Keep On Moving With Advanced Maintenance Systems

Capturing, analysing and effectively using machine condition information can provide strategic and competitive advantage as well as cost savings. ***Casey Ng*** *reports on the evolution in maintenance systems.*

Gleason Corporation

The concept of maintenance started out as a basic and understandable need to keep the functionalities of manufacturing assets operational so that they could continue to perform their tasks. The traditional approach – termed as 'corrective maintenance' – is reactive in approach ie: wait till a failure occurs and then repair the fault in order to restore the equipment back to its original capabilities. Such a maintenance approach typically results in daily fire-fighting and a reduction in the productivity of the equipment. It may also translate to a shorter lifespan of the equipment.

A more sophisticated approach is that of 'preventive maintenance' (PM). This developed from the (seemingly obvious) notion that regular servicing and maintenance would help ensure higher availability of equipment. The Japanese were early and enthusiastic adopters of the idea back in the 1950s. A time-based

maintenance programme, featuring periodic servicing and overhaul, has the added advantage of introducing a certain consistency so as to allow planners to perform more realistic production scheduling and forecasting.

With the pressure from the modern business world to optimise resources, companies are demanding high availability from their considerable capital investments in equipment and machines. Downtime needs to be kept to a minimum as does ad-hoc maintenance that disrupts the normal flow of production. Furthermore, concepts such as lean manufacturing and just-in-time (JIT) production, which many companies use as their competitive edge, are highly dependent on having a predictable manufacturing environment.

Total Productive Maintenance

In the 1980s, the preventive maintenance approach was enhanced by concepts such as total productive maintenance (TPM). Mirroring quality management concepts such as TQM (total quality management), TPM aims to establish good maintenance practices through autonomous maintenance ie: allowing the people who operate the equipment to take responsibility some of the maintenance tasks.

A TPM programme starts by measuring, establishing and analysing the overall equipment effectiveness (OEE), in order to establish a benchmark for comparison against future measurements. Maintenance staff are seen as developing preventive actions and general breakdown services, whereas operating staff take on the 'ownership' of the facilities. The idea is supported by the perception that the operating staff using an equipment regularly are more familiar with its characteristics and likely maintenance needs.

Condition Monitoring

With the pursuit of greater returns on company assets, other concepts such as 'detective maintenance' have surfaced. The idea of condition monitoring, is to exploit sensed signals so as to provide signs that can ascertain the equipment's health status. These signals can then be fed back and analysed to prompt the appropriate action eg: necessary maintenance activity.

Condition monitoring enables users to locate the appropriate maintenance strategy for their specific equipment. Typical strategies can be a mixture of maintenance plans ie: predictive, preventive, etc. Selecting the 'right' maintenance approach offers significant benefits by maximising production hours and minimising maintenance costs. The objective being that the equipment is available for production for the maximum amount of time, with maintenance intervals being extended but not to a level that could result in costly damages to machinery.

Commercially available are software packages and tools that enable companies to set up condition monitoring based maintenance systems. For example, the Entek system (now a brand within Rockwell Automation after the company was acquired by the latter in 2001) provides various types of tools to establish condition monitoring capability for different facilities.

Typical measurement processes include vibration analysis where characteristic patterns and signatures can provide early warning of problems such as imbalance in machinery, misalignment of hardware, and worn out components. In temperature analysis, a rise in temperature of machinery can indicate problems such as bearing wear-out, electrical connection problems, or lack of lubrication.

A US-based gas and electric utility claims to have made savings in excess of US$16 million as result of implementing a condition-based maintenance system based on Entek. Over 1,300 pieces of rotating equipment are monitored on multiple sites, and a variety of test technologies are used to measure different parameters.

Computerised Maintenance Management Systems (CMMS)

Computerised maintenance management systems (CMMS) are tools for users to execute and manage the maintenance functions. Typically, these tools also extend out to include support tasks such as management of work, spares inventory, purchasing, regulatory compliance and documentation. The CMMS can be considered as the repository for the organisation's knowledge on how maintenance is done.

At many plants, big savings opportunities can come from a maintenance plan that evolves after

Courtesy of Emerson Process Management

A well planned maintenance strategy can minimise costly equipment downtime.

Maintenance System Overhaul At Pipe Maker

Clow Water is an Ohio-based manufacturer of iron water pipes and fittings. To meet its compliance reporting requirements and keep the plant running efficiently, several production process variables eg: suction pressure, motor current, water pressure, fan bearing vibration velocity, need to be regularly monitored.

Of course, the obvious incentive in monitoring the condition of machinery is to increase plant uptime and improve the quality of products. But for Clow Water, a division of McWane Inc, monitoring plant equipment was also about meeting state EPA (Environmental Protection Agency) emission standards in order to avoid fines and lost production time.

As a first step in automating the monitoring process, the company upgraded its machinery process controls and also put an HMI (human-machine interface) system in place so as to be able to view data throughout the plant. Clow Water then tackled the two key maintenance system issues: at the equipment level, obtaining data on the various machine conditions; and improving the overall management of the maintenance process.

Equipment Condition Monitoring

To undertake the condition monitoring of the equipment, the company installed Entek (a Rockwell Automation brand) condition-based monitoring tools to monitor the various machine attributes, the goal identifying repetitive failures. However, such failures often go unnoticed and hence recur. While condition monitoring is an effective technique for *identifying* equipment problems, CMMS is aimed at *addressing* the identified problems. When the two are integrated properly, users can become better aware of the repetitive nature of the problems, their associated costs and the means to deal with them. The measurement tools used for condition monitoring can be applied to study a repeated failure and identify the root cause for design-out consideration.

An example of a commercial CMMS package is HOLISTECH (CMMS) from Strategic Maintenance Planning Ltd. The software provides tools to enable: system calendar-based maintenance, meter-based maintenance, condition-based maintenance, and one-off planned work control. In addition, maintenance criticality can be indicated by linking FMEA (failure mode effect analysis) methodology to individual assets and sub-assets. And the software allows automation of scheduling and schedule smoothing to achieve best fit of maintenance resources against work scheduled.

Computerised maintenance management systems enable optimised scheduling of maintenance activities.

DMG

Bring On The Internet

One area of increasing interest in remote monitoring and diagnostics is via the Internet. The main driver for this is the potential to reduce the number of costly on-site calls by specialists and hence establish a faster and more efficient maintenance system.

One such Internet-based service is provided by Siemens with its 'ePS-Network' (Electronic Production Services). Intended for customers using the company's Sinumerik range of CNC controllers, the ePS network connects the machine tool to

being to anticipate problems before they happened. This monitoring was used for both emissions recording and maintenance trend analysis.

With the condition monitoring tools in place, Clow Water can now identify bearing degradation on any of the emission fan bearings and "the data is in near real-time," says Gary Foster, Clow Water maintenance manager. "It makes it possible to track alarm conditions and set up proactive responses."

Being able to predict impending failure and schedule maintenance accordingly has created a production environment with just two percent downtime. Predicting things like bearing failure also means the plant does not suffer damage to other machines or systems when fan bearings fail.

Equipment operating data is available graphically on the RSView32 HMI screens or in an MS-Excel spreadsheet. These spreadsheets are filed for EPA inspection or can be e-mailed on demand to the EPA. In addition to meeting the challenge of emission standards and ensuring accuracy of the measurements, Clow Water claimed a return on investment in the system within one year.

Maintenance Information: Ready And Available

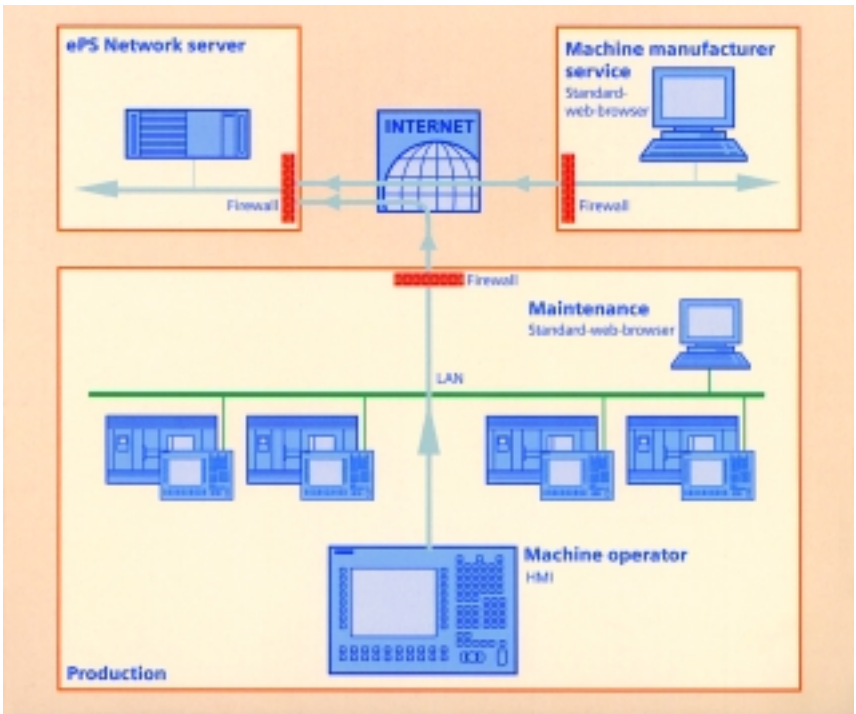
For many years, Clow Water used a conventional, paper-based, process for tracking maintenance. This made it difficult to undertake proper analysis of maintenance activities, and resulted in most of the maintenance work being carried out 'reactively'.

Thus, to bring a higher level of sophistication to its maintenance management process, Clow Water decided to introduce a computerised maintenance management system (CMMS), selecting the MAXIMO product from MRO Software. MAXIMO is used to track, plan and schedule maintenance work. With the CMMS, Clow Water can do extensive, in-depth analysis of its maintenance data – in a way it could never do with the manual system.

For example, reports can be run to determine the mean time between failures and repairs (MTBFR). The ready availability of this type of information enables the company to manage its inventory and spare parts more efficiently and make better business decisions regarding maintenance.

The company's goal in implementing the system was met ie: to move to an environment where 80 percent of maintenance work could be planned and scheduled, and only 20 percent handled reactively. With the manual maintenance process, the numbers were reversed. The system, supplied by Rockwell Automation as a turnkey project, was up and running in about four months.

Information supplied by Rockwell Automation Global Manufacturing Solutions.



Siemens Automation and Drives

Using the Internet, the ePS network from Siemens allows remote and secure access to maintenance data.

ePS-Network servers over the Internet. The data from the production process are then acquired and analysed via the network, and the results on (eg: machine status and process stability) communicated back to the customer. If a fault occurs, maintenance personnel can be alerted via email or SMS and can access the ePS servers, which will have a detailed and updated log of events to aid the diagnostic process.

For machine manufacturers, they can also be linked into the ePS network to enable remote diagnosis and servicing and, in effect, create a useful e-business infrastructure. It is possible for service personnel to have remote access to all operator functions on the controllers – just as if they were working directly on the machine, thus eliminating the need to make a site visit.

Another example of remote maintenance capability is that

INTELLIGENT Maintenance Systems

Dr Jay Lee is Director of the NSF Industry/University Cooperative Research Center in Intelligent Maintenance Systems (IMS, www.imscenter.net) at the University of Wisconsin. Here he talks about the benefits of intelligent maintenance systems.

Q: What is prognostics and why do you consider it an improvement or a step up from the idea of preventative maintenance?

A: Prognostics is defined as the ability to predict and prevent possible fault or system degradation before failures occur. Currently, most maintenance activities are focused on scheduled maintenance as preventive methods or reactive maintenance, which is the fail and fix approach. If we can effectively predict the condition of machines and systems, maintenance actions can be taken ahead of time. As a result, near-zero downtime can be achieved.

Q: How do manufacturers get beyond being either purely reactive or blindly proactive in machine maintenance?

A: Two barriers; one is that maintenance is a day-to-day activity. Most companies do fire-fighting everyday. Second, a barrier is that many companies sell predictive maintenance with high costs and many users can't really afford these improvements without validating the feasibility. Most companies only sell software and expect users to figure it out by themselves. Technicians are not technologically astute and eventually they hesitate to apply new techniques. IMS recognises these barriers and issues and makes sure the predictive tools are invisible in the machine so that predictive maintenance can be achieved without lots of uncertainties and training.

Q: What new business models or forms of customer relationships could emerge if manufacturers adopt an intelligent maintenance approach?

A: First, if a machine has IMS-like capabilities, it would be able to predict its needs and synchronise them with service or suppliers for logistics flow. For example, today's CNC machine should be able to check the cutting tool status, summarise the total utilisation, and provide this information to a tool supplier.

Tool suppliers can deliver the required tools to users without going to traditional ERP and paperwork acquisition systems. Since the CNC machine triggered the sales for the tool suppliers, x percent of the commission could be obtained for CNC machine makers from tool suppliers. In this case, CNC becomes an e-manufacturing/e-business machine, not just a metal-cutting machine. This is a paradigm shift in service models.

Second, if a machine has IMS-like features, we will be able to view the quality of parts or the machine performance remotely. A company will be able to monitor the quality of parts from their suppliers remotely before shipments occur. ISO would be able to audit ISO 9000 processes without making a visit since they can view the quality in real-time. It will change the way we do things for sure.

Q: Is the intelligent maintenance idea primarily a cost-savings philosophy or can a real competitive advantage be obtained?

A: Both. The bottom line is to reduce non-productive overhead time and costs. In addition, it allows for greater advancements for users and manufacturers to service their customers with a competitive edge.

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provided by Rockwell Automation with 'Reliability Online', a service intended for the process industries – especially facilities having a smaller number of critical machines or in isolated locations eg: chemical processing plants, wastewater treatment facilities, offshore oil platforms and passenger ships.

On a predetermined time basis, integrated machine condition data is collected, either by embedded devices in the equipment or by staff using handhelds, and uploaded to a secure website where Rockwell Automation Reliability Online specialists analyse the data; the aim being to identify machine problems early enough to schedule planned maintenance. Statistical reports and recommendations are then provided to the customer's in-house maintenance team, or the data can be sent directly into a CMMS.