Bently Nevada

Making the Case for Plant-Wide Condition Monitoring

Lower Costs, Mitigate Risk, and Increase ROI Using Condition Monitoring

BAKER HUGHES
a GE company

A plant reliability managers' top concern is ensuring that all plant assets remain healthy, online, and productive. The only way to do that with certainty is to frequently monitor the health of every eligible machine in a plant, an endeavor that was nearly impossible -- until now.

Many maintenance and reliability professionals today have adopted modern online condition monitoring and protection technologies for highly critical turbomachinery assets. Proactive prediction of potential issues on these assets is smart and safe since they have significant impact on the health and safety of the facility. Simultaneously, auxiliary or plant-wide assets are traditionally checked via periodic walk-around monitoring, which is economical but infrequent. This leaves opportunities for improvement.

Maintenance budgets are typically allocated to the most critical equipment rather than plant-wide counterparts, making adoption of new monitoring technologies inconsistent across the industry. And even though permanently installed condition monitoring technology has been available for many years, achieving true plant-wide monitoring required the use of multiple monitoring systems simultaneously thus creating a cumbersome, expensive, and inefficient process.

The potentially catastrophic gaps in monitoring that occur by using a piecemealed maintenance method expose plants to significant financial and environmental risks and fall far short of the necessary reliability goals for modern industry maintenance to move from reactive to proactive.

Today, a single enterprise solution is available to monitor the health of our critical and supporting machinery alike. The "eagle-eye view" data collected from a plant-wide condition monitoring system empowers plant reliability managers to make informed proactive decisions about individual machine maintenance, provides a holistic view of the health of their interconnected factory equipment, and helps to better predict potential downtime. It can also improve overall plant ROI and decrease risk associated with reactive, outdated and spotty maintenance techniques.

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Current Maintenance Techniques Leave Risky Monitoring Gaps

Maintenance professionals hold tremendous responsibility. As the safeguards of plant equipment, they're caring for massive investments, preventing costly downtime, avoiding potentially catastrophic environmental hazards, and protecting the health and lives of countless individuals who work within plant walls.

Traditionally, maintenance and reliability professionals were forced to rely on costly and antiquated maintenance techniques that only provided a partial view of equipment health. 'Run-to-failure' maximized the useful life of any given part but risked catastrophic downtime and safety issues when the part failed. Time-based preventative maintenance proactively replaced parts before they failed, forcing the company to purchase potentially unnecessary parts for healthy machines. Furthermore, this strategy alone only accounts for 10 to 15% of the assets in a typical industrial facility.

With the introduction of predictive maintenance, the ability to use data to recognize when damage had occurred that would lead to machine failure was available for the first time, allowing treatment of a specific problem before it progressed. Due to the limitations of monitoring technology and budgetary constraints, predictive techniques have traditionally focused on monitoring highly critical machinery. Unfortunately, this narrow focus leaves acute vulnerabilities in overall maintenance strategy:

- **Blind Spots:** Monitoring only critical machinery leaves massive gaps in predictive maintenance strategy
- **Narrow View:** Current condition monitoring techniques (Portables, Process monitoring and historian systems, Operator rounds, etc.) do not provide a holistic plantwide view, or provide data infrequently, forcing maintenance teams to make decisions based on incomplete data
- **Redundant:** Utilizing multiple condition monitoring hardware and software systems is superfluous, complex, and inefficient

Additionally, plant maintenance experts are approaching retirement and the next generations are not being trained to take their place. As machine complexity increases and expertise levels decline, the risks associated with continuing to utilize incomplete maintenance strategies becomes overwhelming:

- Machine failure and unexpected downtime (Downtime costs $22,000 per minute on average and unplanned maintenance costs 2-5 times more than planned maintenance)
- Decreased ROI
- Creeping Costs (Direct and hidden – See below graphic)
- Inefficient spare parts management
- Human safety
- Environmental hazards

The "Iceberg" Model

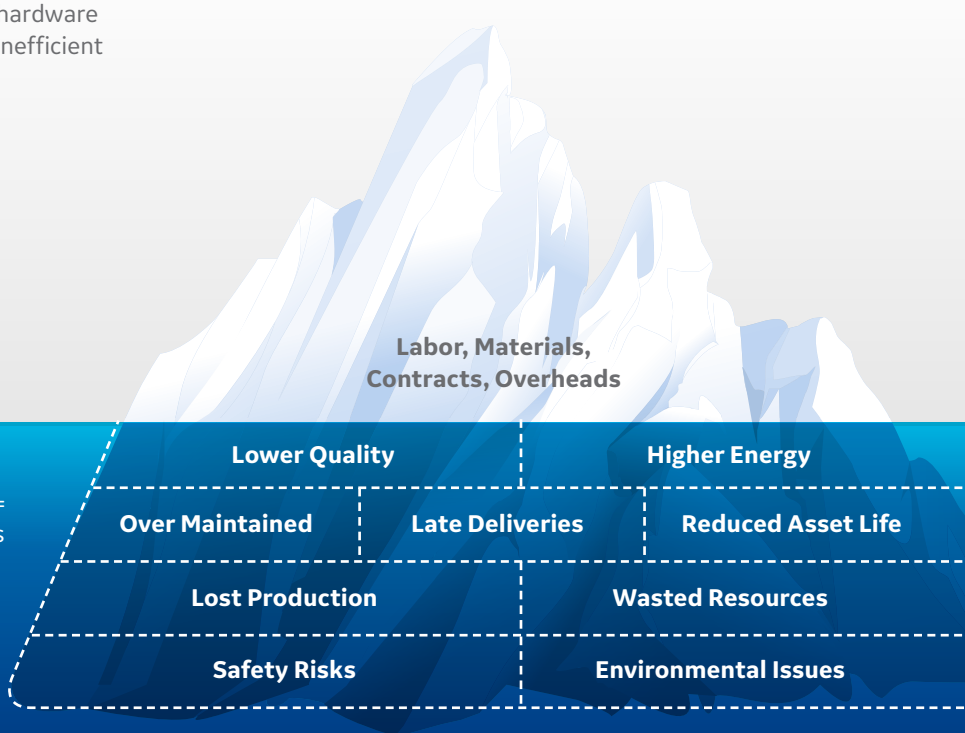

Figure 6: Total Costs of Maintenance - the "Iceberg" Model (Wienker et al.,2016, p.414)

The Future of Effective Maintenance is Plant-Wide Condition Monitoring

What is Plant-Wide Condition Monitoring?

Imagine a world where a reliability manager can monitor the health of nearly all plant machinery and make intelligent maintenance decisions based on real-time data. This scenario is today's reality. The next evolution in predictive maintenance strategy will be a transition to nimble and accurate real-time condition monitoring of an entire industrial facility.

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In addition to the most important assets found in industrial facilities, there are often a host of "supporting" assets that make up the balance of the plant such as pumps, motors, blowers, heat exchangers, fans, and others.

This auxiliary or plant-wide equipment may be spared or unspared, and its' impact on the process stream may vary from minor to critical. Regardless, these machines can benefit from condition monitoring to help access the aforementioned "blind spots" created by outdated maintenance techniques.

Predictive plant-wide condition monitoring is the monitoring of all eligible vibrating and rotating machinery in an industrial plant. It requires the adoption of a unified system of monitoring hardware, software, and analysis system support. Within this unified system, the unique criticality and failure modes of each machine should dictate the appropriate monitoring hardware used on it; from portable data collectors to continuous and online.

Proactive vs. Reactive

Monitoring hardware and software solutions have made huge technological advances in recent years. Techniques that only a few years ago were only able to identify the fact that irreversible damage had started can now be used to identify root cause failure mechanisms in progress and before the damage starts, truly enabling maintenance and reliability teams to be strategic and proactive rather than tactical and reactive for the first time.

CASE STUDY

Preventing Asset Problems with Wireless Condition Monitoring

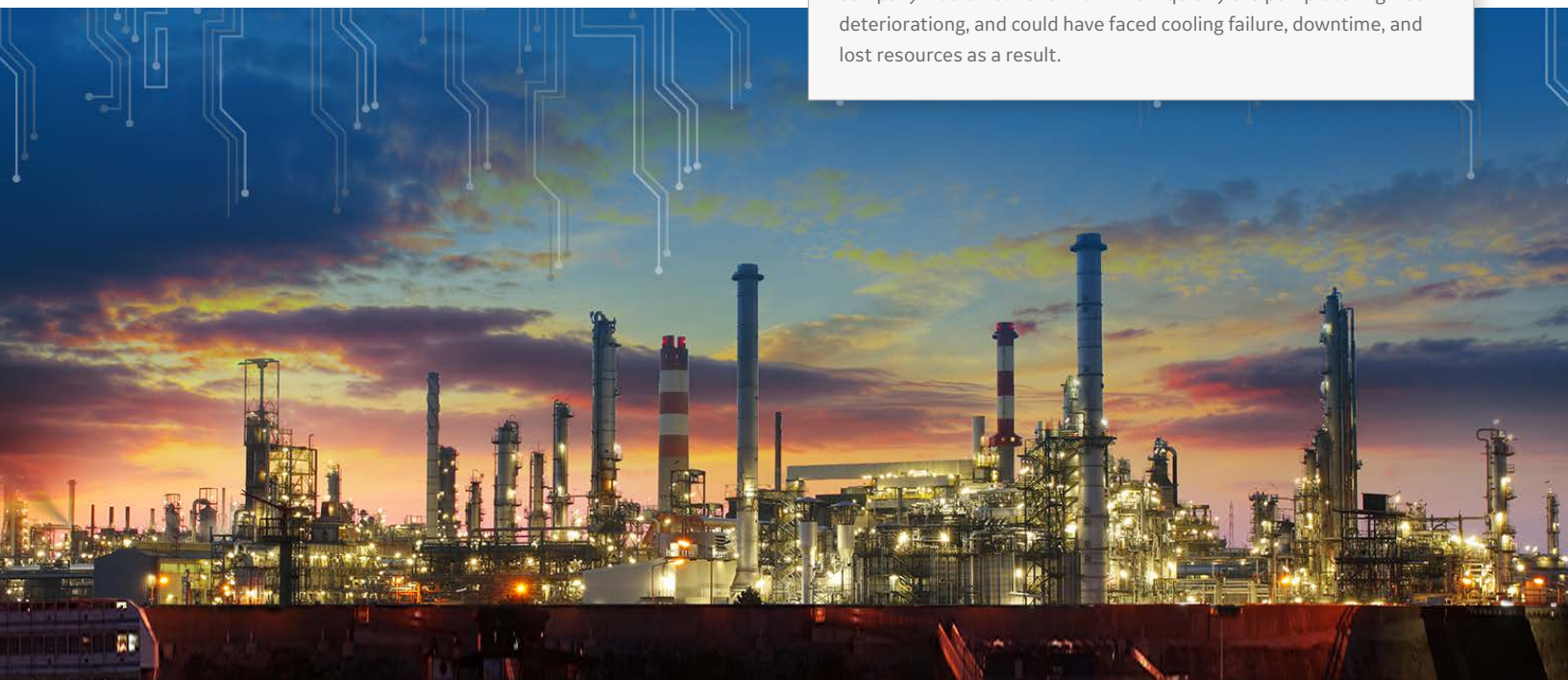
SITUATION: Wireless vibration sensors detect condenser pump bearing failure. A biotechnology corporation was using five condensers pumps to supply cooling water for an essential refrigeration system, used to store sensitive products. They had been collecting and analyzing vibration data from these pumps on a monthly basis to ensure the system was running properly. But during one of those inspections, a fault was suspected in the pump outboard bearing.

ACTION: Wireless vibration sensors were installed right on the pump for continuous monitoring at a more frequent, user-defined interval. Within 8 days, the overall vibration amplitude of the faulted pump bearing nearly tripled, indicating it was time to make the necessary repairs. The wireless sensors were instrumental in providing the data that alerted the team of the extreme degradation rate.

RESULTS: For one company, the vibration data collected by wireless sensors made all the difference.

"[Wireless sensors] saved us valuable time and money by allowing us to collect vibration data at a user-defined interval without having to use a portable collector."
Biotechnology company technician

If they had not used this wireless vibration sensor system, the company would not have known how quickly the pump bearing was deteriorationg, and could have faced cooling failure, downtime, and lost resources as a result.



Industry 4.0 and the Future of Data-Powered Maintenance

Since the Industrial Revolution, the manufacturing industry has seen three major technological advances: steam engine-powered factories in the nineteenth century, mass production powered by electrification in the twentieth century and automated machinery in the 1970's.

We are now entering the fourth phase of technological advancement, known as Industry 4.0. During this phase, we will see the rise of manufacturing processes that are digitally connected along the entire value chain via smart machines, remote sensor monitoring, and IT systems.

A connected and fully-integrated plant-wide condition monitoring system offers a holistic view of the entire plant enabling powerful predictive analytics. The unparalleled amount of data collected by such a system empowers reliability managers and proactive maintenance teams to make smarter decisions. You cannot recreate uncollected data after failure unless you monitor before failure occurs.

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That same connected system also offers company executives the opportunity to quickly assess the health and operability of every individual plant in their portfolio. This eagle-eye view of plant operation will be an essential prerequisite for the larger organization's transition to Industry 4.0.

CASE STUDY

Condition Monitoring Empowered Shipboard Engineers to Monitor and Diagnose Faults on Hard-to-Access Seawater Pumps

SITUATION: The shipping organization of one of the world's largest energy companies was looking for an accurate way to monitor hard-to-access equipment as the next step in the expansion of their shipboard condition monitoring program. They chose to do a trial of Bently Nevada AnomAlert condition monitoring system, installing it on two seawater pumps aboard a Liquefied Natural Gas (LNG) carrier.

ACTION: The two motor-driven seawater pumps that were selected for monitoring were vertical, double-suction centrifugal pumps in the Main Cooling system. After installation, initial assessments with early reports indicated that both monitored seawater pumps were experiencing rubs, misalignment, a vane pass anomaly, and a reduction in pumping efficiency that suggested that early misalignment had contributed to impeller damage.

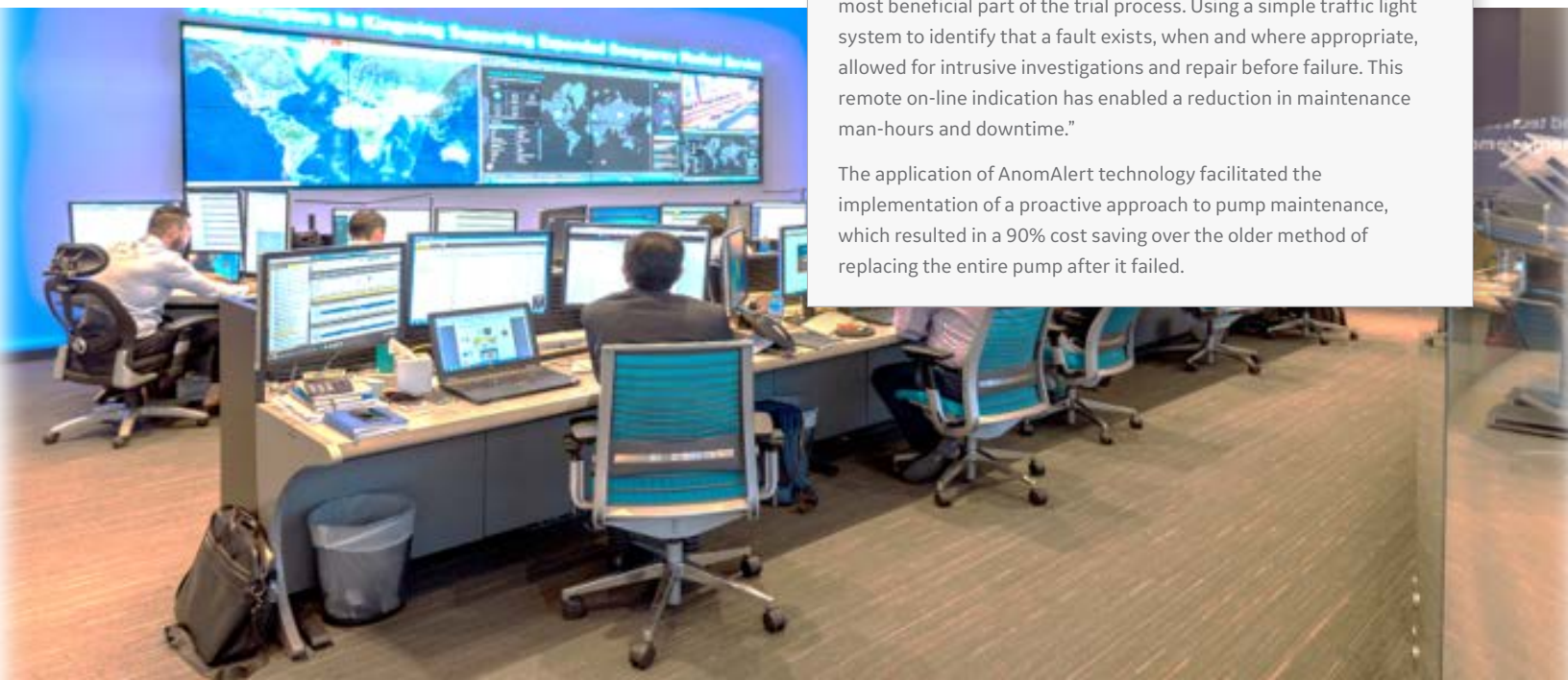
The engineers decided to continue to monitor the pumps to confirm the early reports. Successive data collected confirmed a gradual decrease in power consumption as the pump was able to do less useful work. Maintenance monitoring specialists predicted that pump performance would continue to decrease as erosion advanced.

Once the power factor fell below a pre-determined threshold, maintenance was scheduled to disassemble the motor and pump to compare the as-found conditions with the assessments provided by the AnomAlert unit. When the upper casing cover was removed, it was very apparent that the flow vanes (fins) had suffered significant metal loss due to erosion. The impeller had light fouling, and the wear rings had eroded, causing a reduction in performance by allowing recirculation flow. A small hole had also eroded in the pump casing where a flow disturbance was produced by a wear ring retaining screw.

Maintenance teams took appropriate action to repair the pumps back to good working order.

RESULTS: At the successful completion of the trial, the Engineering Superintendent concluded: "The online system monitoring was the most beneficial part of the trial process. Using a simple traffic light system to identify that a fault exists, when and where appropriate, allowed for intrusive investigations and repair before failure. This remote on-line indication has enabled a reduction in maintenance man-hours and downtime."

The application of AnomAlert technology facilitated the implementation of a proactive approach to pump maintenance, which resulted in a 90% cost saving over the older method of replacing the entire pump after it failed.



90% of failures **are NOT time-based**

A move towards Predictive Maintenance

+25% Production

Machinery Breakdowns **-70%**

Downtime **-40%**

Maintenance Costs **-50%**

50%
Of workforce to retire in the next **5 to 10 years**. Knowledge & experience is not being transferred

60%
Estimated increase in EHS spending among global E&P companies

6x
the cost for unplanned events vs. planned maintenance in process industries

[1] A survey of 500 plants by Keith Mobley, "Introduction to Predictive Maintenance"
[2] U.S. Department of Energy

The Journey to Plant-Wide Monitoring

Industrial maintenance trends continue to indicate that maintenance experts will increasingly be required to do their jobs in higher-value facilities with fewer resources.

Modern Industrial Maintenance Trends include:

- Downsizing plant staff
- Maintenance expertise levels decreasing as maintenance workforce ages with no one trained to replace them
- Predictive reliability maintenance works
- Industry by Industry - A 2018 Frost & Sullivan “Digitization of Condition Monitoring” study compared the various “invest to transform” trends emerging from the adoption of plant-wide wireless condition monitoring:

- The oil and gas industry is moving from siloed oilfield operations to integrated production fields.
- The power industry is seeing the benefits of smart meters and decentralized power generation units with the integration of network and security operation centers.
- The mining industry is identifying the reliability gaps in current operations at mining facilities and implementing corrective actions.
- The food and beverage industry is driven by the need to reduce maintenance costs, centralize visibility of filling machine lines, and standardize the drying process.
- The pulp and paper industry is focused on detecting early bearing degradation and maximizing sensitivity to low-level vibrations.

How to Get Started

If you are interested in learning more about plant-wide condition monitoring solutions, here is a quick "get started" outline and next steps to learn more.

Embrace the future of predictive maintenance. Transitioning from current maintenance strategy to a holistic, plant-wide approach will not happen overnight. Before we even begin the journey, we must truly embrace the belief that the future of industrial maintenance lies with interconnected predictive solutions. Once we understand that the future of maintenance will look very different than when we started out, we can begin to plot our journey to plant-wide.

Make the case for Plant-Wide. A true plant-wide condition monitoring solution requires significant investment as it's an integrated system of hardware, software, and monitoring services, all working together. The better we are able to justify the investment by addressing the following three areas, the more successful we'll be when discussing the transformation with key company decision makers:

A. Increase Efficiency. How will plant-wide monitoring increase plant efficiency in terms of both preventing plant downtime and personnel?

B. Mitigate Risk. What are the specific risk areas that the new solution will help mitigate? Where are the blind-spots in your current monitoring system? What are the associated costs if a machine fails? Explain how a plant-wide system will help eliminate those blind spots.

C. ROI in the Short and Long-Term. Identify specific ROI areas of opportunity that a plant-wide solution will address. How will the investment pay off in the short-term and long-term?

Choose the right condition monitoring partner. The maintenance industry is flooded with hundreds of monitoring solutions and technology partners. It can be difficult to know which one to choose. When you begin to think about a plant-wide solution, the field becomes a bit narrower as very few companies offer a true plant-wide unified hardware, software, and services monitoring solution.

Ultimately, you should partner with a company that has proven their commitment to helping you succeed – someone you can trust with your most valued assets.

Making the transition from critical-only condition monitoring to a plant-wide approach has the potential to elevate a plant to best-in-class status. A fully integrated and modern plant increases the level of sophistication, productivity, and reliability for the entire industrial maintenance field. As we improve safety, uptime, and capabilities, our living standards around the world increase as well, thanks again to manufacturing innovations.

Interested in learning more? Visit us at:

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