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White Paper

Modernizing equipment maintenance strategies for utilities

The days of "business as usual" for utility companies are coming to a close. On one end, pressure emanates from tightening regulations and an increasing reliance on renewable energy sources. On the other end is growing competition from startups taking advantage of deregulation. Together, these are driving what consulting company, Strategy&, calls a **"make-or-break period for power & utilities companies,"** in which companies that will survive are those which are ready to embrace digital transformation.

One area that digitization can have the biggest impact for utility companies is equipment maintenance strategies. Digital technologies can help companies shift from just tracking and fixing equipment to a strategy that maximizes the return on investment (ROI) of physical assets by ensuring equipment is operating at top efficiency and effectiveness. Digital technology also enables the collection and analysis of data so that companies can not only better understand what the maturity of their assets mean, but also assess equipment condition and predict why and when assets will fail.

Use digital operational twin data to track and fix assets

Downtime is costly for any company, but particularly for utilities, where an interruption in mission-critical service can result in downtime for multiple customers—equating to millions of dollars or more in reactive repairs, waste, lost production, and higher energy costs. Whether it's equipment for energy transmission, distributed generation, or wastewater, problems can go well beyond just lost output; faulty equipment can even result in serious safety, health, and environmental complications.

Most utility companies have maintenance programs in place to prevent equipment failures. However, many of these programs still focus on tactical procedures to track and fix assets—they don't provide much analysis into why assets fail or predict when they will. With today's focus on reducing operational expenses across the enterprise and improving the customer experience, utility companies need to gauge their current procedures; determine what kind of asset management system they have in place; and, depending on what they find, move to a more strategic process that incorporates predictive practices.

Given the advancement of maintenance tactics like asset investment planning (AIP), asset performance management (APM), and digital work, enabled by applied technologies like artificial intelligence, machine learning, and digital operational twin, utility owner/operators now have the capability to create the most economic prescriptive maintenance asset management strategy.

Understand the maturity of assets

There are five stages to a utility company's asset management maturity—starting from the very basic and progressing to a comprehensive, enterprise-wide maintenance strategy. These five stages are:

01. Operate
In this stage, the company is reactive on all of its maintenance; it fixes something when it's broken. The company takes few or no preventive measures. This approach raises downtime costs and often results in lost revenue.

02. Consolidate
Here, the company recognizes maintenance could be improved, but can't properly fund a major overhaul in practices. It continues to focus on reactive procedures, but adds some element of planning, such as ensuring spare parts are in inventory and, when practical, rebuilding instead of replacing equipment.

03. Integrate
This is the stage when the company begins to emphasize financial aspects of maintenance. In this stage, the company should communicate its expected ROI to senior leaders to secure extra funding for additional preventive measures such as routine inspections, lubrications, adjustments, and scheduled service. Planning ahead will help to improve equipment mean time between failures (MTBFs).

04. Optimize
As time goes on, enterprise participation grows. That means having the support of management is critical—and mandatory. With a shift toward predictive maintenance, more data will be collected and analyzed to understand when failure is likely to occur and its business impact. The MTBF will significantly improve during this stage because the company is proactively managing risk.

05. Innovate
The final stage includes maintenance as part of a total company system where the company combines prior techniques with operator involvement to free maintenance technicians to concentrate on repair data analysis and major maintenance activities.

The stages have followed the evolution of enterprise asset management (EAM) systems, from computerized maintenance management systems (CMMS) to today's advanced asset performance management systems (APM). CMMS is usually tactical in nature. It provides an understanding of when to repair assets and sets the flow for issuing and tracking work orders. Such a system is well suited to small single-plant operations with limited resources. However, it doesn't take into account the hierarchical nature of complex assets.

Additional challenges today's utility companies are facing

- **Aging infrastructure:** From sewer lines to water mains to electrical substations, utility components put in place decades or even a century ago are increasingly in need of repair and replacement.
- **Workforce in transition:** A significant portion of the workforce is nearing retirement—presenting a potential loss of know-how and a need for focused new employee development.
- **Compliance concerns:** As regulations for tighter discharge limits and air emissions evolve, utility companies need to be prepared to address them while meeting related reporting obligations.
- **Reliability standards:** The need for consistent, reliable service levels puts greater urgency behind the adoption of standards such as PAS-55, ISO 55000, and ISO 50001—which provide guidelines for establishing energy and asset management programs that are accurate, repeatable, timely, and cost-effective.
- **Outdated business systems and models:** Existing processes and systems prevent companies from clearly identifying what needs to be done when, where, and with what priority.
- **Customer experience:** Utilities must be able to meet the demands of today's customers for unprecedented levels of transparency, response speed, and service quality.

Manage the asset ecosystem

Assets aren't isolated; instead, each asset consists of a complex system of other components, likely interrelated to assets across the plant floor. This hierarchical setup requires the ability to monitor, track, report, and execute activities based on an understanding of how one move will impact another—often with potentially far-reaching implications.

For example, a sudden drop in pressure of water moving from one tank to another can be due to many factors—including a crack in a nozzle, build-up within a pipe, or inaccurate pressure in the origin tank. A local power outage could be the result of a faulty transformer or voltage regulator. Managing this ecosystem requires understanding how each asset works with others, identifying indicators to determine where a failure is, and acting to correct the problem.

Modern asset management systems provide EAM tools to help manage the ecosystem, including:

- **Asset hierarchies—**These help processors view assets from both a system and positional perspective, so they can understand true costs of assets with the aim to control, plan, and avoid capital expenditures.
- **Inventory control—**This provides real-time inventory visibility to help reduce inventory and material costs, while enhancing purchasing control and efficiencies.
- **Maintenance control and scheduling—**This functionality helps prevent overtime and lag time, while improving maintenance team effectiveness and work scheduling.
- **Inspection management—**These tools help plan and control inspection routes and measurement points, including ones highlighting vulnerability of critical assets.
- **Regulatory and safety requirements—**Specific information capture and material labeling requirements by categorization help manage US Environmental Protection Agency (EPA) inspections, internal self-audits, spill reports, and all safety-related matters. The right EAM tools can track and manage key safety and regulatory data related to assets, maintenance, and inventory.
- **Warranty management—**This keeps track of asset warranty status to reduce maintenance expenditures and prevent unnecessary work and time on assets under warranty.
- **Asset investment planning (AIP)—**Asset performance analytics can indicate why assets fail, the costs to operate them, where each asset is located to optimize deployment, and with AIP the most economic maintenance tactic can be applied.

All of these tools work together to improve the overall asset ecosystem.

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Build the maintenance program around these best practices

Companies can rely on five best practices to achieve the goal of a strategic predictive maintenance program.

01. Assess the existing maintenance strategy

The stages outlined earlier in this paper provide a good indicator of where a company is in its asset management strategy, but the company must first understand the past and establish a performance baseline—for example, analyzing benchmarks such as percentage of work that's planned versus breakdown related/reactive in nature. These indicators should be further evaluated by equipment class (e.g., reactors) or type (e.g., 1-gal. fill lines) to determine more accurate baselines and possibly even root causes of failures.

The company should also determine its proficiency in capturing and analyzing asset data. The amount of data it can collect and analyze will form the foundation for the entire program. Often the information needed to drive decision-making and processes can come from multiple disparate sources, including asset management and production systems.

The overall equipment effectiveness (OEE) metric, for example, requires availability information from an asset management system, as well as quality and capacity information from a production system. Likewise, production and maintenance requirements and schedules reside in two distinct systems, yet apply to the same equipment. The company needs a holistic view across disparate sources to drive greater efficiencies and better decision-making. With the right data, the company can develop a sense for how its asset portfolio is performing and where to invest additional budget to ensure assets align with strategic goals.

A company that has a multi-plant operation should look at how well it's sharing best practices, as well as handling inventory management and procurement across facilities. Are common performance measures established so that comparisons can be made? Can information be easily consolidated across plants and facilities into a single source of truth for analysis? Is cross-plant collaboration taking place? Answering these questions will help the company gauge how well its operation leverages best practices.

Maintenance is typically thought of in a silo—one plant at a time. Instead, multi-location economies of scale can offer substantial cost savings.

02. Identify strategic assets

Predictive maintenance isn't necessary for all assets. Instead, strategic assets should be identified—the ones that directly have an impact on revenue. A pump is strategic if it's performance and availability affect output. In addition, production throughput should be a factor in determining the extent that equipment failure would lower revenue. Failure of a highly efficient distribution process that operates at high throughput may be more tolerable to the business than stopping a production line that struggles to meet throughput requirements.

03. Determine best indicators of failure

Failure occurs for different reasons and varies by equipment, environment, and operating requirements. A high-pressure pump may suffer excessive vibration before experiencing bearing and seal failure, while excessive energy consumption may signal wear problems in another pump. Trends and patterns can be discovered by looking at the history of asset performance, combined with failure studies and reference cases, as well as institutional knowledge and experience.

In addition, the company's most important strategic assets could be monitored for multiple indicators to minimize production disruptions. But it's important to watch out for false positives. Relating high material usage variances to excessive energy consumption in equipment could be a false positive, for example. In this case, the use of extra energy could stem from poor material or formula quality—and wouldn't serve as a leading indicator of an equipment performance problem.

04. Automate analysis

Timely action based on real-time operating data is instrumental to an effective predictive maintenance program. The old method of having staff sort through data is inefficient and may provide an outdated analysis because of the time lag. Plus, manual review and analysis takes staff away from performing maintenance and creates a backlog of activity. Automating the process allows the company to take action on the real-time analysis.

In combination with an advanced metering infrastructure (AMI), the right analytics tools can help to identify issues and trends. Actionable analysis derived from software that includes a trending engine can pinpoint problems, filter false alarms, immediately notify stakeholders, adapt to ever-changing conditions, and help drive asset management practices.In contrast to systems that capture (for example, a high-pressure pump's real-time performance information that produces reports for an engineer to sift through for answers), a system that supports actionable analysis takes this several steps further.

In the high-pressure pump example, pump performance data (e.g., electrical consumption) is automatically analyzed for predetermined trends over time—such as 10% or more excess energy consumption for more than 60 minutes—and alerts key stakeholders to take action when specific conditions are found. An alert can be in the form of a prescriptive set of steps (e.g., 12-point inspection work plan) that pertain to the pump's condition to guide staff through the diagnosis, repair, and restore process.

Furthermore, industry-leading EAM solutions can now assess situations in real-time, including identifying stalled work orders and issuing alerts to escalate matters and ensure work is completed and regulations are satisfied.

05. Measure and refine

An asset management program must be continually measured and refined to achieve better results and ensure it expands to cover additional assets and business processes. To do this, the company should identify the best opportunities for improvement, monitor the most critical areas, implement enhancements, and measure them. The impact of process changes across the program must be evaluated, not just at one data point.

With today's leaner supply chains and reduced safety stocks, the company must be able to minimize the time it takes to correct issues and increase equipment availability. While there are many different approaches to measurement, from OEE to MTBF and energy efficiency, there's no single "Holy Grail" for measurement—the company must find one or a combination of several that best meets its respective needs.

Measure energy efficiency to predict failure

Energy efficiency is often overlooked as part of a company's asset management practices. Indeed, measuring energy efficiency is one of the best-kept secrets about predicting failure. Energy consumption actually can indicate, far in advance of a failure, that a problem is developing. In the earlier example of the complex nature of identifying the cause of a change in pressure, monitoring energy usage of each asset can indicate which asset is either drawing too little or too much energy—thereby providing an informed starting point for inspections.

As an added benefit, asset sustainability—the combination of asset and energy-demand management in one system—has been shown to lower energy consumption by up to 20% across an operation or facility. By measuring consumption across each asset, companies can identify equipment drawing more power than the manufacturer specified. The alert generated starts a chain reaction to determine why the asset isn't performing at its optimum and correct it.

For example, a single 100-hp motor running continuously at 95% efficiency for five years should consume approximately $350,000 in energy (at 10¢/kWh). If the same motor develops a minor problem, not detected by traditional inspections and monitoring, and consumes just 5% more energy, it will cost almost $17,500 more to operate.

The problem is pervasive. Most plants can incur significant added expenses by continuing to operate assets whose energy consumption has increased. When integrated with an asset management system, alerts can trigger when energy consumption or efficiency reaches a predetermined threshold for each asset and can initiate a case-management incident requiring inspection. In some cases, the energy consumption indicator can serve as warning signal for a larger issue that could impact production if it isn't caught early enough.

Develop a comprehensive asset strategy

For utility companies, failure isn't an option. It costs too much. Capital assets and operational efficiency dictate economic return and determine success. Today's asset management involves more than balancing asset performance and longevity. With asset investment planning embedded in the solution, maintenance planners can now select the most economically correct maintenance tactic from run to failure to renew/replace. In addition, they must consider energy efficiency to develop a comprehensive strategy to eliminate unplanned downtime and reduce operational costs.

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