Understanding How Predictive Analytics Tools Benefit Power Utility Asset Management

by Mike Reed, Manager of Analytical Services, Schneider Electric

Executive summary

The impact of utility industry restructuring is being felt on several levels. The upside of distributed generation growth and the diversification of power sources are also resulting in the downside of loading issues, less switching flexibility and the potential for reverse power flow. New predictive asset analytics tools allow utility personnel to address these issues before they become problems. This paper r eviews how these tools can be applied to both utility operations and maintenance.

Introduction

Utilities today are looking for new ways to address an evolving energy marketplace. The pressures of government regulation, increased competition, and rising consumer demands are driving the need for improved reliability, efficiency, and safety. The upside of distributed generation growth and the diversification of power sources have unfortunately augmented the downside of loading issues, less switching flexibility and the potential for reverse power flow. In addition, an aging infrastructure and workforce is driving the need for asset renewal and knowledge capture.

The amount of "big data" available today is providing utilities with an opportunity to overcome some of these disruptive obstacles. Forward-looking utilities are beginning to invest in monitoring and predictive analytics tools that help to leverage this data. Navigant Research estimates that utilities will spend almost $50 billion on asset management and grid monitoring technologies by 2023.[1] Using predictive asset analytics software, utilities can improve equipment reliability and performance while avoiding potential failures. These tools also leverage power network data to prioritize maintenance and reduce operational and maintenance expenditures.

Field case: Equipment failure

Predictive asset analytics solutions provide early warning of equipment failure and abnormal operating conditions that may go unnoticed within the realm of traditional maintenance practices. For example, consider a 110MW steam model turbine with seven bearings (including generator bearings). According to the asset maintenance records, over one year this turbine demonstrated sporadic isolated issues, followed by an escalating condition that eventually resulted in the shutdown of the unit. The maintenance personnel identified turbine bearing vibrations and took corrective action. Upon completion of the maintenance, a similar cycle of sporadic issues began again, in addition to the introduction of new problems.

This unit's raw historical data was then analyzed with an up-to-date predictive analytics tool (in this case, Schneider Electric's Avantis PRiSM® tool). The results were significant. Had a predictive asset analytics solution been in place, plant personnel would have received early warning that turbine thermal expansion issues were developing and becoming chronic over the year. Through a modeling exercise, the tool was able to detect the fault patterns with early warnings six months prior to failure. The model showed that the bearing vibrations were a symptom while thermal expansion issues were the primary cause of the problem. Proactive remedial maintenance would have corrected the thermal expansion problem before it led to bearing vibration issues and the shutdown of the unit. The result would have been significant savings in maintenance costs as well as additional generation sales due to increased unit availability. Estimated savings in this case are in the millions of dollars - a result of 35 days avoided downtime offline and associated repair costs.

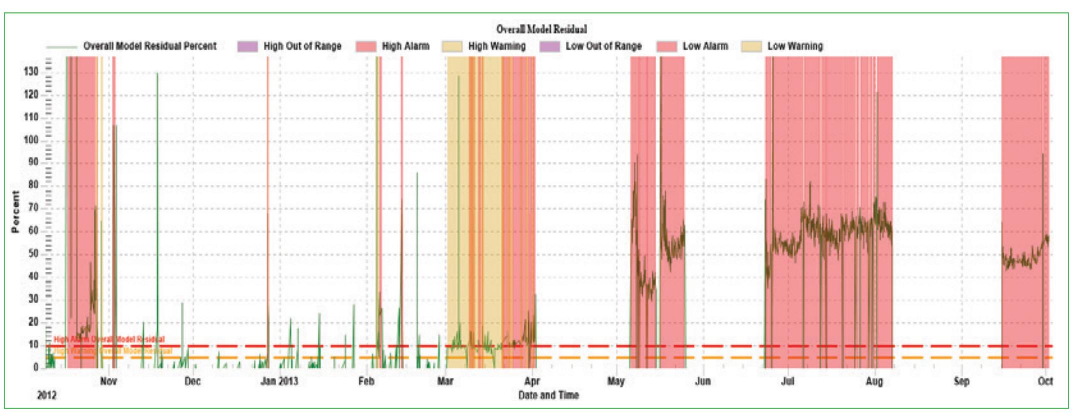

Figure 1

Anomalies indicate a deviation from the anticipated performance behavior of the turbine asset

[1] Navigant Research "Utility Spending on Asset Management and Grid Monitoring Technology Will Reach Nearly $50 Billion through 2023" (March 2014)

Figure 1 illustrates an overall model residual trend (which represents the total deviation from predicted operation of the asset), and shows how engineers would have identified the early problem with this particular turbine. **Figure 1** highlights the deviations between predicted operation and actual performance, thereby providing an early warning. In particular, the software would have identified the deteriorating conditions that caused a forced outage in April (followed by the subsequent issues the remainder of the year). An operations crew would have been able to take action that would have avoided unit shutdown (with associated loss of availability and increased maintenance costs).

Additional benefits

Predictive asset analytics software allows for operations and maintenance personnel to be more proactive in their work. Instead of shutting down a section of the power plant immediately, a problematic situation can be assessed for more controlled outcomes. Loads can be shifted to reduce asset strain or the necessary maintenance can be scheduled during a planned outage. The software tools allow for better planning which in turn reduces maintenance costs. Parts can be ordered and shipped without the need for stressful rush and equipment can continue running while the problem is being addressed. Maintenance windows can be lengthened as determined by equipment condition and performance. Other benefits include increased asset utilization and the ability to identify underperforming assets.

Other savings can be realized when avoided costs such as loss of power, replacement equipment, lost productivity, and additional man hours are considered. The power of predictive analytics tools is that they transform raw data into easy-to-understand and actionable insights that result in improved availability, reliability and decision-making.

Predictive analytics tools allow personnel to visualize actual and expected performance of an asset including detailed information on ambient conditions, unit loading, and operating modes. Operations personnel become knowledgeable regarding where inefficiencies exist and what the impact is on financial performance. They can gauge the future consequences of the actions and decisions they make in the present. Risk assessment becomes a more exact science and the potential behaviors of each monitored asset and can be used to better prioritize capital and operational expenditures.

Knowledge capture is another benefit of the predictive analytics tools. In an environment where transitioning workforces are becoming more prevalent, knowledge capture ensures that maintenance decisions and processes are repeatable. Therefore, when experienced personnel leave the company, their years of accumulated knowledge remain available to incoming staff.

The reliability and efficiency improvements that accrue through the use of predictive asset analytics software also result in increased customer satisfaction rates. Consumers can experience more reliable service with fewer outages because utilities have the insight needed to avoid potential equipment failure and forced outages.

Maintenance practices

Listed below are various types of maintenance approaches currently practiced within power utilities. The levels of attained precision are dependent upon the nature of the tools deployed (see **Figure 2**).

Reactive maintenance

Reactive Maintenance is the most basic strategy and allows an asset to run until failure. It is only appropriate for non-critical assets that have little to no immediate impact on safety or the reliable generation of electricity. This approach may also be used for assets that have minimal repair or replacement costs and that do not warrant an investment in advanced technology.

Preventive maintenance

Preventive Maintenance (PM) approaches are designed to ensure that an asset gets examined before it reaches the point of failure. The Preventive maintenance strategy prescribes maintenance work to be conducted on a fixed time schedule or based on operational statistics and manufacturer / industry recommendations of good maintenance practice.

Condition-based maintenance

Condition-Based Maintenance (CBM) focuses on the physical condition of equipment and how it is operating. CBM is ideal when a measurable parameter is a good indicator of impending problems. The condition must be definable using rule-based logic, where the rule does not change depending on loading, ambient or operational conditions.

Predictive maintenance

"According to research by ARC Advisory Group, only 18 percent of assets have a failure pattern that increases with use or age. This means that Preventive maintenance alone is not enough to avoid failure in the other 82 percent of assets and a more advanced approach is required."

If a potential asset failure results in significant damage, then safety or power outage risk is high. In these cases, a more proactive maintenance approach is required. Predictive Maintenance (PdM) relies on the continuous monitoring of asset performance through sensor data and prediction engines to provide advanced warning of equipment problems and failures. PdM typically uses Advanced Pattern Recognition (APR) and requires a predictive analytics solution for real-time insights of equipment health.

Predictive asset analytics solutions are a key part of a comprehensive maintenance program. According to research by ARC Advisory Group, only 18 percent of assets have a failure pattern that increases with use or age.[2] This means that Preventive maintenance alone is not enough to avoid failure in the other 82 percent of assets and a more advanced approach is required. Predictive analytics software compares historical operational signatures of each asset to real-time operating data for the purpose of detecting subtle changes in equipment behavior. The software is able to identify changes well before the deviating variables reach operational alarm levels, creating more time for analysis and corrective action.

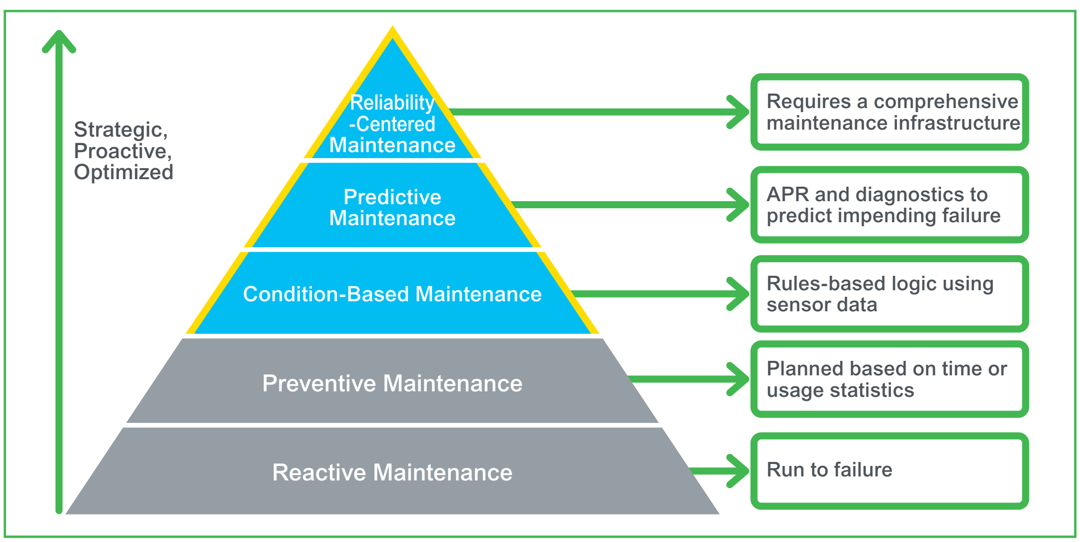

Figure 2

Levels of maintenance are often associated to the level of risk of both stand alone or consolidated assets

[2] Ralph Rio "Proactive Asset Management with IIoT and Analytics" (January 2015) ARC Advisory Group

Reliability-centered maintenance

All of the aforementioned maintenance approaches create the foundation for Reliability-Centered Maintenance (RCM). RCM is a comprehensive prognostic strategy focused on outcomes and is the process utilized for determining what should be done to ensure that an asset operates the way the user intended. RCM is the capstone of a fully integrated maintenance program and can't be sufficiently deployed without a repeatable process for the foundational maintenance practices, which includes using a predictive analytics solution in support of predictive maintenance.

Conclusion

Predictive asset analytics solutions help grid operators, systems engineers, controllers, and many other plant personnel take advantage of the massive amounts of data available today and use it to make real-time decisions that have a significantly positive impact on reliability and performance. Advanced pattern recognition software helps personnel work more effectively by providing early warning notification and allowing more lead time to plan necessary maintenance, ultimately avoiding potential equipment failure and improving performance.

Power generation and delivery utilities can transform their maintenance strategies by leveraging data and predictive asset analytics solutions to spend less time looking for potential issues and more time taking actions to gain the greatest return on every single asset. New predictive asset analytics software tools can allow power utilities to monitor critical assets for the purpose of identifying, diagnosing and prioritizing impending equipment problems — continuously and in real time.

About the author

Mike Reed is the Manager of Analytical Services for Avantis PRiSM at Schneider Electric. Mike has more than 20 years of extensive hands-on experience in engineering design, construction, commissioning and operations, with an emphasis on power generating plants for various OEMs. For the past 5 years, he has been actively involved in Remote Online Diagnostic Monitoring of power plants both domestically and internationally. Mike is currently responsible for the implementation and optimization of Avantis PRiSM predictive asset analytics solutions with clients globally. Mike earned a Bachelor of Science in Mechanical Engineering from the United States Military Academy at West Point, and a Master of Science in Systems Management from the University of Southern California. He is also a veteran of the United States Army.

Schneider Electric Software
26561 Rancho Pkwy South, Lake Forest, CA 92630 Telephone: +1 (949) 727-3200 software.schneider-electric.com

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