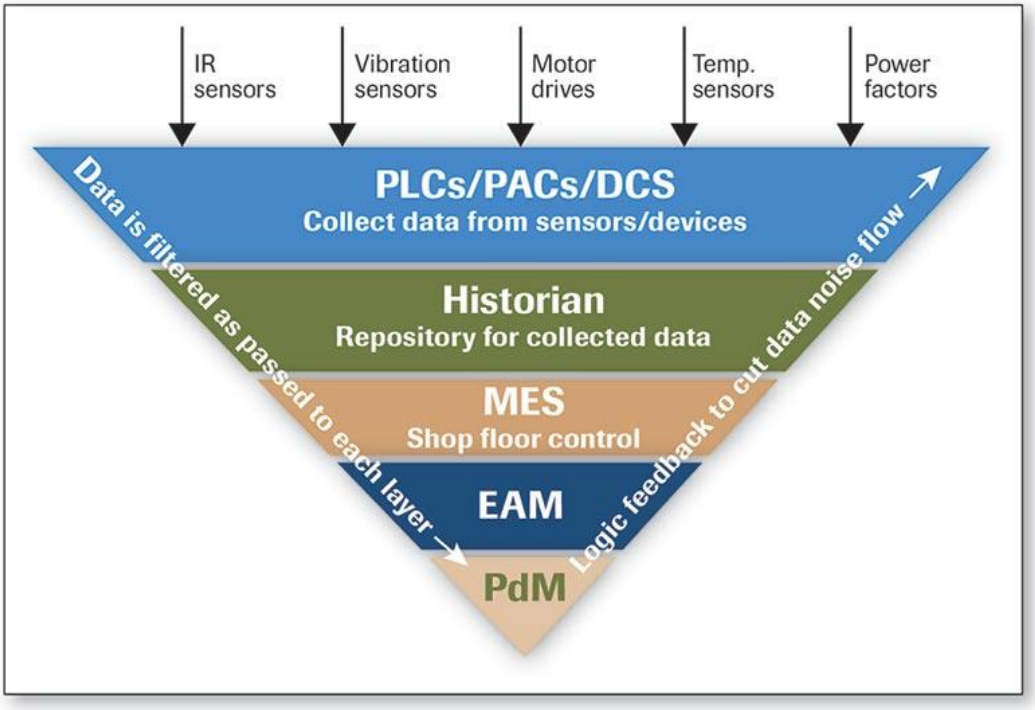
FoodEngineering

Predictive maintenance, Internet of Things can lead to big maintenance savings

The Industrial Internet of Things and low-cost sensors make PdM a must-have tool to stay competitive.



Aptean sees the flow of manufacturing data as traveling through a funnel. The flow of potential maintenance information originates with sensor inputs. Data not appropriate for PdM is filtered out. When intelligence reaches the EAM, a more accurate PdM strategy can be developed. *Source: Aptean.*

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Wayne Labs, Senior Technical Editor

No machine is an island in today's connected plant and enterprise. At least it shouldn't be—because the times, they are changing.

Unlike in the past, most machines built today will come with condition monitoring systems built in or added for a modest additional charge. Why? Because, coupled with a data historian, predictive maintenance (PdM) system and Internet-based technology, the status of a machine can be monitored by the machine builder or the end user—anywhere, anytime.

Knowing when a machine will fail and for what reason, a food processor can plan maintenance at an opportune time rather than incurring unscheduled downtime. What's more, the machine builder will often be spared an expensive trip across the country or the world. These all equal big savings.

Tetra Pak realized this and has begun transforming its services by pioneering the use of the latest technologies, focusing on improving the ability to predict machine errors, thus accelerating response times and giving the end user faster, direct access to the supplier's global expertise.

"Digital technologies are revolutionizing every industry, and it's exciting to make the latest innovations work for our customers," says Dennis Jönsson, Tetra Pak president and CEO. "We are pleased to be the first to launch digitalized services, offering customers reduced costs, enhanced efficiency and peace of mind."

Besides empowering Tetra Pak's local service engineers with wearable technology, the machine builder links them with global specialists for additional expertise when they need it. In addition, data from filling lines around the world is collected into a central database from which it can be accessed and analyzed by a team of Tetra Pak's global experts. This robust database makes it possible to provide advanced machine analysis, which can be used to predict problems and optimize machine performance. Finally, all the equipment at a beverage plant can be connected to the Microsoft Azure cloud system managed by Tetra Pak, enabling machines at different production stages to communicate and synchronize with each other, giving the processor an overview of the plant and offering performance optimization opportunities for the whole production.

IIoT: Gimmick or reality?

The Industrial Internet of Things (IIoT) certainly conjures up a fantastic scenario where every device communicates via wire or wireless using TCP/IP. The general concept is not new inasmuch as many industries have used largely proprietary wired and wireless data acquisition/control systems for years. However, the rapid evolution and deployment of IIoT technology today are unprecedented, and IIoT has the power to change the way we do industrial monitoring and control—and predictive maintenance.

"The data supplied by SCADA usually was the tool for the end users and their staff," says Harry Kohall, VP, business development at Eagle Technology Inc. "The IIoT tools allow the data to go back to the engineering and design teams for the machine manufacturer, letting them understand the operating environment and providing feedback to the machine [builder] about the conditions their equipment is running in."

For end users, the IIoT-based SCADA system has pluses.

"The IIoT essentially brings about the next level of SCADA—connecting machines across plants in the cloud, enabling large-scale data aggregation and predictive and prescriptive analytics," says Paul Lachance, Smartware Group president. "A cloud-based CMMS [computerized maintenance management system] integrated with an asset monitoring system can automatically process and centralize huge swaths of data from a wide range of equipment."

"The IIoT is one key aspect of a confluence of technology evolution that is enabling rapid deployment of progressive PdM benefits," says Jim Henry, SKF director, business development, food and beverage.

IIoT enables the movement and aggregation of data to allow experts to collaborate more effectively than ever before, freeing them from any geographical restrictions. IIoT connectivity makes the transparency

of productive business practices and the leverage of fleet-wide machinery operation and maintenance standards much more practical than in a disconnected world, adds Henry.

“IIoT allows for a lower-cost/lower-disruption solution for PdM strategies, and the continuous improvements in networking performance—for both wired and wireless—enable us to gather more and more meaningful data,” says Kay Jenkins, director, Aptean Asset Point product line. “This current era for IIoT seems to be analogous to the fast-paced trajectory in personal computing capabilities during the 2000s, in that the rapid pace of hardware and networking innovation during that time allowed us to create the applications we have today on top of those rapid innovations in the infrastructure. This parallels what we are seeing and are yet to see in IIoT.”

It’s the lower cost of sensor installation and greater access to critical asset and device data that are driving IIoT, says Jacob Swafford, Emerson Automation Solutions reliability and condition monitoring expert.

“Wireless is enabling us to put sensors where they could not be put before,” Swafford says. “The pure cost of sensors is continuously getting smaller, which is allowing us to instrument and monitor processes that were not monitored before.”

Even better, this data (such as vibration data) is now in the hands of OEMs and end users, who are able to manage this data either in remote monitoring or centralized integrated operations centers.

IIoT brings a wide variety of data to the forefront through “gateway” connections, so that real-time 24/7 information is available for quick decision-making, says Mark Young, reliability director at Advanced Technology Services/Operational Excellence. Machine builders can now offer these gateways that display the critical physical and process parameters needed for analysis.

“One of the opportunities IIoT brings is the potential to collapse the automation stack,” says Keith Chambers, Schneider Electric, software director, operations and execution systems.

The traditional Purdue Reference Model of operations separates out the control layer from manufacturing operations, business planning and logistics. This means that interactions between these three layers require a layer for processes and communications, complicating workflow between the stacks.

“Advances in low-cost sensing, IIoT technologies and cloud computing have enabled new, lighter deployment models with the potential to compress the automation stack,” says Chambers. “This can help further integrate or bridge the prior divide between the control, operations and enterprise layers, particularly in plants that lack [the] network infrastructure needed for plant-wide control and SCADA networks. Greater visibility of machine data facilitates a broader, more accurate approach to reliability and predictive maintenance at all plants.”

Changes at the controls level feed PdM

Bosch Rexroth, a member of the Control System Integrators Association, builds in condition monitoring tools that are drive based, essentially turning the servo motor into a “smart sensor,” along with controller-based solutions. Within the Bosch Group, the offering extends to sensors, big data analytics and software platforms, says John Gaddum, corporate account development.

“The biggest push for this technology has been led by end users,” Gaddum says. He explains this is because end users are looking for ways to capture even fractional amounts of savings to help improve profitability.

“The big change that IIoT brings is the increase in the amount of data available and the ease of access to that data through the control system,” says Richard Jennens, drives, Schneider Electric. “An example of this would be variable frequency drives. Typically, a drive has been seen as an actuator rather than a process monitoring device, but with the latest generation of advanced drives, such as the Altivar Process range, the drive can be used to provide the control system with performance data on the motor, pump and process.”

While legacy machines may not have the functionality to transmit condition data, that doesn’t mean they have to be replaced. A more cost-effective alternative is adding hardware to make them into smart machines, says Dr. Stephan Ihmels, business development manager, Siemens, Digital Factory Division, Lifecycle Management.

“We recently were contacted by a major food and beverage company that uses vibration data from BluVision beacons [a Siemens MindSphere ecosystem partner] and Siemens MindSphere to perform condition-based maintenance on over 200 small motors in their bottling line,” adds Ihmels. “For industries such as food and beverage, with huge numbers of less critical and low-cost motors on the production floor, it’s been more difficult to justify the business case for a data-driven strategy for PdM. The combination of new and continuously less expensive wireless sensors is now making it possible for vibration monitoring that is both affordable and easy to install.”

Kurt Sas, maintenance manager for InBev Brewery in Leuven, Belgium, contracts with Coservices, a predictive maintenance firm and Emerson Automation Solutions partner, to maintain plant assets. Coservices uses Emerson’s AMS (Machinery Health Manager) software to prepare customized reports showing the complete machinery health of each critical component of the facility’s production lines.

One machine monitored by InBev’s reliability program is a bottle filling carousel. Vibration monitoring (using Emerson’s AMS machinery health analyzers and vibration transmitters) indicated a growing problem on a 75-cm double bearing of the carousel. Failure of this large bearing would down an entire production line for a full day, costing the brewery more than 20,000 euros in lost production, replacement parts and emergency labor.

“This carousel is the heart of the whole production line,” says Sas.

Because the problem was detected early, Sas was able to replace the bearing rollers during a planned downtime rather than a forced shutdown. The PdM program has also helped the brewery by generating more than 100 problem notifications and has caught at least 10 potential failures each year.

Big data: Who/what handles it first?

With all these sensors, we have gobs of condition monitoring data that are helping to collapse the barriers between the three-level plant hierarchy. So, what system should be first responsible for presenting this data in a way that supports PdM, e.g., HMI, MES, ERP, EAM (enterprise asset management and, sometimes, a component of ERP) and/or CMMS? And, how should the data flow? The answers to these questions will depend partially on a plant’s organization—and how its maintenance department fits in with the overall operation of the facility.

“Any PdM strategy begins with an enterprise evaluating their existing infrastructure, workforce availability, most common issues and operational goals,” says Phillip Bush, Rockwell product manager, remote monitoring and analytic services. “By knowing what’s most important to meeting production targets, manufacturers can then begin to figure out what data to collect and where, whether on the edge of a network on in the cloud. One result of that evaluation is determining the best system—network, hardware, software and service solutions—that delivers PdM information.”

Remote monitoring begins with collecting data from a company’s industrial assets and then aggregating information in plant, near plant or in the cloud, depending on the information needed, says Bush. At the cloud level, enterprises can deploy predictive analytics as a service. Existing machine learning technologies and application experts are used to build a performance signature for an asset and identify patterns within that performance signature, signifying a change. The system can learn from historical data, helping provide predictive services from the moment it deploys. Asset management software works from a centralized location. Maintenance teams can set the software on auto-discovery, and it will track every asset on the network, providing this information in a digestible report.

It is possible for a processor to start out with simpler tools and move up the ladder as it grows.

“ICONICS recommends utilizing both real-time and historical data within an easy-to-use dashboard visualization tool,” says Melissa Topp, senior director of global marketing. “This dashboard can be deployed from a centralized location and then rolled out to maintenance personnel via tablets, smartphones and other Web-enabled devices, without losing necessary details.”

A connected fault detection and diagnostics system can be integrated with existing “institutional knowledge” gained through extended time with various hardware and systems. When equipment or lines are added, that inherited knowledge can be adapted to reduce maintenance time and costs, says Topp.

“Predictive data should be presented in one place that automatically notifies and escalates action when maintenance is required,” says Bob Argyle, Leading2Lean chief customer officer. “Cloud-based solutions provide technicians with mobile capability that puts everything at their fingertips. Basically, there’s 100 percent transparency to maintenance resources, spare parts, machine conditions and historical data.”

It also allows technicians to access the current revision of procedures, drawings and manuals from the worksite. This data is not only valuable in troubleshooting current problems, but is also useful when designing and modifying equipment, adds Argyle.

“In my experience, a CMMS/EAM provides the most comprehensive insights into maintenance data and asset and equipment condition,” says Smartware’s Lachance. “While HMIs and MESs are helpful for keeping track of manufacturing and production processes on the floor, they’re not necessarily going to be able to show you the same depth of maintenance and reliability insights into equipment and asset condition.”

“A CMMS should be responsible for presenting the real-time data in a way that supports PdM,” says Rona Palmer, eMaint Enterprises marketing director.

When data is gathered and aggregated electronically, reliability engineers, maintenance managers and others have the ability to correlate data from various technologies (infrared, vibration and power, for example) and share it across the enterprise. Managers are able to assess equipment condition in real time and, by viewing data on easy-to-understand dashboards, forestall unplanned downtime, adds Palmer.

But should this data stay at the CMMS level? Many ERP vendors think it should reside in the ERP or enterprise asset management (EAM) system.

"We feel that an ERP platform is the best place to store maintenance data," says Scott Deakins, Deacom COO. He explains two reasons for this opinion:

- **Production scheduling benefits:** Production scheduling is often the lifeblood of food and beverage manufacturers. By allowing maintenance tasks to be scheduled in conjunction with production jobs, manufacturers are able to work maintenance into their schedules.
- **Combined data benefits:** Viewing a machine's maintenance history with production data (e.g., what job ran, for how long, when) can help a processor establish and identify patterns. Often, the processor finds that a certain changeover activity or product line will affect a machine's health in a different way than expected.

IFS Applications support the ISO Standard 55000 for maintenance and asset management systems by keeping all data acquired over the lifecycle of equipment assets in a single, consistent database, says Patrick Zirnhelt, vice president, enterprise service and asset management, IFS North America. IFS Applications supports the capital process of constructing a new equipment asset and will, therefore, capture as-designed and as-built specifications. This data is then turned into equipment structures used to support maintenance and operation. As changes are made to an asset, either due to emerging needs or to address reliability issues, that data becomes part of the as-maintained record, which feeds into the planning of a replacement or new asset.

"This data on the physical state of the asset is combined in world-class EAM with fault data and condition monitoring data to facilitate design of replacement and future assets," adds Zirnhelt.

As maintenance history accumulates over the years, using the principles of RCM (reliability centered maintenance), EAM software will enable users to identify the ideal maintenance approach for each piece of equipment and component, adds Zirnhelt. (Equipment event data would be contained in a plant historian.)

"The system that should be the first responsible for presenting the data that supports PdM should be the EAM," says Mike Stone, product manager—Infor EAM, Infor CloudSuite Facility Management. "EAM can provide immediate actionable information to both maintenance and engineering while communicating with operations. It can update asset history as well as create work orders based on the conditions history and analytics."

With manufacturers building in predictive capabilities, as well as machine learning capabilities coming into use, they can determine trends and identify anomalies much faster than before, adds Stone.

This shows how the data flows from machines to the EAM and PdM, but a proper system should eliminate duplicate and unneeded data at the EAM/PdM level.

"I view the flow of information as a funnel," explains Aptean's Jenkins. "The machine is at the mouth, collecting what could be an overwhelming amount of information. That data is then routed to a historian to begin to sort through what is true and what is noise. Passing the information through a MES provides more insight, so the data becomes transformed into actionable intelligence. When that intelligence reaches the EAM, a more accurate PdM strategy can be developed. The logic should not just flow downstream; it needs to move back through the layers as well, so that with each pass, less noise is presented, and the remaining information is more accurate and relevant."

The more integrated EAM, MES and ERP are, the more accurate the information will be to help processors design a PdM strategy. Food and beverage processors can achieve the most holistic view of the shop floor by taking advantage of an integrated software suite that includes ERP, which dictates; MES, which executes; and EAM, which ensures reliability and uptime, says Jenkins.

An ERP system can include maintenance functionality and production scheduling, which are included in Deacom.

“Maintenance teams can utilize Deacom’s MRP functionality to ensure that their stock rooms always have accurate stock levels for all parts,” says Deakins. “With CMMS embedded into the ERP solution, the accounting team does not need to do journal entries at the end of every month for the maintenance team. With production and maintenance scheduling done in the same tool, Deacom ensures that maintenance does not get overshadowed by the production team.”

On the path to RCM

It is important to note that if processors have already put the effort into a PdM strategy, reliability-centered maintenance (RCM) may assist in choosing risks and overall maintenance strategies.

RCM is a process to ensure that manufacturing systems continue to do what is required in their present operating context.

“The goals of RCM include the ability to evaluate, categorize, prioritize and understand the appropriate way to intervene in the impact of failures,” says eMaint’s Palmer.

RCM methodologies can be used to optimize PdM programs, helping to determine which techniques and technologies should be employed and how frequently the data should be collected, according to SKF’s Henry. It also identifies and eliminates extraneous tasks that consume resources.

“RCM takes PdM to the next level by identifying what to monitor and how to monitor assets,” says Infor’s Stone. “The RCM study identifies the failure modes and components involved and determines how to [detect] failure modes before they become problems.”

Ultimately, by performing RCM, an organization is looking to develop unique maintenance schedules for each critical asset within a facility or the organization itself. Successful implementation of an RCM process, coupled with CMMS software, will increase cost effectiveness, asset reliability, equipment uptime and an enhanced understanding of the level of risk that the organization is managing, adds Palmer.

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