Predictive Maintenance Saves Money

Routinely monitoring equipment using predictive technologies and data collecting can help better plan for equipment repairs and save money in downtime and replacement costs. ALAN GAMBSKY, AARROWCAST INC., SHAWANO, WISCONSIN

The traditional views of maintenance in heavily capitalized industries such as metalcasting may trend more along the lines of cost avoidance. Seen as a necessary chore, maintenance is considered a cost center, with too high inventory costs and a low return on investment.

This belief can affect the culture and performance of an organization and indicated silos of knowledge, function and power instead of shared experience, common goals and resource management. Maintenance doesn't have to be viewed as a cost center. It is a resource that can and should be utilized to maximize safety, environmental responsibility, efficiency, utilization, quality delivery and morale. Maintenance and engineering efforts are reflected in bottom line costs.

Routine condition monitoring of equipment using predictive maintenance technologies can detect developing equipment wear early in its failure mode. This allows for planning of the repair before catastrophic failure while extending the remaining life of an asset.


Aarrowcast has increased its equipment uptime by using predictive maintenance.

Predictive maintenance technologies have reached a level of maturity and cost now affordable to most departments. Having this capability onsite can show a quick return on investment through the use of condition-based repair intervention, improved maintenance planning, improved equipment availability, and support of precision maintenance practices. Repairs that historically were made on a time-based schedule can be deferred if the running condition shows no reason for repair or replacement. This can lead to reduced inventory of spare parts while increasing the effectiveness of the maintenance schedule.

Content of Good Maintenance Programs

When it comes to the equipment in your metalcasting facility, if you can't measure it you can't control it. Procedure-based maintenance utilizes a computerized maintenance management system to standardize an operation, improving completion times, quality and repeatability. As the CMMS database grows, it becomes a repository for the cumulative knowledge of the operation. Fast ROIs are possible if the right maintenance technologies and people are chosen and supported with investment in training.

In terms of maintenance philosophies, running to fail is the most expensive, followed by scheduled, periodic maintenance. Not all maintenance can be performed on a periodic basis, so a condition-based component can be added to a dominant periodic maintenance program. A next step in maintenance is to use a predictive maintenance plan with a condition-based component.

The longer you can extend the time to failure on the equipment, the better the ROI becomes. The bathtub curve in Fig. 1 shows that the sooner a failure mode is detected and corrected, the cost of the repair will be lower and the need for replacement will be delayed.

Aarrowcast Inc. (Shawano, Wisconsin) uses various forms of work requests or work instructions that form the inputs and outputs of its computerized maintenance management system. Operator-based maintenance is ordered, performed and tracked just like scheduled maintenance. Predictive maintenance procedures are scheduled, performed, and tracked as well. When any of the processes are reviewed, the CMMS is updated to the desired change.

Retaining the processes in this way protects Aarrowcast and its customers against the loss of intellectual assets. If a technician leaves, a training document is available to sustain the process. Aarrowcast's predictive maintenance system involves equipment operators working closely with maintenance technicians to make sure the processes are working as defined. Maintenance and production supervisors are the first level of quality assurance, while the predictive maintenance group is the second level. The operators are given periodic training on predictive maintenance because they are the ones who do most of the routine operational inspections and lubrications.

Every time a new asset comes online, Aarrowcast performs baseline monitoring and equipment commissioning. The testing processes and equipment qualifies Aarrowcast to make sure the equipment performs as specified in the purchase order. The metalcaster can test the equipment's performance before the supplier leaves the premises, preventing costly returns and contract disputes.

Table 1. Estimated Investment in Data Collectors

Investment	Cost
IR Thermography	4,000
Ultrasound DCA	11,000
Vibration DCA	22,000
Motor DC/Analyzer	25,000
Power Logger	6,000
Misc. Other Electrical	5,000
Misc. E/M Test Equip.	5,000

Predictive Maintenance Technologies

At Aarrowcast a number of predictive maintenance technologies are used, including vibration analysis, thermal imaging, ultrasonic analysis, oil analysis, and power condition and monitoring.

Aarrowcast's vibration analysis database includes more than 1,600 data points with 87-91% updated weekly or bi-weekly. The remaining are updated as opportunity or needs arise. The detection of problems has improved and increased as training and experience has grown. Ultrasonic shock pulse monitoring recently has been added to its suite of automatic vibration tests if the device being tested is rotating at less than 600 RPM.

Infrared cameras perform thermal imaging of electrical components and check the bearing, gearbox, refractory and bin levels temperatures for hotspots. The detection of an undesired temperature (either too hot or too cold) has long been used to find problem areas. This technology assists others, such as vibration and ultrasound, to provide additional information about what stage of failure the device being tested may be in. Temperature loggers attached to the process enables Aarrowcast to calculate trend values for time/load/function correlations.

Friction and turbulence produce ultrasonic noise the human ear cannot hear. Ultrasonic instruments are tuned to frequencies as high as 100 kHz. The unit processes the signal down to a proportional range of frequencies humans can hear. Certain noises, based on their origin, can be tuned in and given a decibel value. A bearing's noise level, for example, is trended using a 25 kHz frequency. As this level is tracked, the technician can monitor whether it needs lubrication or is entering a fault condition.

Aarrowcast uses ultrasonic analysis in conjunction with infrared imaging on electrical apparatus because ultrasound can "hear" a fault condition that infrared may not "see" and vice versa.

Ultrasonic analysis can be used to test valve functions and pump operations. The detection of airborne ultrasonic turbulence generated by a compressed air leak can be used to reduce energy losses from a compressed air supply.

Oil analysis, which Aarrowcast outsources to the oil supplier, is conducted on samples taken during scheduled maintenance or as a special sample taken to back up vibration or ultrasonic technologies. Results are reviewed and work orders generated to respond to needs as determined.

Routine online and offline motor tests on critical equipment throughout the plant can be used to evaluate power supply problems and monitor motor conditions.

Offline motor test procedures include gathering inductive, capacitive and resistive values in the de-energized motor circuit. The motor's insulation properties are evaluated and trended along with the levels of imbalnance that exist among the components.

Other testing and data collecting procedures include stroke monitoring of vibratory conveyors, dew point monitoring, laser alignments, precision lubrication, fan wheel balancing, root cause failure analysis and continuous process improvement.

Stroke monitoring can be used to monitor the wear in drive components and how it effects the stroke of the conveyor. Dew point monitoring of the air discharging from compressed air driers helps in scheduling desiccant material changes when it's necessary, instead of on a time-based schedule. The testing procedures also involve making sure the unit

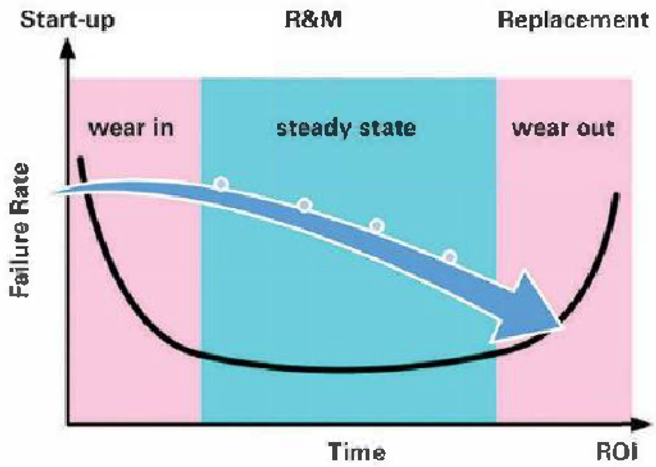

Fig. 1. Each dot on the pass-fail curve (blue arrow) represents an opportunity to detect a failure using predictive maintenance.

is functioning and that critical operations, such as coremaking, are receiving the quality of air needed to make a good core.

Precision maintenance depends on achieving accurate shaft and coupling alignments to prevent premature wear of components. Proper alignment with lasers has been proven to reduce energy costs as well.

Root cause failure analysis and continuous process improvement is performed whenever a predefined alarm level is reached or a component failure is detected. The predictive maintenance process is not used to simply find a problem and replace the component. The goal is to extend equipment life by providing prompt restoration of function. Often, this means the corrective action taken can eliminate the root cause of the failure mechanism.

For example, if a loose electrical connection is found during a thermal scan, it can be tightened before a catastrophic failure event that costs loss of function and an expensive repair. The investigative process of root cause failure analysis and application of continuous improvement often leads to re-engineering the part or process, resulting in improved reliability and extended life cycle.

Maintenance Economics

When first starting a predictive maintenance program, the metalcasting facility does not have to purchase everything all at once. It makes sense to put the technology in place only as fast as the team can digest it.

Using route-based data collectors will save time and quickly provide the big data you crave. A good data collector is worth the salary of two technicians. See Table 1 for estimates on costs for various data collecting investments.

By using vibration analysis, ultrasonic analysis, infrared and motor conditioning monitoring, metalcasters can develop a strategic maintenance plan using reliable, accurate and repeatable measurements to assess machine health and identify opportunities to optimize machine processes and performance (alignment, balancing, precision installation or repairs). It also can reduce premature mortality on repairs and new installations.

In one study, Aarrowcast wanted to investigate whether its successes in reducing vibration were sustainable

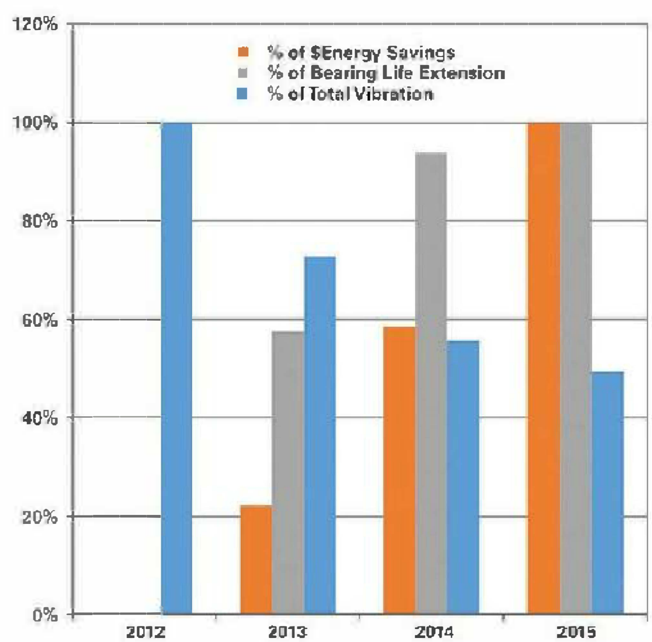

Fig. 2. This chart shows the impact of reducing vibration has on energy costs and bearing life.

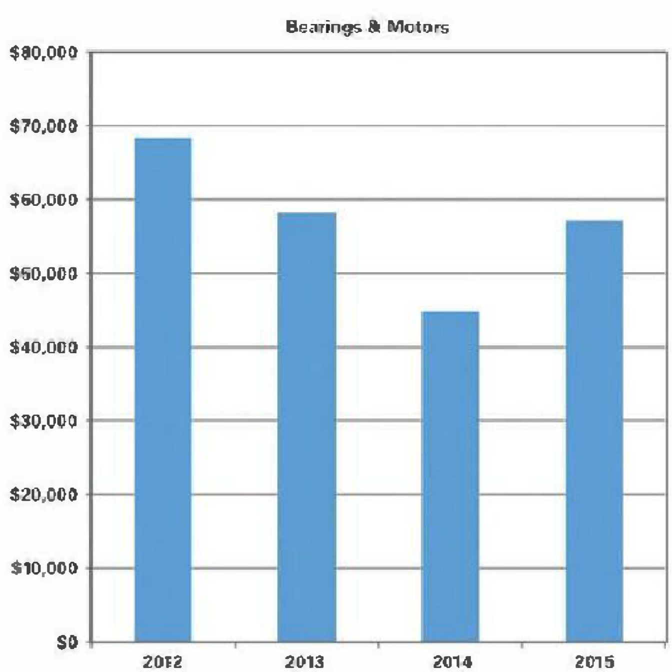

Fig. 3. The cost of bearing and motor replacements decreased due to data collection and predictive maintenance.

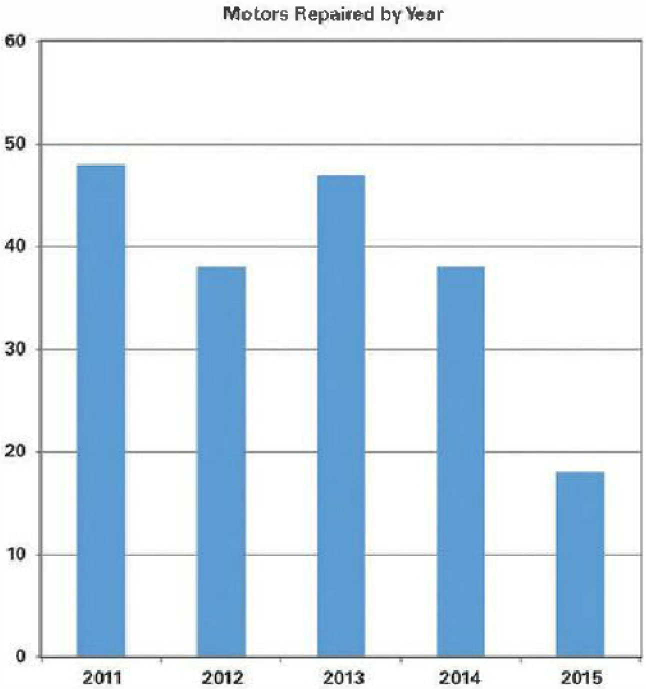

Fig. 4. Improving the lubrication process based on data collection has led to a reduced number of motors replaced per year at Aarrowcast.

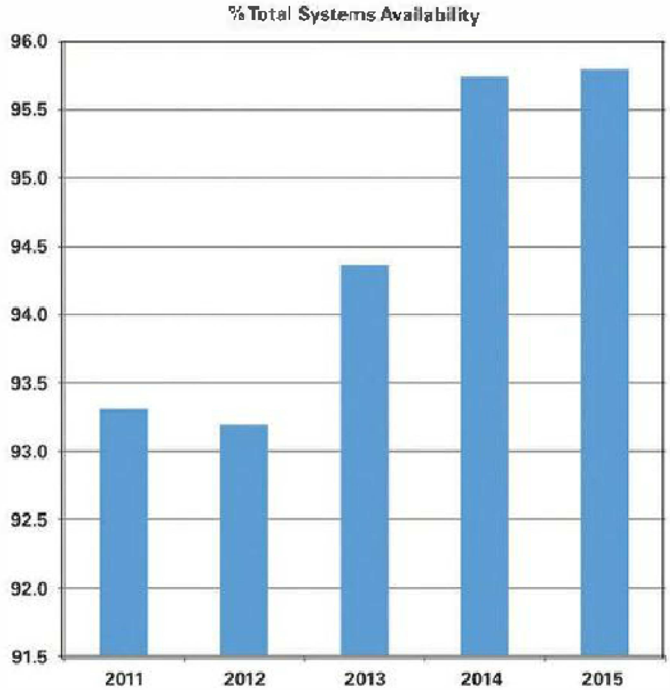

Fig. 5. Equipment uptime has trended upward since predictive maintenance was started at Aarrowcast.

and what other effects it would have on bearing life, energy, and periodic maintenance intervals (Fig. 2). With 2012 as a benchmark, the company discovered that by 2015, it has recorded $36,000 in energy savings, increased bearing life by 200% and reduced vibration from the baseline by about 50%.

Lubrication is historically performed as a continuous process using automatic lubricators or as a scheduled routine. Using ultrasound to optimize the continuous and manual process, Aarrowcast adjusted the lubrication rates based on when the bearing needed it and by how much. Figure 3 shows how replacements have trended downward since 2012. In 2015, several scheduled motor replacements were made based on scheduled maintenance during a planned shutdown.

Historically, motors at Aarrowcast were taken out of service by routine or scheduled maintenance. By improving the lubrication process and adjusting or delaying the periodic replacement, the metalcaster has seen a dramatic reduction in the number of motors being replaced annually (Fig. 4). In this case, if it's not broke, don't fix it, applies. Under normal use, motors have a rather long pass/fail curve, making them ideal candidates for a predictive maintenance strategy.

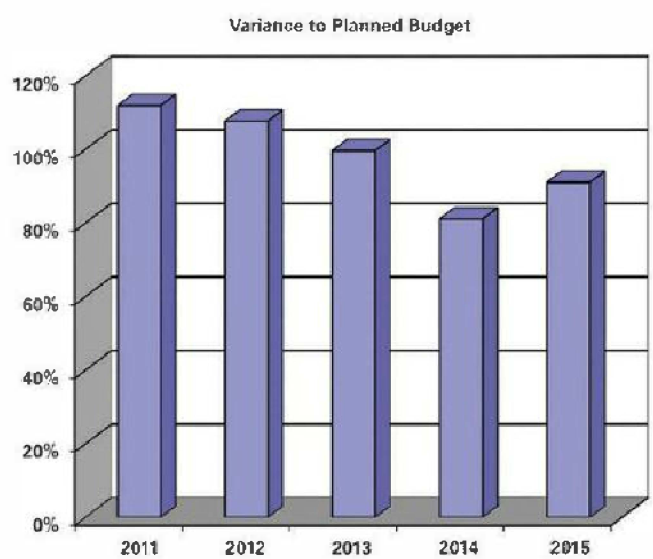

Fig. 6. With data collection and predictive maintenance, Aarrowcast is better able to budget maintenance costs month to month.

Uptime related to how often the machine runs to specification when the operator turns on the switch and how well it stays running to the end of the shift is perhaps the most watched metric of all. Figure 5 shows the historic trend of all production lines at Aarrowcast from the onset of its predictive maintenance effort to the end of 2015. Currently, the metalcasting facility is operating in the 97-98% range. Piece counts per hour have also been improved through other continuous improvement efforts.

In the end, what's it worth to the company to be able to predict and sustain what is planned to be spend for maintenance? When Aarrowcast started its predictive maintenance strategy with one part-time personnel, the department was, on average, over budget. By 2013, when two full-time personnel were dedicated to predictive maintenance, spending was under budget and it has stayed that way since. MC