Plant Services
SPECIAL REPORT

COST-JUSTIFY YOUR
RELIABILITY INITIATIVES

Next generation dynamic reliability centered maintenance

"How effective is your maintenance strategy?" is a question that is often asked to engineers, and one that is often very difficult to answer with any degree of certainty. If you have essentially relied on your experience or intuition when trying to determine the most cost effective and risk adverse maintenance strategy for your assets then you'll know that wrong decisions can be very costly.

If you are serious about your bottom line then you need to be absolutely sure that your maintenance strategy is promoting operational efficiency. Today, technology advancements make this possible, resulting in strategies that engender a very real and positive impact on asset reliability and availability and overall organizational success.

What lies behind these capabilities is the evolution of closed loop reliability centered maintenance (RCM).

Reliability-centered maintenance (RCM) has long been used as a tool to assist the development of maintenance strategies for key operational assets. But until recent years, the only RCM solutions available have remained specialized PC-based systems that assisted in the design of maintenance strategies in isolation from other business systems. Over the years, this structured approach to RCM has rewarded organizations with significant benefits in asset reliability and increased safety, but it has also been hampered by certain limitations. By nature of its isolation, RCM has never achieved its true potential.

The emergence of dynamic Reliability Centered Maintenance (DRCM) offers all the benefits of traditional RCM, but also the advantages of complete collaboration with other critical information systems (such as production controls and maintenance management) and especially the key operational assets themselves. The key differentiator is DRCM's capability for full integration into those operational assets and their control systems.

Integration: The Heart of Next Generation Dynamic RCM

This integration is what maximizes a company's ability to achieve full transparency of asset information—and enables real-time collaboration and simulation capabilities that give engineers a far more accurate picture of equipment requirements and maintenance outcomes.

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to become an integral part of critical operational processes.
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A maintenance strategy is incomplete unless it can be "hardwired" to become an integral part of critical operational processes. Otherwise it will likely not achieve its optimal results. A maintenance strategy working in isolation is not capable of reacting quickly enough to the dynamic environment where the asset exists—meaning that even the best thought-through strategy will always be outdated.

In short, integrating DRCM within an organization can enable benefits such as:

- Proactive identification of asset performance issues. A DRCM system is able to identify failures that should have been prevented by the maintenance strategy— failures that are then proactively flagged and a message automatically dispatched to the responsible manager informing him/her that the problem has occurred.
- Reduced resource waste and analysis errors. Avoids the long and tedious task traditionally performed by maintenance people of manually reviewing histories and assessing any failures, thus also reducing the potential for missing those failures, which can impact business productivity.
- More effective reviews of asset care strategies. Automated alerts are often the prompts

to reviewing an existing maintenance strategy, helping managers quickly identify where a strategy for a piece of equipment may need to be rethought. Only by ensuring seamless connectivity is it realistically possible to put the vast amount of information available across a business to real use. Once properly implemented, DRCM basically extends asset care to all stakeholders within an

- organization and provides the basis for optimizing life cycle costs.

Simulating Potential Outcomes
Expanding further on the concept of DRCM, vendors have built solutions that empower engineers with advanced simulation capabilities to better support more definitive cost and risk analyses of maintenance needs. Such capabilities are being achieved through advancements in integration that enable DRCM solutions to work collaboratively with systems such as service requirements planning (SRP) engines. This provides engineers with the means to simulate and forecast maintenance outcomes with a greater degree of certainty than ever before.

This technology can be very useful, for example, when determining whether the cost of "failure

prevention" ultimately outweighs the cost of a "run-to-fail" approach for a piece of production equipment. The simulations can help illustrate where preventive maintenance practices might be more or less expensive than the actual cost of failure. To put it into context, we change the oil in our cars every 6,000 miles or so in the expectation that this will stop the engine from failing prematurely. But the cost of changing it more frequently could ultimately outweigh the expense of failure and repair, or perhaps even increase the chance of failure. In the past, no one solution could ever provide this level of real-time simulation capability. It's an invaluable step in the process of developing a case for an effective asset maintenance strategy.

Can You Afford Not to Integrate?
In addition to considering the benefits of DRCM, businesses also need to consider the long-term issues that could result if they sit on the sidelines. Competitive business environments call for maximum productivity, customer service and profitability. For businesses facing such pressures, the dangers of not extending RCM capabilities could mean for instance:

- **Limited visibility of asset issues.** Maintenance systems working in isolation mean that manag-

> Providing that the right criteria are met, the benefits of this evolutionary approach to RCM are significant for businesses across all industries.

ers are in danger of operating almost blindly and not noting issues in a timely enough way to prevent more significant problems for the business.

- **Increased risk of asset downtime.** If a maintenance strategy is not working properly or effectively enough—even in some areas— then a business is increasing the risk of downtime and wasting the original maintenance investment.
- **Resource waste.** Operating in isolation means that a business could be carrying out schedules that are not necessary or not having the desired effect, thus wasting valuable engineer time and money, as well as risking unnecessary production losses.
- **Limited analysis.** Integration limitations of traditional RCM systems make it difficult for engineers to access information and carry out the level of accurate analysis needed to fully review, verify and, where necessary, rethink maintenance strategies.

The reiterative message here is integration across the business. There is little point in moving towards dynamic

RCM unless a business's maintenance platform is seamlessly connected to the rest of the organization's information systems. Many businesses today are embracing open technology platforms such as MIMOSA (Machinery Information Management Open Systems Alliance) that allow them to build links across their wide range of operational assets without being limited to equipment vendors complying with particular standards. Providing that the right criteria are met, the benefits of this evolutionary approach to RCM are significant for businesses across all industries.

Why Opt for Integrated Dynamic RCM?
- Offers all benefits of traditional RCM, but fully integrated into all business processes
- Extends asset care to all stakeholders, not just the maintenance department
- Enables greater certainties in risk and cost evaluation of maintenance strategies
- Brings the maintenance strategy into real time
- Focuses vital and limited maintenance skills to the right place ◾

Predictive technologies enhance equipment reliability

Predictive tools now offer improved portability, connectivity, affordability and usability.

Assets tend to exhibit subtle changes in condition before a failure occurs. Tools and devices designed to detect these signals proactively and trigger corrective actions are becoming increasingly

By monitoring and measuring asset data continually, you can predict and circumvent problems.

sophisticated. Improvements in portability, connectivity, affordability and usability are prominent in several recent product announcements.

Portability: There are instances in vibration analysis when two-channel portable data collectors

are inadequate and permanently installed online vibration monitoring systems are impractical. Emerson's (www.emersonprocess.com) alternative is the CSI 2600 Machinery Health Expert. It's a portable

tool capable of unattended, online monitoring and recording of 24 channels, continuously and simultaneously, for weeks at a time. Its integration with AMS Suite predictive maintenance software permits advanced vibration diagnostics.

"While traditional multi-channel portable devices focus on monitoring turbomachinery, the CSI 2600 is capable of detecting rolling element and gearbox problems as well," says Deane Horn, product line manager for Emerson's line of online machinery monitors. "It uses Emerson's PeakVue technology for identifying early indication of bearing wear, and features transient analysis, fault frequency overlays, order tracking and time synchronous averaging."

Connectivity: Certain degradation occurs between preventive maintenance cycles. By monitoring and measuring asset data continually, you can predict and circumvent problems. Infor (www.infor.com) EAM connectors provide out-of-the-box connections from devices that supply real-time PLC, building automation and metering data to the Infor

Ultrasonic detection instruments with touchscreen capabilities simplify the route inspection process by improving usability.

EAM software application, where rule-based work orders for predictive maintenance can be generated automatically.

"We knew we had to supply the complete asset sustainability ecosystem, providing not just software and services, but also hardware to collect this data," says Johnny Bofilios, Infor's director of asset sustainability. "One of our hardware partners is Echelon (www.echelon.com), whose i.LON SmartServer is a standards-based energy manager. Energy spikes that i.LON reveals could be indicative of high motor temperature, phase imbalance or other asset conditions that require maintenance."

Adding connectivity between hardware devices also improves productivity. MeterLink from Extech Instruments (www.extech.com) automates the sharing of Extech electrical and environmental meter diagnostics and Flir infrared camera diagnostics. "Previously, a camera would scan for a hot spot and a meter would collect electrical readings, and manual or audio note taking was required to integrate these readings when compiling inspection reports. With MeterLink, meter readings are recorded instantly and directly via Bluetooth into the infrared images, allowing faster inspections and more accurate reports," says Andre Rebelo, global PR manager for Extech Instruments.

Affordability: Infrared thermometers provide a numerical readout of the temperature of single spots on an asset – a manual process that's time-consuming but affordable compared to traditional infrared cameras. A new, low-priced thermal imaging camera has the potential to replace thermometers in the toolbox. The Flir (www.flir.com) i3 point-and-click thermal imaging camera retails for $1,195. "Now, for about the same price as a premium infrared thermometer, you can get a visual picture with thousands of pixels of temperature data in a single image, allowing you to isolate hot spots immediately," says Rebelo.

Usability: A number of performance and usability upgrades were recently made to Azima DLI's (www.azimadli.com) Alert machinery condition assessment software, particularly in the area of walk-around data collection. For instance, a redesign of the DCX and DCA-60 data collection user interface improves functional and navigation efficiency and provides access to more information. It supports hands-free, voice controlled data collection with optional verbal feedback. The system accommodates complex notes and it can record and play voice notes. In addition, the automated diagnostic system (ADS) technology has been improved, allowing expanded diagnostic coverage and an unlimited

number of machine test locations for better application on large and complex machines.

Ultrasonic detection instruments with touchscreen capabilities simplify the route inspection process by improving usability. The Ultraprobe 15,000 Touch from UE Systems (www.uesystems.com) is a handheld, full-featured inspection system that measures, analyzes and collects data by touch. "The operating software enables inspectors to review important route information, such as baseline data, images of test points and previously recorded baseline sounds, which can be viewed on the spectral analysis screen," says Mark Goodman, vice president of engineering for UE Systems. "While the data can be downloaded to a host computer, the on-board features provide for in-place field analysis of potential failure conditions in fluid, electrical and mechanical systems."

Ultrasound image clarity is the target of University of California, Berkeley, (www.berkeley.edu) scientists developing a metamaterial that uses evanescent sound waves for super-resolution acoustic imaging. The material could potentially improve the images generated in non-destructive, ultrasonic testing. ▪

By Editor Sheila Kennedy, managing director of Additive Communications

The power quad: A plant manager can do four things that maximize reliability

Many plant managers aren't aware of the four ways they can help optimize asset reliability to reduce cost, maximize asset utilization and increase plant capacity. It's about time they became engaged in the reliability process. Many plant managers want optimal reliability at an optimal cost, so they trust maintenance professionals to manage plant reliability but never bother to understand their own role in the process. Many are unaware they can affect asset reliability more than anyone else in the plant. Don't get these steps out of order and follow them all.

The first thing a plant manager should do is study reliability from the 60,000-ft. level to understand the process and basic reliability principles. Find an instructor who can take you to ground level, if needed.

Bring the production and maintenance managers for the same training. Learn about:
- Plant-wide ownership of reliability (the culture change and why).
- Developing a business case for reliability (calculation of financial losses).
- Prioritizing assets based on risk and condition.
- The maintenance process (preventive maintenance, planning, scheduling, work execution, work follow-up and performance assessment).

The journey to reliability involves everyone in the plant, from the lowest level to the highest level, because everyone owns reliability.

- Identifying the right work at the right time using the P-F interval and how it affects losses.
- The roles and responsibilities of specific job functions related to reliability.
- Key performance indicators (leading, lagging and nesting).
- Managing reliability to provide optimal reliability at optimal cost.
- Best practices in maintenance and reliability (including benchmarks).

Skipping this step jeopardizes the success of the process. Any plant manager who thinks they have a good understanding of these subjects should take my "Asset reliability test for plant managers" to prove it. It's a wakeup call for most.

The second thing a plant manager should do is post a plant scorecard, because everyone in the plant needs to know the score in the reliability game. The line

> The objective is for everyone to pull a little on the same rope, which enhances asset reliability and plant performance.

graphs on the scoreboard should be updated daily. If you have multiple production lines, the format might require a little thought. Every week the plant manager should brief each crew about what the scoreboard is telling them and how their role affects the score. Be positive about it, and be prepared for production capacity to increase between 2% and 4% within a few weeks.

The third thing a plant manager should do is provide reliability education to plant personnel. Sit in on the training sessions but use an outside source to lead the classes. Include the plant management team, including supervisors and support staff (8 hrs.), maintenance personnel and production operators (4 hrs.), front office and other support personnel (2 hrs.).

The journey to reliability involves everyone in the plant, from the lowest level to the highest level, because everyone owns reliability. So I'd also recommend asking corporate leadership to sit in on one of the workshops. If they want more reliability education, take advantage of the situation. Attend another reliability workshop with these executives. It's a great opportunity to gain the support a plant manager will need in the future.

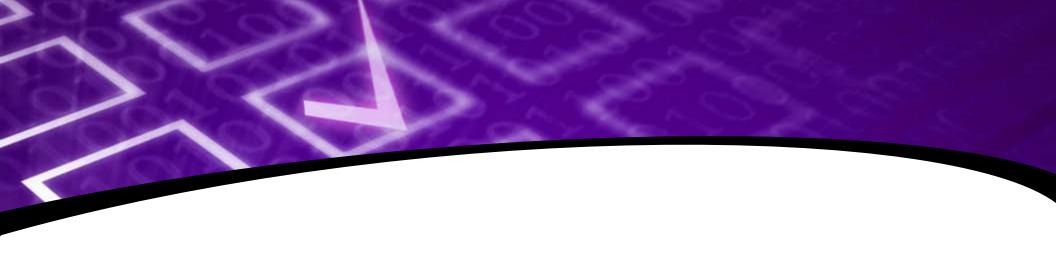The fourth thing a plant manager should do is publish the key performance indicator (KPI) dashboards and send them to every level of management. KPI dashboards help everyone understand the score in the game. Most managers and supervisors don't know how well they're performing until something either great or bad occurs. Each KPI dashboard should highlight measurable leading and lagging metrics that are linked to both the next level of management KPIs and to the plant's goals. It's a process called "nesting."

At a later date, introduce the KPI dashboard concept to production operators and maintenance technicians so they can begin to manage at the floor level. The objective is for everyone to pull a little on the same rope, which enhances asset reliability and plant performance.

These four steps should be followed in the order given to ensure success. One thing a plant manager will learn from this exercise is that everyone has an effect on asset reliability. It's a wonderful experience that can inspire everyone in the plant.

Your plant's resident expert in the asset reliability process should be the maintenance manager. If this person requires additional training, provide the support and focus on results, not the cost. This training must be in an outside environment among other reliability professionals. I've never met a maintenance manager who didn't need additional reliability training. ▣

By Ricky Smith, CMRP, ricky-smith@comcast.net

Effective maintenance programs start with a critical equipment list

Assess the relationships between various types of maintenance to determine the best strategy

Preventive maintenance, run-to-failure, zero tolerance for equipment failure, predictive maintenance, operator rounds, thermography and routine maintenance are the tools and programs that facilities use to ensure plant equipment performs effectively and efficiently.

Of course, we all know there's much more to this picture than a simple question and subsequent answer. What would a perfect power-generating facility look like from an operations and maintenance perspective? What would be the perfect activity balance to maximize resources while operating safely and operating within budget? This can be broken into several categories.

The first category would be management perspective or management protocol with regard to maintenance. Different managers can have various mindsets

when it comes to preventive maintenance versus run-to failure models. Some managers established hard lines for the preventive maintenance and corrective maintenance work activity percentages.

Corrective maintenance typically falls into one of two categories. The first category is when equipment that has been well maintained simply breaks or fails to some degree that it requires maintenance. Corrective maintenance to make any needed repairs is scheduled and performed.

The second corrective maintenance category is when equipment is run to failure deliberately before any corrective maintenance is scheduled and performed. This is what we'll call the run-to-failure model. As indicated earlier, some managers have hard percentage numbers for the relationship between corrective maintenance and preventive maintenance. A typical

scenario would be 60% of maintenance work hours are scheduled for preventive maintenance and the remaining 40% of scheduled hours would be for corrective maintenance.

Define the numbers

There are two basic approaches to determining these percentages. One approach holds that the more preventive maintenance performed, the less corrective maintenance will be needed. An example is changing the oil in an automobile. It's generally accepted that if motor oil is changed regularly, the less engine maintenance will be required. Using the same vehicle example, a person wouldn't consider changing certain pieces, such as a muffler, until it actually fails. That's the run-to-failure approach given that mufflers rarely fail and the cost to replace one is relatively low. To review the first item

Managers who follow this percentage guideline would expect
the corrective maintenance work hours to be 40% of the total work week
hours, if 60% of the hours were spent on preventive maintenance.

in our discussion, management philosophy normally determines the percentage for corrective maintenance work hours and preventive maintenance work hours.

The preventive maintenance percentages are the leading indicators for the overall maintenance program. Managers who follow this percentage guideline would expect the corrective maintenance work hours to be 40% of the total work week hours, if 60% of the hours were spent on preventive maintenance. If either percentage fell outside a predetermined tolerance window, the maintenance program would undergo a review.

Now that we've defined the two subcategories of preventive maintenance and run-to-failure in a maintenance program, we need to determine the category in which each piece of equipment falls. Most maintenance programs begin by establishing a critical equipment list.

Make a list
The list can be delivered several ways, but most programs use some form of the probability and consequence table to determine the category. This involves a determination that quantifies the probability of equipment failing and the consequences associated with the failure.

Consider a 1-to-10 scale with 1 being a low probability and 10 being the highest failure probability.

Management needs to assign the actual scale numbers to use for this determination. Most equipment in a power-generating facility has a low failure probability, or else it wouldn't have been purchased and installed in the first place. Even so, there will be some equipment with a higher failure probability than others, and these receive a higher probability rating. Because probability failures are normally low, the consequence of a failure number assigned to the piece of equipment carries more weight than the probability.

But we need to use both numbers in our run-to failure versus maintenance performance equation. We'll use the same 1-to-10 scale for the consequence, with 1 being low-to-no consequence and 10 being high negative consequence.

How do we quantify the equipment failure consequence? Most power-generating facilities use the safety, environmental, equipment and megawatts (SEEM) method. Safety should be the No. 1 criterion when determining negative consequences. Going through the acronym, the second most importance consideration is environmental impact, followed by equipment damage and finally megawatt loss.

Each item is important and should be considered when determining the equipment failure consequences. Determining the consequence level and the failure probability allows us to determine the maintenance frequency. The critical equipment list is the final list of

identified equipment with the highest level of probability and consequences.

Data sources
There are many tools and programs that can help determine equipment failure probability and consequences. The plant's historical records are a good starting point. Reviewing the equipment past performance, including corrective maintenance work activities performed along with documentation from any preventive maintenance records, helps establish a number for the equipment failure probability and consequence.

Company records of like-in-kind equipment can be a good information source for the determination. Consult with those at other power-generating facilities within your company. This is normally relatively easy.

Industry standards and operating experiences (OE) are another good source of information. In the digital age, searching for similar equipment types is as simple as a few keystrokes. Check for lessons-learned records from other power-generating facilities. If possible, find a point of contact and communicate with the site. Most facilities will share generic information about equipment failures and maintenance programs. Another source of information is vendor recommendations. No matter how good the working relationship with your company's vendors is, they're going to default to more conservative data when it comes to equipment mainte-

nance. This isn't necessarily a bad thing, but make sure you factor in other resources of information for your probability and consequence equation.

Individual crew member experience usually is a good source of information. Don't limit your equipment questions to the most experienced crew members, but question anyone that has been exposed to maintenance on the equipment. Sometimes the newest crew member will have the best insight on maintenance. Along that same line, question other work groups, such as operations. Plant operators can certainly bring a different perspective to suggested equipment maintenance. Plant operators know which equipment gives them the most trouble. Ask operators what equipment failure they'd most hate to see. Other suggested work groups to question might be an environmental specialist and a regulatory specialist, if your site has them.

How often?
Once armed with a critical equipment list, it's time to determine the frequency of maintenance needed to maintain the equipment properly. The tools described above also can be used to determine the frequency of maintenance needed for a piece of equipment. I've seen maintenance frequencies range from daily checks to a five-year inspection frequency, and everything in between. Establishing the initial maintenance frequency isn't an exact science, but using the tools described above should get you in the ball park.

You should review your maintenance frequency list yearly, at a minimum, to ensure the frequency is still adequate. Sometimes maintenance frequencies need to be extended, and sometimes they might need to be shortened. For example, a weekly inspection on a bearing temperature might be extended to monthly if historical records indicate there has been no movement in the temperature reading. Be careful not to extend the frequency prematurely, but only after careful research and review. Another example might be yearly inspection of a motor that is getting some serious age on it. In this example, the maintenance frequency might need to be changed to semiannual or quarterly. Again, you don't want to shorten the maintenance cycle prematurely, but if you're going to make a change, this would be the more conservative approach.

Spec the maintenance
When you determine which equipment needs to be part of the preventive maintenance program and you establish the maintenance frequency, you need to determine the type of preventive maintenance to perform. Most maintenance activities fall into the intrusive and non-intrusive categories. Intrusive means there might be a high possibility that you'll introduce problems when performing the maintenance. Some types of electrical checks might cause wiring insulation to break down if not performed carefully.

While we need to have confidence in the technicians performing the maintenance, we need to help eliminate any potential problems that could result from performing the maintenance. It might be necessary to perform the electrical check based on the research performed, but there might be a suitable alternative that can shift the maintenance activity into the non-intrusive category, while obtaining an acceptable test result. Predictive maintenance normally falls into the non-intrusive maintenance category.

It's advisable to use as many of these tools as needed to ensure your equipment maintenance program is sufficient to meet the goals your management team established. No one tool gives all the information needed to set up a quality maintenance program. The program needs to be reviewed yearly, at a minimum, to determine if the overall program or any individual maintenance frequencies need to change.

A quality maintenance program integrates each step outlined above. An understanding of management team expectations with regard to the balance between corrective maintenance, run-to failure and preventive maintenance is a primary starting point. The expectations, or management philosophy, should include a basic approach to developing your critical equipment list. This usually includes some variant of the probability and consequent curve. Preparing a critical equipment list is needed to place equipment into its proper maintenance category. Then the equipment can be incorporated into a frequency-driven work activity, taking into account the degree of maintenance needed. If you can choreograph the steps outlined above, you'll have a quality maintenance program. ■

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Mining For Money Through Energy Monitoring and Management

By Drew D. Troyer

I've always been interested in the connection between reliability management and other functional responsibilities within a manufacturing organization, such as quality and safety. Clearly, reliable manufacturing processes improve quality, one of the three primary elements of overall equipment/business effectiveness (OEE/ OBE). Also, when manufacturing processes are reliable and predictable, there is less chance for injury. Lately, I've been giving much thought to the relationship between reliability and energy management. In my opinion, there is a close connection - one that is worth exploring.

Monitoring and managing energy consumption is good for the organization and good for the environment. It's a win all the way around. In the United States, 30% to 40% of the electricity we generate is required to power industrial electric motors! Even a small ener-

gyefficiency gain can significantly increase the aggregated demand for power, reducing capital expenditure to build more power plants and the consumption of fossil fuels and associated emissions. For your firm, spending less on energy translates into real dollar savings. Plus, by reducing strain, wear and tear on your machine assets, manufacturing reliability is improved, creating even more value for your organization.

Outline of Benefits

Over the life cycle of a machine asset that supports manufacturing processes, energy consumed is frequently the largest expense. Some aspects of the cost to energize a machine can't be controlled, but some can.

Let's look at the economics of energizing a 200-horsepower electric motor. Assuming a load factor of 80% and a modest energy cost of $0.06 per kilowatt

hour (kWh), it requires more than $57,000 each year to power the motor, assuming an 8,000-hour operating year (Figure 1). A quick scan of the Web revealed that the price for a three-phase, 460-volt electric motor is in the $5,000 to $8,000 range. I'm sure there are motors that cost more or less, but the point is that the cost to energize the electric motor is about 100 times its purchase price, assuming a 10-year life. Carving 5% to 10% off of this cost can profoundly affect the bottom line.

In my example, a 10% improvement in energy efficiency drives an extra $5,700 to the bottom line - and that's for a single, gardenvariety 200 hp electric motor! How do you get this savings? I've listed a few items for you to consider. Some have direct, positive effects on operational reliability in addition to the obvious energy cost savings.

Paying a 50% up-front premium
for a high-efficiency electric motor yields
an internal rate of return of 229%. That's the
equivalent of finding a bank that will pay you
229% interest annually on your deposits.

Energy Savings Calculator - 200 HP Motor Example	
Horsepower (HP)	200
Load Factor	80%
Kilowatts (kW)	119.36
Hours Used	8,000
kW Hours Consumed	954,880
Cost per kW Hour	$0.06
Annual Energy Cost	$57,293
Energy Consumption Reduction Target (%)	10%
Projected Annual Energy Cost Savings	$5,729.28

1. Select high-efficiency motors — comparing brand-to-brand performance. High efficiency motors cost more money up front. Don't be lulled into accepting the up-front savings. Assuming a regular efficiency electric motor costs $5,000 at purchase and uses 10% more energy than a high-efficiency motor, you could spend up to $60,000 on a high-efficiency motor and still be ahead money in terms of the economic rate of return over the 10- year life cycle of the asset (assuming an 8,000-hour operating year). Paying a 50% up-front premium for a high-efficiency electric motor yields an internal rate of return of 229%. That's the equivalent of finding a bank that will pay you 229% interest annually on your deposits. A 5% energy efficiency for which you must pay a 50% price premium up front still yields a 115 % internal rate of return. You'll be hard-pressed not to justify this investment if you're employing decision-making tools based on life cycle cost.

2. Design drivetrains for energy efficiency. Failure to consider energy losses in mechanical drivetrain decisions can significantly affect your overall energy bill for an asset. Sure, we want motors to be efficient, but improving the efficiency of the driver is only half the battle. We need to manage the efficiency of the driven components, too. Selecting energy- efficient gearbox and coupling designs, for instance, can substantially affect the total energy bill. Apply the precision balance, alignment, looseness, resonance and lubrication principles discussed in points 6 and 7 to the entire drivetrain.

3. Manage electrical system integrity. If your motor control center (MCC) has bad connections, degraded or undersized wiring, or shorts, energy efficiency will be compromised. If circuits run hot or become hot, energy isn't being carried efficiently. Moreover, the reliability of the MCC and (in some cases) the motor itself can be compromised. In the case of stray current, the high buildup of potential also can lead to electrical discharge erosion, a wear mechanism often referred to as "fluting." Here again, the loss of energy compromises reliability.

4. Operate in ideal load range. Using our electric motor example, operating above or below its rated load range produces poor energy efficiency and decreases reliability. For most electric motors, energy efficiency degrades precipitously when the motor is operated at less than 40 percent of its rated load.

5. Make optimized rebuild/replace decisions. When an asset wears out, it gets loose and sloppy, which of course results in energy waste. Getting that last few days, weeks or months of service may be costing you dearly in terms of energy efficiency.

6. Manage balance, alignment, looseness and resonance. Imbalance, misalignment, looseness and resonance all generate mechanical friction. It takes power to create friction — which converts electrical energy into thermal energy - and you have to pay for it. In some instances, friction is desirable. When it's caused by lack of precision in managing balance, misalignment, looseness and resonance, you're literally paying for the energy required to increase wear and reduce the reliability of your machines. Precision maintenance pays off, both in terms of reliability and in energy management.

Monitoring and managing energy consumption is a slam dunk. Gaining just 5% improvement can translate to considerable savings for your organization.

7. Employ precision lubrication. Improper selection of lubricant viscosity can significantly affect both energy consumption and reliability. If the viscosity is too low, surface-to-surface friction occurs. If the viscosity is too high, viscous drag results. Both waste energy. A common mistake is to employ multi-purpose grease in electric motors. The viscosity of this grease is typically around 320 centi-stokes at 40ºC. Most electric motors require grease that is formulated using base oil with a viscosity of 100 to 150 cSt at 40ºC. The extra viscosity reduces energy efficiency and compromises the motor's reliability. Likewise, motors frequently are over-greased, further compromising energy efficiency and reliability.

8. Monitor energy consumption. Changes in asset condition are frequently revealed with energy monitoring. We traditionally have employed vibration analysis, thermography and other condition monitoring tools to identify and troubleshoot abnormal asset conditions. By definition, if a machine starts vibrating or getting hotter, it is using more energy or converting energy with reduced efficiency, so monitoring energy efficiency is a natural condition monitoring activity. Moreover, it is comparatively easy to do and can be done on a continuous basis. Energy monitoring also enables you to compare the efficiency of various equip-ment and component designs, helping you make better design and procurement decisions that minimize life cycle cost of ownership and maximize return on net assets (RONA).

It's Worth the Energy

Monitoring and managing energy consumption is a slam dunk. Gaining just 5% improvement can translate to considerable savings for your organization. If you're mismanaging several of the above-named factors, 10%, 15% or more improvement may be possible. Because this wasted energy is frequently converted to heat and/or mechanical displacement (vibration), good energy management policy and good reliability policy are natural allies. To sweeten the pot, there are several government programs that are intended to motivate you to be energy conscious, often covering all or part of the up-front investment required to improve your energy efficiency.

To recap: reduced electric bill, improved reliability, economic support from the government and good environmental citizenship. What's stopping you? Start monitoring and managing energy consumption today in order to minimize life cycle cost of ownership. ◼

By Drew D. Troyer. "This article originally appeared in the Machinery Lubrication Magazine."

The Energy Behind Asset Management

You're faced with aging assets, harsh operating conditions, more government oversight than ever, and really tough market conditions. Costs are up, margins are down, and to make matters worse, your CFO has put the brakes on spending. How do you compete?

Companies like yours need more than asset management because current business solutions don't solve today's problems, much less tomorrow's. You can't get where you need to be through traditional enterprise asset management (EAM). Traditional EAM solutions don't let you factor one of your largest maintenance and operating expenses into your asset management strategy--Energy. You need to focus on it, otherwise, you're ignoring 50% or more of your operating costs. What's more, energy, as a leading indicator of asset performance, can serve as a key contributing factor to reaching your availability and reliability goals.

Your survival lies in the energy behind asset management. Where does that leave you? Demand—and get—more from your EAM software. That's why more than 15,000 organizations worldwide are using Infor EAM to solve their toughest issues—from preventative maintenance for discrete manufacturing, to predictive maintenance for food and beverage companies, emissions and energy demand management in pulp and paper, risk-based maintenance in life science organizations, fleet management for transportation companies, linear asset management for oil and gas, asset tracking and condition-based maintenance for public sector organizations, and more.

You know what you need from an EAM solution. Now you can get it with Infor EAM.

See What You've Been Missing.
What if your assets could tell you where to find the money? When you can see exactly where you're wasting energy, and how to fix it, you'll know where your opportunities lie. You need to take action and make decisions throughout the asset lifecycle, from design and purchase to operate and maintain to replace, with energy in mind.

You need more than traditional enterprise asset management, and you get it with Infor EAM.

Get the tools you need to monitor and manage the deployment, performance, energy efficiency and maintenance of company assets, helping to prevent operational surprises and uncover hidden profits. Infor™ EAM, a complete enterprise asset management and sustainability solution, allows you to continually monitor asset health and behavior, analyze data to detect key trends and anomalies, forecast performance issues, make decisions, and drive action. Doing all of this with energy in mind will allow you to drive superior operational and environmental performance and ensure that you meet projected financial results.

Infor has provided leadership for using EAM as an aggregator of energy management information. EAM Asset Sustainability Edition extends Infor's asset performancemanagement platform with energy management, monitoring, reporting, and analytics.

—Ralph Rio, Research Director, Arc Advisory Group

With Infor EAM, you can:
- Monitor the energy usage of your assets.
- Make better decisions with a more complete picture of your operating and maintenance expenses, including energy costs.
- See, automatically detect, and prevent energy waste.
- Send automatic notifications and escalations to ensure timely response.
- Pinpoint where and how to reduce environmental impact.
- Replace the right assets at the right time with complete financial justification including energy usage.
- Perform better with EnergyStar benchmarking.

Most importantly, with Infor EAM you'll be able to reduce your overall energy consumption and costs. You'll be able to improve your asset performance by including energy and other operating and environmental parameters in your maintenance decision process at the asset level. By better visualizing the energy performance of each asset, you can drive out inefficiency and cost from your operations. How much can you save with this approach? According to

the Department of Energy and Texas A&M University, you will reduce your total energy spending by as much as 20%.

Know You're Healthy.
You know that your critical assets are up and running today, and when they're available. So, it's easy for you to assume they're just fine. But how close are you to your next failure? How long will it take and how much will it cost to get that asset back up and running? What will it mean for your organization? And what will it mean for your competitors?

What if you could remove the risk? What if you never had to worry about the health of your assets again? Let your assets tell you when and why they're hurt. That's the kind of peace of mind you get with Infor EAM.

You need to continuously monitor your asset health, identify areas for improvement, proactively identify performance degradation, and facilitate corrective measures while ensuring compliance with your customers' and your regulators' requirements.

With Infor EAM, you can put built-in predictive maintenance (PdM) and condition-based mainte-

nance (CBM) to work for you, without incurring the costs, complexity, and uncertainty of third-party software. You get not only the equipment alarms, but also the data and real-time intelligence you need to take quick and precise action, and escalate problems, when necessary, to the appropriate resources.
- Act based on early notification of unhealthy assets—The Infor EAM analytics and action engine lets you define multi-condition rules to predict failure and drive specific action. You get alerts and notification when you need them— giving you plenty of time to respond to avoid disruption.
- Fix problems right the first time—Unlike traditional EAM systems that give you generic alarms and passive notifications, with Infor EAM's ability to analyze real-time performance data, you get a precise understanding of the nature of the problem, what's wrong, and how to fix it. And that means you fix it right the first time you visit the asset.
- Continuously improve responsiveness and productivity—You'll be able to continually expand and refine your analytics to really hone

Infor EAM delivers 10% improvement in asset availability; 5% improvement in asset reliability; 20% reduction in energy usage; and 20% reduction in inventory carrying costs.

in on specific problems, and then refine precise solutions. You'll be able to drill down to the specifics of the problem, and precisely determine how to fix it. Over time, you can build up that knowledge in Infor EAM, so it's available to everyone, and you're driving the right actions.

- Act at the right time—Maintenance and production schedules and goals often don't coincide. Infor EAM lets you see all your maintenance and production requirements in one place, so you can more easily coordinate schedules and act at the optimal time for the organization.

Acting at the right time and fixing problems right the first time requires getting the right alerts and intelligence at the right time. When this happens, your costs go down, while availability, reliability, and productivity increase. You can significantly improve your asset performance by including energy and other operating and environmental parameters in the maintenance process at the asset level, thanks to Infor EAM. Early notifications of issues, work orders, and emails go to the right people because Infor EAM continuously monitors asset health, analyzes performance data, and generates alerts based on precise diagnosis. This ensures that your predictive maintenance programs drive response at the right time.

Work Your Way.
Your workforce is changing. Your most experienced workers, who have all the institutional knowledge, are transitioning out, and a younger workforce is taking their place. Those younger workers are accustomed to getting the information they need on the go—on their smart phones, mobile devices, and on the web.

It's not just your workforce that's changing—your business is changing at the speed of light. And you need to be ready to respond to anything at a moment's notice. Can you afford to force your company to work within the constraints of an inflexible, cookie-cutter solution? You need a solution that works the way you do, with a look and feel and perspective that's right for you. One that works with your IT systems and technologies—your existing ERP system, your financial solutions, your Microsoft and Oracle technology. That can easily adapt to your business processes, and not the other way around. And one that lets your workforce use the tools and technologies they're comfortable with, in the office, on the plant floor, on the road…wherever.

You need easy IT. And you get it, with Infor EAM. You'll be able to:

- **Work with your look and feel**—You get single sign-on, simplified navigation and a consistent

user interface across applications. Plus, you'll have the design tools to tailor the user experience just right for you. And, you'll be able to work on what matters most by organizing and simplifying key information, activities and metrics.

- **Work from your perspective**—View assets hierarchically. Search for assets with a map. View work from your geographical information system (GIS). Create work orders from a map. You get the information you need to do your job, when and how you want to see it.

- **Work with your tools and technology**—You get a solution that works with your other systems without the costs, risks, and confusion that can come with integration, thanks to Infor EAM and Infor ION. Span multiple systems with Infor ION, a flexible architecture at the heart of Infor solutions. Smoothly integrate EAM with your other business processes with connectors for EAM and other Infor and third-party applications, reducing the risks and costs of your implementation. Plus, because Infor is tightly aligned with Microsoft, you get the business-specific solutions you need on the technology platform you already know and trust—including Microsoft SQL, Microsoft

With Infor EAM, you can see a 20% improvement in labor productivity; 50% increase in warranty cost recovery; and 50% reduction in purchasing process costs.

SharePoint, Microsoft Project, and more.

- **Work your way with your business processes**—Easily leverage Infor EAM logic and data in your applications through an extensive web service library and toolset.
- **Work where and when you want to**—Whether your workforce chooses to use their smart phones, tablets, mobile devices, or a web interface, they can get all the information they need. Your workers can download assignments from Infor EAM to their device of choice, automating virtually every aspect of maintenance and data collection. They can create field-based work orders, use drill-down menus to retrieve detailed information about a piece of equipment, and capture actual "wrench time" as work occurs.

Get The Most From Your Assets.

Isn't it time you took control of your assets? With Infor EAM you can:

- Understand your total cost of operation and maintenance with the only EAM solution that combines acquisition, installation, maintenance, and energy costs.
- Predict asset failure, perform maintenance when and how it's needed, and protect your operation.
- Detect and eliminate energy waste to reduce

energy usage, costs, and environmental risks.

- Adjust your maintenance strategy based on performance, costs, impact, and benchmarking intelligence.
- Perform maintenance at the right time, not when the time is right, due to coordinated production and maintenance schedules.
- Know when to replace or extend asset life with a complete cost picture, including energy, in mind.
- Get to know the energy behind your assets with Infor EAM.

Powered By Innovative Technology.

Infor's newest technologies bring our portfolio of proven products to new levels of power, usability, and flexibility. Some of these technologies include:

Workspace—You don't need more information; you need the right information at the right time. Unified navigation, single sign-on, and single-click access to all Infor systems, personalization, web parts, and shortcuts get you to the information you need quicker and easier. You'll have everything you need to work on what matters, in a way that makes sense to you, so you can simplify your work day.

ION—The unifying platform to connect and manage all your applications, Infor and non-Infor, so you can integrate and manage your data, no matter where the data resides and no matter what

application created it. With Infor ION, your systems and your people can simply work together.

- Connect it all—Seamless, flexible integration between your current core applications and your third- party solutions, whether they're on-premises, in the cloud, or both.
- Manage your process while you listen for exceptions—Identify your key business processes and let the exceptions find you —automatically alert your users based on key issues so they can respond immediately. You can monitor the status of your tasks in relation to promised completion or established service level agreements, and automatically receive alerts about exceptions and potential non-compliance.

Reporting and Analytics—You get a common data repository, so everyone has the same solid data in the right application. Dashboards deliver actionable information based on your role, so you get the information you need for your job, the way you want to see it. And then you can turn that information into insight with multiple, analytical views on your performance.

Cloud deployment—With no upfront installation costs and the ability to use the same powerful, proven business applications in the cloud or on-premises, you realize faster time to value and unprecedented flexibility. ■

About the sponsor

INFOR™

Infor is a leading provider of business applications, with over 8,000 employees serving over 70,000 customers in 125 countries. Infor focuses on two core beliefs: the importance of constant innovation and the value of laser focus on its customers. Infor delivers software that is simple to buy, easy to deploy, and convenient to manage.

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