solution

As ARC learned during recent briefings, the Schneider Electric Asset Performance Management solutions include Avantis EAM and Avantis Condition Manager. According to the company, these software packages can help industrial customers improve the availability and performance of their critical assets and support real-time maintenance execution.

The Avantis EAM offering has a range of functions for managing maintenance. These include asset information, work order planning and scheduling, purchasing, inventory management, human resources, and financials. Avantis Condition Manager's "wizard" user interface makes it easy to create applications that collect operational information and perform diagnostics in real time. According to the company, the solution is platform-independent, enabling it to work with a variety of EAM and control systems. These products have matured with over ten years of use, customer feedback, and development. Schneider Electric's recent acquisition of In-Step with PRiSM enables a holistic solution that extends across corrective, preventive, conditional, predictive and proactive maintenance strategies. Combining PRiSM's advanced pattern recognition technology with IIoT opens new opportunities for improving uptime and asset longevity.

Conclusion

The "bathtub curve" (type E) for predicting equipment failure may seem to be intuitively obvious, but four extensive studies in the preceding table performed by both corporate and military organizations over the last 40 years consistently show that this pattern applies to an average of only 3 percent of assets. Overall, the age or usage related failure patterns apply to just 18 percent of assets. The other 82 percent have various types of random failure patterns; i.e., with no correlation to either age or usage. Preventive maintenance does not align well with the random failure patterns. Human error while performing the maintenance task can cause downtime problems.

Asset owners continue to face pressure to improve their key performance indicators for uptime, asset longevity, yield/quality, and safety; while con-

trolling costs. They need an approach that goes beyond preventive maintenance. With PdM and proactive asset management, maintenance can be performed when needed, i.e., prior to when an issue becomes a failure. Owner-operators should:

- Review their maintenance strategy and consider more significant adoption of condition monitoring and predictive maintenance solutions – particularly with the availability of packaged solutions that can help significantly reduce engineering implementation and support costs
- Pilot the use of analytics with focused datasets for proactive maintenance – especially for complex assets or a common asset type
- Monitor the maturing of IIoT and APM for their industry, and pilot applications when practical

Equipment suppliers should develop predictive maintenance algorithms for their equipment and deploy these as an after-market service offering.

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