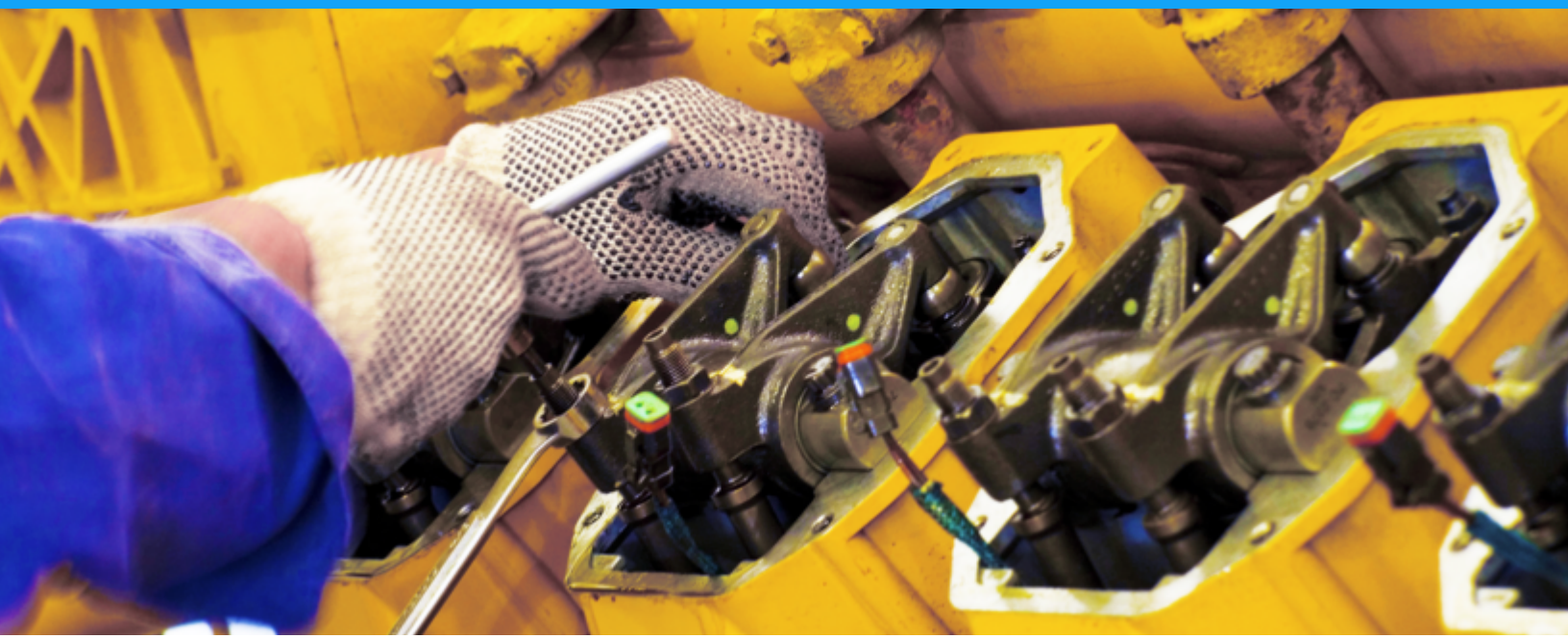

How to fix your maintenance program

In today's highly competitive manufacturing landscape, it's no longer enough to simply track and fix your equipment assets. Your maintenance program needs to go deeper. By collecting and analyzing asset data not only can you better understand what the maturity of your assets means—but you can predict why an asset will fail or when. With this information, you can plan preventive maintenance schedules as well as a maintenance program that will align with your company's strategic goals.

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Use operational data to track and fix your assets

Downtime is costly in any industry but particularly in manufacturing, where it can equate to hundreds of thousands of dollars or more in waste and lost production. Problems can lead to scrapped output or the need to rework a production run, incurring extra material and energy costs. Safety mandates may require emptying equipment prior to its repair. In addition, today's lean supply chain and lower inventory levels may mean insufficient raw materials and finished product are on hand to meet demands.

Most 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, it's time to assess your current procedures; determine what kind of asset management system you have in place; and, depending on what you find, move to a more strategic process that incorporates predictive practices.

Understand the maturity of your assets

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

1. Operate

In this stage, you are reactive on all of your maintenance; you fix something when it's broken. You take few or no preventive measures. This approach raises downtime costs and often results in lost sales. It prompts excessive safety stocks that reduce inventory turns and increase pressure on cash flow.

2. Consolidate

Here, you recognize maintenance could be improved but can't properly fund a major overhaul in practices. You continue to focus on reactive procedures but add some element of planning, such as ensuring spare parts are in inventory and, when practical, rebuilding instead of replacing equipment.

3. Integrate

This is the stage when you begin to emphasize financial aspects of maintenance. In this stage, you should communicate your return on investment to senior leaders to secure extra funding for additional preventive measures such as routine inspections, lubrications, adjustments, and scheduled service. Planning ahead will help you to improve equipment mean time between failures (MTBF). Preventive maintenance can also extend the lifecycle of critical equipment, allowing you to put capital funds toward other projects rather than replacing shop floor assets.

4. Optimize

As time goes on, enterprise participation grows. That means having the support of management is critical—and mandatory. You'll be shifting towards predictive maintenance—data will be collected to understand when failure is likely to occur and the business impact. Your MTBF will significantly improve during this stage because you're proactively managing risk. Most importantly, you will be able to schedule downtime when it will least impact customer satisfaction and be less likely to cause disruption to the workforce.

5. Innovate

The final stage includes maintenance as part of a total company system which combines basic tactics with the involvement of the machine operator and performance results. Less time required for break-fix repairs allows the technician to focus on repair data analysis and long-term maintenance strategies.

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. 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.

With today's focus on reducing operational expenses, it's time to assess your current procedures, reevaluate the asset management system you have in place, and

move to a more strategic process that incorporates predictive practices.

Manage your 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. It's like playing chess. But when it comes to your business, an asset chess game can be daunting when you realize how far reaching a problem can be.

For example, a sudden drop in pressure of a liquid moving from one tank to another can be due to many factors, including a crack in a nozzle, build up within a pipe, inaccurate pressure in the origin tank, a pump's motor or even a faulty transformer or voltage regulator feeding power to the entire process. 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 manufacturers view assets from a system 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 environmental 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 tool keeps track of asset warranty status to reduce maintenance expenditures and prevent unnecessary work and time on assets under warranty.
- **Asset analysis—**Analytics can tell you why assets fail, the costs to operate them, and where each asset is located to optimize deployment.

Taken together, these tools all work together to improve your asset ecosystem.

Build your maintenance program around these best practices

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

1. Assess your existing maintenance strategy

It's difficult to move forward if you don't know where you've been in the past. The stages outlined earlier in this paper provide a good indicator of where you are in your asset management program, but you first must understand the past and establish a performance baseline. For example, analyze benchmarks such as percentage of work that's planned versus breakdown related/reactive in nature. Further evaluate these indicators by equipment class or type to determine more accurate baselines and possibly even root causes of failures.

Also, determine your proficiency in capturing and analyzing asset data. The amount of data you can collect and analyze will form the foundation for your entire program. Often the information you need to drive your decision-making and processes can come from multiple disparate sources, including your 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. You need a holistic view across disparate sources to drive greater efficiencies and better decision-making. With the right data, you can develop a sense for how your asset portfolio is performing and where to invest additional budget to ensure assets align with strategic goals.

In a multi-plant operation, look at how well you're sharing best practices, as well as handling your inventory management and procurement across your facilities. Are common performance measures established so you can make comparisons? Can you easily consolidate information across plants and facilities into a single source of truth for analysis? Is cross-plant collaboration taking place? Answering these questions will help you gauge how well your 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.

2. Identify your strategic assets

You don't need to use predictive maintenance for all of your assets. Instead, identify your strategic assets—the ones that directly have an impact on your revenue. A part is strategic if it's essential for making product, for example; its performance and availability affect your output. In addition, consider production throughput to determine to what extent equipment failure would lower revenue. Failure of a highly efficient production line that operates at high throughput may be more tolerable to your business than stopping a production line that struggles to meet your throughput requirements.

3. Determine your best indicators of failure

Failure occurs for different reasons and varies by equipment, environment, and operating requirements. A pump handling abrasive slurries may suffer excessive vibration before experiencing bearing and seal failure, while excessive energy consumption may signal wear problems in another pump. You can discover trends and patterns when you look at the history of your assets' performance, combined with failure studies, reference cases, and your own institutional knowledge or experience.

In addition, your most important strategic assets could be monitored for multiple indicators to minimize production disruptions. Also, 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 quality—and wouldn't serve as a leading indicator of an equipment performance problem.

Assets aren't isolated; instead each asset consists of a complex system of other components, likely interrelated to assets you must monitor, track, and report

all across the plant floor.

4. Automate analysis

Timely action based on real-time operating data is instrumental to an effective predictive maintenance program. The old method of having your 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 you to take action on your real-time analysis.

The right analytics tools can help you 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 your asset management practice. In contrast to systems that capture, for example, a generator's real-time performance information and produce reports for an engineer to sift through for answers, a system that supports actionable analysis takes this several steps further.

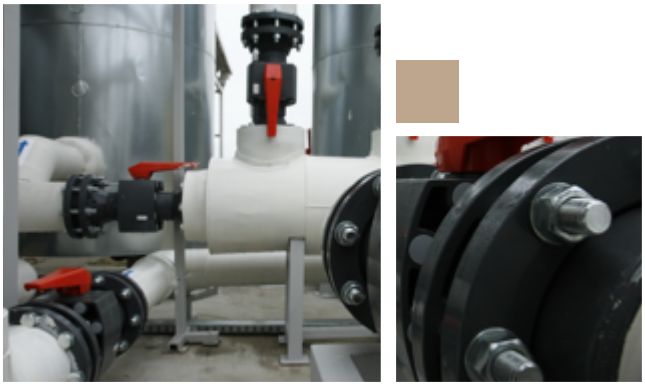
It automatically analyzes generator data (e.g., electrical consumption) for predetermined trends over time—such as 10% or more excess energy consumption for more than 60 minutes—and alerts key stakeholders to take action when specific conditions are found. An alert can be in the form of a prescriptive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

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

5. Measure and refine

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

With today's leaner supply chains and reduced safety stocks, you must be able to minimize the time it takes to correct issues and increase your 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—you must find one or a combination of several that best meet your needs.



Measure your energy efficiency to predict failure

Energy efficiency is often overlooked as part of a company's asset management practice. 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. Consider the example of the complex nature of identifying the cause of a change in pressure in the flow of liquid from one tank to another. By monitoring energy usage of each asset, you can tell which asset is either drawing too little or too much energy and start your inspections there.

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, you 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.

To relate this to actual costs, consider a single 100-hp motor running continuously at 95% efficiency for five years. The motor 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 industrial manufacturers, 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. Companies must employ predictive maintenance techniques on their most strategic assets. In addition, they must consider energy efficiency to develop a comprehensive strategy to eliminate unplanned downtime and reduce operational costs.

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