

White Paper

Reaping the Rewards of a Remote Monitoring and Diagnostics Program



**Proactive monitoring of rotating equipment and control systems
can increase plant efficiency and reduce unplanned downtime,
operating and maintenance costs**

Rockwell
Automation
Global Manufacturing Solutions



Unplanned downtime can be extremely costly, particularly in continuous flow and process applications such as the pulp and paper industry.

As today's manufacturers continue to seek new methods and tools that can enable them to do more with less, many leading-edge companies are turning to innovative monitoring and diagnostics tools that can dramatically enhance and improve a company's existing maintenance, repair and operation (MRO) programs. Often referred to as "remote monitoring and diagnostic systems," such technologies can help companies cut overall production costs, improve quality, minimize downtime and increase operational efficiency.

Thanks to the Internet, new intelligent monitoring tools, and high-speed plant floor and telecommunications networks, manufacturers today can collect and analyze data from every corner of a plant, providing the ability to monitor and protect the health of plant assets — even from remote, offsite locations. Progressive manufacturers realize that capturing, analyzing and effectively using condition and operating information from machines can significantly reduce — and even prevent — unplanned downtime and enable managers to make informed production decisions. In short, remote monitoring systems can provide an important strategic and competitive advantage that can improve profitability.

But deciding on whether or not a remote monitoring system is right for a particular company is no easy task. Complicating the issue is the fact that there are many variables to consider when deciding how to implement such a system, from the technology to use to the people that will monitor and analyze the system. For example, is it better to create an in-house department responsible for machine monitoring? Or would it be more cost-effective to outsource such duties? Companies must weigh their options carefully before making such a decision.

Avoiding downtime is critical

Manufacturers know all too well the high costs of premature or unexpected equipment failure. Unplanned downtime can be extremely costly, particularly in environments such as continuous flow and process applications, where a single hour of unplanned downtime can cost tens of thousands of dollars — perhaps more. At the same time, most manufacturers can't afford to stop production just to identify potential or developing equipment problems.

According to Dr. Jay Lee, director of the Center for Intelligent Maintenance Systems¹ in Milwaukee, the need for speed and agility is paramount for today's manufacturers as competitive pressures continue to raise the bar on performance and delivery. "The growth of e-commerce and use of the Internet has injected a velocity into industry and societal interactions that allows little room for downtime," Lee said. "So much is being done at the last minute, and being done quickly, that any breakdown in the chain can have a major impact."

What should be monitored

When implementing a remote monitoring and diagnostics program, manufacturers should first determine what equipment to monitor based on their type of process and the role of that equipment in the process. The next determining factor is the type of information that needs to be collected, monitored, and analyzed from that equipment: machine conditions, operating data or both.

Machine condition is normally associated with mechanical and rotating devices and includes lubricant state, vibration, alignment, wear, moisture, and component temperature. Condition-based monitoring involves regularly collecting information on these parameters from selected machines to determine when an undesirable change of state occurs and how corrective action can be triggered. By determining when a machine condition deviates from an acceptable state — and learning how to prevent such conditions — manufacturers gain a proactive and predictive maintenance tool that helps minimize machine damage, unexpected breakdowns, and product quality issues.

For example, advanced condition monitoring technology can accurately predict when a machine's oil is degrading and should be changed. So, instead of routinely changing the oil for a piece of equipment according to a regular maintenance schedule, a manufacturer may potentially save time and money on maintenance by changing the oil less frequently — on an as-needed basis. While such savings may seem small on a per-machine basis, they can quickly become significant when calculated for all affected equipment across the facility.

¹ The Center for Intelligent Maintenance Systems is a joint research center of the University of Wisconsin-Milwaukee and the University of Michigan, studying predictive maintenance, remote monitoring and Web-enabled agents to achieve near-zero-breakdown conditions on the factory floor.



High speed plant floor networks and telecommunications technologies make it possible for process and controls specialists at Rockwell Automation's In.Site Command Center in Cleveland, Ohio to remotely monitor real time production data from plants located almost anywhere in the world, 24x7x365.

Operating data such as line speed, pressure, input/output voltage, process temperature and flow rate can be remotely collected and monitored through the electronic control system of the machine. This information can be used to immediately notify maintenance personnel or an outside support service when a fault has occurred or a pre-defined process variable has deviated outside of the acceptable operating range. The problem can then be diagnosed and corrective action or maintenance activities performed to maintain quality and minimize or prevent downtime.

"We all understand that if you want to stay healthy as an individual you have to maintain yourself," Lee said. "Yet many of today's top companies still don't apply these same rules to their manufacturing plants. Maintenance is not 'fail and fix,' it's 'predict and prevent.' If you don't know how to predict and prevent, you're not taking advantage of some powerful cost-cutting tools."

The strategy of monitoring and predicting machine problems in advance is a significant shift in maintenance philosophy and resource allocation — from reactive to proactive activities. To properly implement a proactive system, manufacturers need to invest and commit to not just fixing a problem, but also identifying its root cause. Such a process means more than just knowing that the bearing in the motor needs to be replaced on a regular basis, or the line speed must be constantly adjusted. It means uncovering why the problem is consistently happening. Is it simply a lack (or excess) of lubrication? Or is a system component prematurely failing? A remote monitoring and diagnostics program can help uncover and solve such mysteries.

Web-enabled Condition Monitoring Keeps BP Shipping Ltd. Afloat

- BP Shipping Ltd. operates a fleet of 29 tankers, carrying crude oil, oil products and liquefied natural gas around the world. Working with Rockwell Automation, BP Shipping has made shipboard plant-equipment data accessible to its engineering superintendents anywhere in the world. Ship engineers manually collect data on levels of vibration and other variables, such as pressures and temperatures, for critical plant equipment on a routine basis. The data is then automatically e-mailed via the ships' satellite communications to BP Shipping's central database at its Hemel Hempstead, UK, headquarters, and to Rockwell Automation's monitoring center in Chester, UK.
- At the monitoring center, the data is collated and analyzed. Each month, reports on the condition of the plant equipment are available through a secure Rockwell Automation Web site, which can be accessed by BP Shipping personnel with the necessary security clearance. Each ship has its own Web page, which provides technical information for the vessel and collates all analysis reports, technical documents, manuals and user guides.
- At the click of a button, ship engineers can obtain help from Rockwell Automation condition monitoring experts via an online e-mail form. Additionally, on a monthly basis, the ships receive PDF versions of the monthly reports via e-mail. A CD-ROM containing all reports is mailed every six months.
- BP Shipping receives two major benefits from Web-enabling its condition monitoring data:
 - 1** It provides a cost-effective means of collecting and analyzing data from what are basically mobile factories. The company has already realized savings by reducing unexpected breakdowns and repairs, thereby enabling better planning of routine maintenance.
 - 2** It helps reduce survey costs incurred to keep the ship registered with its classification society, Lloyd's Register. Lloyd's Register normally requires that all major plants onboard be inspected on a five-year rolling basis. However, because Lloyd's Register is able to carry out "virtual" assessments of the plant's condition just by checking the condition monitoring reports online, the approved condition-monitoring program used by BP Shipping exempts the ships from a large portion of these costly shipboard checks.

In.Site Continuous Support Helps Finch, Pruyn Reduce Downtime Costs, Improves Efficiency

Over the years, many organizations have subscribed to the age-old wisdom, “If it ain’t broke, don’t fix it.” However, companies that run continuous production operations often adhere to a different philosophy — “an ounce of prevention is worth a pound of cure.” That’s because a sudden machine failure can damage thousands of dollars worth of products and disrupt delivery schedules, particularly in continuous-production industries such as paper manufacturing. Such unplanned machine failures create increased labor costs, lost revenue and unhappy customers.

No one is more aware of this reality than Finch, Pruyn & Co. Inc, a leading manufacturer of fine uncoated papers for marketing, book publishing and business office use. Based in Glens Falls, N.Y., Finch, Pruyn paper is known for its superior smoothness, high brightness and opacity, and excellent printing characteristics. Founded in 1865, the locally owned and independent company produces more than 240,000 tons of paper per year.

Finch, Pruyn operates four paper-producing machines in its plant. One of these machines, which produces bonded specialty paper, accounts for 55 percent of Finch’s total paper output. With more than half of the company’s revenue stream dependent on a single machine, the ability to achieve maximum uptime on this production line is critical. In order to maximize uptime and productivity, as well as drive growth, the paper producer needed a solution that would help prevent problems before they occurred.

For Finch, Pruyn, its objectives were two-fold: first, minimize or eliminate costly troubleshooting delays; second, shift the company’s maintenance strategy to a more proactive, preventative approach. To accomplish these objectives, Finch, Pruyn turned to Rockwell Automation, which recommended that Finch, Pruyn switch from its current reactive approach to “In.Site Continuous Support,” a proactive, real-time remote monitoring and diagnostics service from Rockwell Automation. Finch, Pruyn was quick to recognize the potential benefits of the In.Site support program and decided to implement the remote monitoring service on its specialty paper line.

As a first step, Rockwell Automation engineers traveled to Finch, Pruyn’s New York manufacturing facility to install a network communications kiosk on the plant floor. The kiosk is used to connect to the In.Site service each intelligent device

(e.g., controller, drive) involved in the specialty paper production process. The wide area network transmits data collected from the plant floor to a data warehouse at Rockwell Automation’s In.Site Continuous Support Command Center outside Cleveland.

With the connection to Finch, Pruyn’s production process established, engineers at the Command Center continuously assess production status using proprietary software applications to compare real-time and historical process data (e.g., line speed, yield, mean) to a pre-determined optimal range. If a parameter deviates outside the range, In.Site Support staff notifies the plant floor at Finch, Pruyn — often before the paper producer realizes there is a problem — and then begins troubleshooting activities to diagnose the cause and determine corrective actions. Once corrective measures have been determined, In.Site engineers collaborate with the plant maintenance staff to execute the actions and restore normal operations.

“Not only are we proactively identifying acute problems that could lead to unplanned downtime, but we are calling the customer immediately to let them know that we are already working to correct it,” said John Strohmenger, manager, Rockwell Automation In.Site Command Center. “Very few product vendors can provide that level of service.”

In the first year of the In.Site program, numerous potential unplanned downtime events at Finch, Pruyn were prevented, improving the overall profitability of the specialty paper line. For example, the service helped Finch, Pruyn to avoid \$347,000 in lost production and manpower hours by reducing the number of unplanned downtime events nearly 50 percent. The increased productivity and reduced maintenance expenses allow Finch, Pruyn to focus on higher priorities, such as producing high quality printing paper and improving business profitability.

“Our specialty paper line is critical to the success of our business,” said John Zak, drive system specialist, Finch, Pruyn. “Before we had In.Site Continuous Support, unplanned downtime was a constant concern. But now, we are confident the line will remain in operation. And, if it does go down, we know the duration of the event will be minimized. This has resulted in a significant improvement in profitability. The In.Site program has already paid for itself three times over.”

Evolution of plant floor monitoring technologies

Once it has been determined what to monitor, the next step is to determine how to monitor it. Computer diagnostic technology first entered the manufacturing production process with the use of self-evaluating devices that could send “help needed” messages when a machine encountered a problem. This type of remote monitoring only indicated when repairs were necessary. While this was an improvement over simply knowing a problem existed because the machine was down, it was a system that did not provide much insight into the problem source, or how to correct it.

Over the past decade, plant floor monitoring technologies have been able to provide more specific machine information, but they have been labor-intensive and time-consuming, relying on maintenance or engineering personnel to walk around the plant to gather information from machines. The collected data was then often taken to another location to analyze and determine necessary changes. With those changes in hand, the maintenance person would then go back to the machine and perform the necessary tasks. The information was rarely leveraged or shared within an organization for decision-making or coordination of activities.

Today, remote monitoring and diagnostics technology has evolved considerably, and the Internet and a wide range of network and telecommunications technologies have made their way to the plant floor. When used in conjunction with these communication technologies, accelerometers and probes mounted directly on plant floor equipment, and the control systems on that equipment, can send plant floor information throughout an organization — virtually eliminating the need for manual data collection. Best of all, these technologies allow companies to cost-effectively implement a truly remote, real-time process monitoring and asset optimization program that can potentially be accessed from almost anywhere in the world.

Because of the wide range of remote monitoring technologies that are now available, selecting the best approach for a given situation requires a thorough understanding of exactly what needs to be monitored, the costs associated with a specific monitoring technology, the skill level of plant floor personnel to implement and utilize the technology, how quickly information needs to be collected and analyzed, and the goals the program should achieve.

Immediate and proactive response to problems

Scalable to organizations of almost any size, remote monitoring and diagnostic tools can be tailored to fit virtually any plant floor application that utilizes intelligent devices (e.g., controllers, drives, sensors). Whether a manufacturer needs periodic predictive maintenance, continuous evaluation of critical machinery or as-needed response, remote monitoring and diagnostic tools can provide quantifiable benefits.



In some applications where in-house resources or expertise is limited, machine condition data can be collected manually and then sent to a central location or a third party for analysis.

One of the underlying strengths of a remote monitoring program lies in the immediate and proactive response it allows. This is especially important in industries where production disruptions can be extremely expensive, such as pulp and paper — potentially costing tens of thousands of dollars in downtime per event, as well as lost product. Through a remote monitoring and diagnostics program, information can be continuously collected from rotating equipment (e.g., rollers, dryers and gearboxes), control systems, and drives to identify even the smallest changes in operating variables or conditions — allowing problems to be identified and corrected well before they become visibly apparent.

Such remote monitoring systems can also help identify the root cause(s) of consistent failures or inefficiencies. For example, in applications where a pump is not performing to expectations, the problem can often be traced to a faulty pump seal. But a pump seal failure is often a symptom of something else, such as misalignment, overpressure or high temperature. By monitoring the right machine conditions and operating data, companies can identify the source of a problem that may otherwise be very difficult to detect.

Leveraging the benefits of external remote monitoring experts

Many manufacturers are looking outside their organization for assistance in non-core competencies, including remote monitoring and diagnostics programs. This strategy can help manufacturers focus on key goals — such as product development and faster delivery — while outside vendors find ways to reduce equipment downtime and improve efficiency. Outsourcing remote monitoring and diagnostics of critical machinery can also provide specific cost advantages, particularly in situations where machine performance is crucial but in-house monitoring is not practical because of limited resources. Even large companies that have in-house remote monitoring and diagnostics programs have found that employing external experts to analyze data and recommend corrective actions minimizes gaps in staff expertise and on-going training requirements.

External experts can also advise companies of commonalities — such as similar problems or potential cost-savings steps — that have been employed in other locations or similar applications. Likewise, a remote monitoring specialist working for a manufacturer with facilities in different parts of the world may be able to gather information from each plant and identify cross-organizational trends. For instance, if a particular piece of equipment operates within specifications in three out of four locations, data can be monitored and analyzed from all four sites to help identify the cause of the problem on the affected equipment.

Qualified remote monitoring experts can also provide manufacturers with peace of mind. Many of these specialists operate from a central, offsite service center that is online 24 hours a day with each production facility, and immediate help is always available to assist maintenance personnel with problems that have been identified. The offsite specialists can also remotely access plant floor systems to change machine settings or restore lost or corrupted software.

In some cases, the remote monitoring service provider may even offer Web access to the same data they are collecting and



Through collaborative partnerships with service providers like Rockwell Automation, manufacturers can supplement in-house support and maintenance capabilities and more effectively manage the operation of their production assets.

monitoring offsite. The Web site can include the ability to view current operating conditions, store and review support incident and trending reports, and download current software versions or machine settings in the event of unexpected file loss or damage. When integrated with a computerized maintenance management system (CMMS), such status reports can trigger work order requests directly to the facility via fax or e-mail.

Evaluating your remote monitoring and diagnostics options

When evaluating the feasibility and benefits of a remote monitoring and diagnostics system, manufacturers should consider a number of different variables and personnel-related issues:

- The number of sites the company wants to monitor.
- The accessibility of the sites and equipment to be monitored. Are isolated or hazardous locations involved?
- The size of the company. Are costs of hiring a full-time diagnostics expert justified? Or is it more cost-effective to hire an outsourced remote monitoring service provider?
- The immediacy of action required for the equipment being monitored. How critical is the machinery to the manufacturing process? Real-time analysis of data will signal an immediate alarm if parameters deviate outside of normal operating ranges.
- The cost of implementing and maintaining an in-house program. With outsourcing, upfront costs are generally lower. The smaller the company, the less likely it is to justify the cost of an internal program and equipment.
- The value of equipment. Outsourcing is ideal for monitoring critical equipment, especially those with fast failure rates or critical maintenance needs. Lubrication or bearing failure, for example, can critically damage a machine in just 30 minutes.
- The need to standardize diagnostics across more than one location. If a company uses separate groups to collect data, information may be difficult to integrate for company-wide trending and analysis.
- The experience and skill sets of company personnel. Due to the training time needed to develop an effective internal program, results may not be immediate. With an outside provider who is already familiar with monitoring and analysis procedures, the first diagnostic set will be timely and accurate.
- The availability of vibration analysts. Vibration analysis is a highly specialized field and it can be extremely expensive and difficult to obtain a full-time employee with the neces-

sary level of expertise. In addition, if an in-house vibration analysis expert leaves the company, it may be difficult to find another staff member that can precisely and authoritatively analyze the data until a replacement is found. Using external resources means multiple experts are continuously available to support and consult to the manufacturer.

Predicting the future of intelligent maintenance

As remote monitoring and diagnostic systems help manufacturers move closer to 100 percent levels of reliability and productivity, what does the future hold? According to Dr. Lee, "The future of outsourcing strategies for remote monitoring and diagnostics will be found in service business automation. Companies cannot afford downtime for both their equipment and their supply chain. More and more, efforts will be placed on prognostics and 'predict and prevent,' rather than 'fail and fix.' The trend is toward 'smart' products and machines that can automatically call for service or order spare parts."

Dr. Lee's Center for Intelligent Maintenance Systems has coined and trademarked the phrase "Device-to-Business" (D2B) to account for this technology of tomorrow. Already in plant-floor testing, the Web-enabled D2B platform transforms machine data into more useful formats, optimizes maintenance and production scheduling and synchronizes data from other systems, suppliers and customers.

Sophisticated monitoring and diagnostic technologies are greatly improving the ability of manufacturers to reduce long-term operating costs and increase uptime and asset availability.



Isolated and hazardous locations are often ideal candidates for remote monitoring and diagnostics programs.

Expanding the Scope of Predictive Maintenance at Air Liquide America

There are many real-world instances in which remote-monitoring and diagnostic services have provided leading manufacturers with cost savings and other tangible benefits. For example, Air Liquide America, a leading supplier of gasses to a wide variety of industries, is currently working with Rockwell Automation to implement a hybrid on-site, remote monitoring and diagnostics program. The program is designed to expand the scope of its predictive maintenance at gas production facilities across the United States.

Because many of Air Liquide America's facilities operate automatically with a limited on-site staff, the company doesn't have resources available at each site to effectively use data gathered from its machinery.

For walk-around plants, Rockwell Automation Engineers collect data and perform the analysis. Data and reports are then sent to the Rockwell Automation embedded program manager who imports the data into the database. For online plants, the data is collected by permanently mounted data acquisition devices and transferred via Air Liquide's WAN to the database. The program manager then performs the analysis remotely. Reports and recommended actions are available to Air Liquide Plant Managers and Zone Reliability Engineers via a website developed and maintained by Rockwell Automation. This centralization of data allows Air Liquide to fix developing problems before production or safety is negatively affected, while also monitoring for machinery trends or consistent equipment failure across all of its sites.

Glossary of Terms

| | |
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| asset availability | the level of immediate access a plant has to parts, equipment or specialized personnel at any given time |
| CMMS | computerized maintenance management system |
| condition monitoring | monitoring to measure the condition of an asset |
| downtime | the period of time during which an item is not in a condition to perform its intended function |
| maintenance | any activity carried out to retain an item in, or restore it to, an acceptable condition for use or to meet its functional standard |
| MRO | maintenance, repair and operation |
| periodic maintenance | cyclic maintenance actions carried out at regular intervals, based on repair history, data, use or elapsed time |
| plant assets | the physical resources of a plant, such as the plant itself, parts, equipment, components and personnel |
| predictive maintenance | use of measured physical parameters against known engineering limits for detecting, analyzing and correcting equipment problems before a failure occurs; examples include vibration analysis, sonic testing, infrared testing, thermal testing, coolant analysis, tribology and equipment history analysis |
| preventative maintenance | maintenance carried out at predetermined intervals, or to other prescribed criteria, and intended to reduce the likelihood of a functional failure |
| proactive maintenance | style of maintenance initiative that is anticipatory and consists of planned activities |
| reactive maintenance | unplanned maintenance carried out in response to equipment faults and failures after they occur without warning |
| remote monitoring and diagnostic systems | MRO enhancements that utilize the Internet and intelligent monitoring devices to collect and analyze plant data |
| uptime | the period of time during which an item is in optimum working condition to perform its intended function |

Campbell, John Dixon. Uptime. © 1995 Productivity Press, Portland, Oregon

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