Plant Services

SPECIAL REPORT

6 WORST PRACTICES AND HOW TO AVOID THEM

What you avoid is just as important as what you do

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Worst Practices

6 processes that can derail your manufacturing productivity

By Burt Hurlock, CEO, Azima DLI

Best practices from top industry thought leaders are everywhere. But we often learn more from what we do wrong than we learn from what we do right. Here are some of the processes that afflict a large segment of manufacturing companies in the United States and prevent them from achieving optimal efficiency and productivity.

Just Check the PdM Box

High-level commitment to equipment reliability is a great step forward for manufacturing companies as executives recognize the correlation between corporate performance and condition monitoring programs. However, executive-approved reliability initiatives need buy-in from plant-level personnel. Too often, plant managers will purchase technology and engage outside vendors to simply "check the box" rather than fleshing out what a reliability program entails. Organizations must set benchmarks against expectations for maintenance and repair activity, diagnostic frequency, machine condition trending and risk profiling or else reliability programs don't yield actionable information.

Don't Seek Senior Management Support

Great reliability programs have senior management who celebrate and acknowledge success. Involved managers promote the success of their programs throughout the organization by communicating bottom line contributions to margin improvement as well as cost avoidance. Senior management champions are involved in the development of reliability program benchmarks and regularly review the results against the pre-established KPIs that were chosen to measure the effectiveness of improving the plant's productivity. There should always be a champion who shares these findings with colleagues to ensure the maintenance team's hard work is recognized and valued.

Don't Let the Executive Team See Maintenance Numbers

Industrial America is highly decentralized with decision-making resting in the hands of fiercely autonomous plant managers. The result is ring-fenced operational "silos" with no organizational commitment to, or incentive for, the information sharing required for enterprise-wide continuous improvement. Very few companies will commit the energy and resources to put in place the processes, procedures, reward systems and communications infrastructure to institutionalize and build-on knowledge to drive savings from continuous improvement.

Transparency is essential for the executive team to understand the impact of the maintenance program and raise awareness about efficiency, reliability and safety. Maintenance professionals should feel comfortable reporting the facts without fear of repercussions. Companies should worry when transparency is threatening as it suggests there is something to hide.

Transparency works: Air Liquide Large Industries (Air Liquide) is a member of the Air Liquide Group, the world leader in gases for industry, health and the environment, provides an excellent example of how to leverage maintenance performance statistics constructively. The company created a uniform methodology to ensure that its operations met customers' expectations for reliability, safety and efficiency. This gave each site tangible goals for the maintenance organiza-

tion to meet, monitoring the results via a cloud-based dashboard. This made it easy for the executive team to identify key personnel who were hitting plan and reward them with bonuses and promotions. Machinery performance improved and the program fostered competitive camaraderie amongst employees.

Ignore the Skills Gap

It is not a secret that institutional knowledge is growing scarce as experienced maintenance professionals age and retire. The next generation is largely seeking alternative career paths, putting knowledge of machine performance and experience with failure modes at risk of being lost forever. Plants that once ran highly effective reliability programs no longer have the expertise to support them and cannot find or keep the professionals required to maintain a program. Companies have two options when confronted with this situation: recruit heavily from the latest engineering schools and commit significant resources to training these new recruits to bridge the skills gap, or consider outsourcing functions to credible third-party partners. Both of these options come with benefits and drawbacks but the decision to address the skills gap must be made before organizations make themselves susceptible to large-scale machinery failures.

Overwhelm the Maintenance Staff

The pressure to reduce cost has left many production operations understaffed. Routine periodic procedures like data collection sit low on the priority list, especially in highly reactive environments where operators are moving from crisis to crisis. Maintaining a disciplined cycle of data collection and analysis provides sufficient advanced warning of incipient machine faults and failures to take remedial action and eliminate crisis, but these cycles are the first to be sacrificed by time and staffing constraints. Plant managers need to understand that proactive data collection and analysis can eliminate the need for unplanned machinery outages so equipment can be repaired during regularly scheduled shut downs.

Do Not Showcase Long-Term Value

The best reliability programs are the most vulnerable to cost-cutting. Programs that successfully mitigate unplanned downtime and excessive maintenance spending can become the victims of decision-makers with a “what have you done for me lately?” attitude, who forget the origins of their success. Without institutional commitment to reliability and shared understanding of the associated avoided costs, it’s hard to weigh the cost of increased risk, reduced safety anddeclining efficiency that creep back into the system when reliability programs are compromised or eliminated.

These are the top six reasons why reliability programs fail. If you recognize any of these behaviors in your own program you want take the necessary steps to eliminate them and drive change. Many large plants across the United States understand the potential of PdM programs but make half-hearted attempts to implement them. Make sure your company understands the capabilities, limitations and costs of a PdM program before implementing new technologies or processes. When done right, PdM can be a game changer under correct implementation and will contribute to the operational efficiency and revenues of the whole organization.

HOW TO AVOID PRODUCTIVITY DERAILMENT

Avoiding worst practices is easier said than done. Turning "worst" into "first" requires keen planning and a strategic approach to maintenance and reliability.

Once you've identified the potential pitfalls — forgetting to create an organizational plan for maintenance; implementing without a champion; not sharing metrics with the organization; ignoring the skills gap; overwhelming the maintenance staff; and not showcasing long-term value — the next step is to develop a strategy that helps you to avoid them.

The following stories shed some light on the practices that can help you to sidestep these pitfalls and make the most of your maintenance practices.

"Where Business Schools Fail" addresses the skills gap and the importance of demonstrating the value of maintenance.

"Prove the Value of Predictive Maintenance (PdM) to Senior Management" offers some real-world advice on ensuring the entire organization understands how maintenance impacts profitability.

Where business schools fail

Traditional philosophy can be counterproductive

By Tom Moriarty, P.E., CMRP, contributing editor

I've been blessed to have been exposed to a variety of experiences throughout my working life. Early on in high school I was a laborer doing everything — stocking shelves, pumping gas and mowing fields. Later, I was a machinery technician working on hydraulics, diesel engines, HVAC systems, pumps and piping systems, and evaporators; I was even a volunteer firefighter and emergency medical technician for a spell. I progressed from laborer to mechanic to supervisor to manager to director and currently am president of a company. I earned an associate of science degree, then a bachelor of science in mechanical engineering and finally a master of business administration (MBA) degree.

All of the experiences a person goes through in life offer different perspectives. But I'll tell you something I've not heard discussed much — the curriculum in business school. There are at least three places where business schools fail to provide business leaders with a good foundation for running a business:

- overemphasis on government's ability to generate economic activity
- believing that it's right to outsource lower-skill, lower-paying jobs
- viewing operations and maintenance activities as a cost that must be minimized.

On the first item, I'll just say that the Keynesian approach, taught almost exclusively in B-school, has been shown in recent months and years as insufficient to deal with major economic issues. It might work well to stimulate around small perturbations in the economy, but it sure falls apart in the face of excessive government regulations and debt, restraining business growth.

> Operations and maintenance activities transform potential production into actual production.

The second failing is the belief that outsourcing lower-skilled and lower-paying jobs to other countries is the correct path. Striving to build an economy increasingly on high-tech, high-education jobs has a major flaw. Complex systems still must be fabricated and maintained. That means you need to have skilled workers to fabricate and maintain those systems. Where do skilled workers get their skills? They start out at a low-skill position gaining experience in how to be an employee, obtaining training and increasing their knowledge. Eventually, these people become higher-tech workers with higher skills.

As "educated" business leaders executed their strategies during the past decades by outsourcing low-skill jobs to foreign manufacturers, the available feeder stock for domestic high-skilled persons has dwindled. Meanwhile, we've fostered a segment of the population that thinks they're entitled to a high-paying job by virtue of the fact they have a college degree and can fog a cold mirror. In addition, tax policies and regulations encourage businesses to manufacture offshore.

The third business-school failure is the idea that operations and maintenance are simply costs that need to be minimized. This results in shortsighted budget decisions. Operations and maintenance appear as a cost on financial statements, so the MBAs act in accordance with their training. It goes something like this. Shareholders expect executives to maintain or expand profit margins. That means you have to achieve a combination of selling more and/or reducing costs. Operations and maintenance costs looks like a good place to cut; after all, these usually have pretty good-sized budgets. This is where you get the lazy solution of 10% across the board budget cuts.

Like other business school failures, the problem is that the business schools aren't teaching students how to look at things from the right angle. If you look at operations and maintenance from the effect they have on the organization's profit and loss, you get a different perspective. Consider if you did nothing to maintain equipment — you'd have no maintenance costs; but eventually every single production system would fail. The result would be no production.

Operations and maintenance activities transform potential production into actual production. Similarly, procurement, human resources, sales and marketing each have a role to play in the team achieving optimized profitability.

Organizations need to optimize performance; they need to get the best return on investment for

the operations and maintenance resources. To do that organizations need a sound foundation — organizational structure, budgeting and strategic plan. These need to be focused on optimum performance. Organizations also need well-designed and defined processes that are measurable and repeatable. And most importantly, organizations need to focus and execute. Focus and execution depends on an aligned senior management team, professionalism in leadership and management techniques, and an understanding that it's not the absolute cost of functions that is important, but their effect on bottom line performance.

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Prove the value of predictive maintenance (PdM) to senior management

Proof of predictive maintenance benefits can have an astronomical effect

By Russ Kratowicz, P.E., CMRP, executive editor

The constellations of the zodiac appear along the path of the sun, in what's called the ecliptic. More than 2,000 years ago, skywatchers studied these star patterns and predicted how the movement of the planets "through" them affected civilization on Earth.

Many individuals still cling to the promise of these predictions, or horoscopes, based on astrologers' interpretations of star patterns in the ecliptic, even though most astronomers dismiss it as a bunch of silly cosmic mumbo jumbo.

Plant and maintenance managers might sometimes feel similarly pressed to defend the merits of predictive maintenance (PdM) techniques. A PdM program requires the use of technologies that help industrial personnel to make better decisions on when to performance maintenance. And these technologies cost money.

Predictive maintenance technologies are numerous, but how much of each is best? In other words, what's the most cost-effective combination? "Applying the RCM concept for determining what maintenance strategy should be appropriate for each failure mode is best," says Reid Neubauer, reliability engineer at Therma-Tru's (www.thermatru.com) manufacturing plant in Butler, Indiana. "I say that because failure-mode maintenance strategies consider, as the first and best option, condition-based maintenance, but only if the means to determine the condition of an asset is technically feasible and worth doing. That might include the use of a specific PdM technology."

Another take comes from Doug Smithman, P.E., president of EMP Engineering Services (www.empes.com), in Dresher, Pennsylvania. "Anybody involved knows the percentage of failures related to bearings, misalignment, poor installation, insulation and the like," he says. "They also know that some tests are better at early identification of certain problems than others. The trick is to mix those technologies properly. This is where most programs start off on the wrong foot. Is a program initiated by developing a wish list and then attempting to appropriate the needed funds or by optimizing a budget that has been granted? In most cases, it's the latter because the program isn't funded as desired anyway." In that case, linear programming is the best technique to use to optimize the application of technologies for a host of equipment, he explains.

It's the focus on the bottom line that can make the difference. This means including the labor content in the equation. "First it must cost less to do the technology than to not do it," says Jim Taylor, CPE, CPMM, director of operations at Machinery Management Solutions (www.machineryhealthcare.com) in Clarks Hill, Indiana. "Then optimize the cost of the full program over the entire plant. An individual technology might be cost-effective for a few machines, but when we look at the entire operation, it might be too expensive. Of course, consider the various ways to apply the technology — contract out, partial in-house, partial contract or fully in-house. Some are more effective if contracted out, especially if they require extensive training or ongoing experience to maintain skills."

Appropriate application

Once you have a handle on which technologies are optimum for your plant, the next question most people confront is how rigorously and intensely they should be applied to plant assets.

"The process of RCM-based maintenance strategies determine the intensity and frequency of the PdM technology used," says Therma-Tru's Neubauer. "The objective would be to mitigate a functional failure before the asset reaches that stage, which means the P-F interval is long enough to allow the management of the potential failure by scheduled corrective action."

The P-F curve (Figure 1) often is cited as a way to determine periodicity, says Machinery Management's Taylor. "But it's rare that we can plot one for actual machines," he says. "We can, however, form an initial estimate based on experience. Use industry norms as a starting point. Then take into account the machine type, speed, load, operating environment and consequences of the failure mode. After you gain some experience with that periodicity, use a technique like age exploration to see if you can safely extend the interval."

Another key to establishing the intensity of an application lies in historical records. "The source information is typically in the form of CMMS work orders, reflecting equipment maintenance history," says Paul Lachance, chief technology officer at Smartware Group (smartwaregroup.com). "Work orders show the real-life needs during equipment failures. It's helpful to compare corrective maintenance with preventive maintenance, as well. Meter readings also can be used for PdM analysis. If you can retrieve this data in an automated way, you'll get more data points on the asset while eliminating human error doing data entry, thus giving better, more accurate and timely analysis."

Dean Wallace, president of Applied Facility Solutions in Jeffersonville, Pennsylvania, agrees that equipment history is another factor and suggests results from the PdM program be reviewed to determine if the frequency needs to be adjusted.

"If by intensity you mean frequency, then equipment criticality, shaft speed, typical repair costs and lost production factor into monitoring intensity," says EMP's Smithman. "However, intensity often can mean more than frequency. It also can mean the types of monitoring performed. Is oil sampling appropriate? How about a megger test versus a full electrical analysis? Do we monitor vibration on each bearing or simply on the entire component?"

Truthful numbers

To gain any traction for a PdM program at the management level, the cash saved because a breakdown didn't occur need to be quantified. "We use cost avoidance," says Therma-Tru's Neubauer, "which is a total of parts, labor and the cost of the asset being unavailable." Downtime should be looked at as parts and resources are available, or if they aren't, he adds.

"This is an area where condition monitoring aficionados tend to oversell themselves," says EMP's Smithman. "If the lost opportunity cost is $35,000/hr, a lost week is 7 times 24 times $35,000, or almost $6 million, right? Of course not. Any effective plant finds ways to reduce the hemorrhaging once the corrective measures begin. The hourly cost will drop off, usually by quite a bit. Likewise, citing the full savings over every bearing identified is dishonest. People identified worn bearings by sound and temperature and overloads long before anybody thought of using spectral analysis. Lose sight of that fact or your numbers, and you can lose credibility."

Each time you find a problem, make sure you publicize the catch and what would have happened if it hadn't been caught, explains Machinery Management's Taylor. "You want to build a subconscious belief in PdM's effectiveness," he says. "Then, for at least the major finds, do a repair work order estimate as if the failure had occurred, but don't overdo it with cascading and secondary failures. Be conservative. Then compare that to the cost of the PdM program. I'd strongly advise having someone from the treasurer's or comptroller's staff on the team putting together the cost avoidance. When that cost/benefit study gets to the plant manager or higher, you want the comptroller to be able to say, 'Those are good numbers; my staff helped put them together.' One other thing, I'd advise reaching agreement a priori on the cost of lost avail-

ability. Direct costs are not too controversial, but lost production or sales cost can be."

Getting what you need

So, you've done the research, you've benchmarked, you've scoured the CMMS database, and you think your argument for purchasing enhanced predictive maintenance technology is rock solid. That might be so, but your funding requisition needs to be persuasive on an objective level. How do you prove something didn't happen because of maintenance practices and then quantify its benefits?

"Use cost avoidance and MTBF," says Therma-Tru's Neubauer. "If the PdM is effective, corrective action can mitigate a functional failure. MTBF is an excellent indicator that shows the value of PdM condition based maintenance."

Be prepared with specific examples of where PdM will reduce costs and improve uptime for the facility, explains Applied Facility Solutions' Wallace. "Include the cost of purchasing diagnostic equipment, CMMS changes and training the plant personnel," he advises. Also, provide estimates of labor and material for ongoing implementation of the PdM program, suggests Wallace.

"Bean counters are what they are," adds EMP's Smithman. "You won't impress them with technology. You'll impress them with ROI. Don't forget that. Factor in the important elements, not just lost production. Did you damage in-process product? Could somebody get hurt? Might it make the newspaper or stock report? Might downstream processes be affected? Does it affect energy efficiency?"

> "The best way to integrate the CMMS and the PdM technology is to connect the online data collection into a condition-based inspection that alerts a subject-matter expert when there's an abnormal condition."

Machinery Management's Taylor suggests a cost/benefit study. "But you need to put it in a format that the deciding manager is used to and comfortable with," he adds. "Is it payback, NPV, IRR or some other measure? If you have the comptroller's staff member on your team, they'll know how to do that. They'll also validate your assumptions of dollar estimates. Make sure you consider all possible savings. Make up some worksheets to document how you come up with your estimates. Be conservative in payback. The Association for Facilities Engineering Certified Plant Maintenance Manager (CPMM) Program offers a CPMM Review Pak that has some good examples."

Smartware's Lachance agrees. "Show ROI capabilities from implementing a good PdM application," he says. "Any good CMMS vendor can prove the ROI from PdM analysis as a result of proper implementation of a quality CMMS system. Once designated equipment information is entered into a CMMS system, PM schedules can be set up and work orders issued. If maintenance and repair patterns can be captured automatically, operational benefits and ROI can be achieved quickly."

CMMS then reduces equipment/facility downtime by identifying equipment in advance that needs additional care and then putting additional PMs in place. This reduces maintenance costs — PM is always cheaper than corrective work — and decrease lost production time." Lost production is expensive for manufacturers, resulting in overtime, potentially late deliveries and increased parts costs, explains Lachance.

Plant floor partisans

It's also helpful to have the backing of the plant-floor personnel who must use the PdM technology. After all, they will be bringing the grand plan to fruition and achieving the predicted financial results. The last thing you need now is subtle sabotage.

"Our plant," says Therma-Tru's Neubauer, "uses a two-pronged approach. We include operations or maintenance in the decision process, and we provide the end user with as much of a turn-key product as possible. This means that if you sell them on the use of a process and then require them to finish the tasks, the buy-in goes away quickly."

Demonstrating how PdM will improve their jobs will save time, recommends Applied Facility Solutions' Wallace. "Foster a sense of ownership in the program by making them active participants in every phase of PdM implementation," says Wallace. "Communicate successes and needs for improvement. Reward and thank the technicians and operators who are key members of the team."

Ideally, adds Machinery Management's Taylor, those technicians and operators should be the ones to initiate the project. "If you can't orchestrate that, get a couple of the thought leaders on board early," he suggests. "Publicize the downside, from their point of view, of the current situation. Then start building a desire for change in the workforce."

Sans cable

An up-and-coming approach to industrial maintenance involves wireless communication between and among the various elements of the maintenance team — the CMMS, schedulers, technicians, upper management and other relevant stakeholders, and it has its advantages and its shortcomings.

"It's not always user-friendly to take PdM on-condition readings," warns Therma-Tru's Neubauer, "because of a safety issue or because it requires disassembly to get to the reading point so using either remote devices or remote data logging units make real sense."

However, on-the-go CMMS technology makes operational maintenance more streamlined and thus effective, argues Smartware's Lachance. "Better, faster data entry ensures that the information needed for PdM is more accurate and faster to analyze," he says.

Machinery Management's Taylor agrees. "Wireless should be considered strongly," he says. "Wireless makes it much easer to use installed monitoring because you eliminate much of the cabling. The savings in manpower for walk-around monitoring, reduced mistakes and improved data will repay the higher up-front cost quickly. You'll also get a shorter delay in notification if something goes wrong."

Oops, my bad

The best-laid plans are of particular interest to our old friend, Murphy. Things can go wrong. It's one thing for a piece of hardware to fail unexpectedly, but it's quite another to find that human error was responsible for a debacle.

"Make sure that adequate data-gathering training is used," says Therma-Tru's Neubauer. "And look for ways to do online data collection that don't require the use of human input."

Human error always will be a risk, asserts EMP's Smithman. "Whether it's in collection, interpretation, implementation or programming, human error is a risk in any technology program," he says. "The goal is to reduce human error, not eliminate it. That said, a manageable combination of test standards and methodologies, the criteria for alarm and failure values, and continuing education are all important."

Applied Facility Solutions' Wallace suggests a phased approach. "Start by implementing an effective training program," says Wallace. "Develop a small

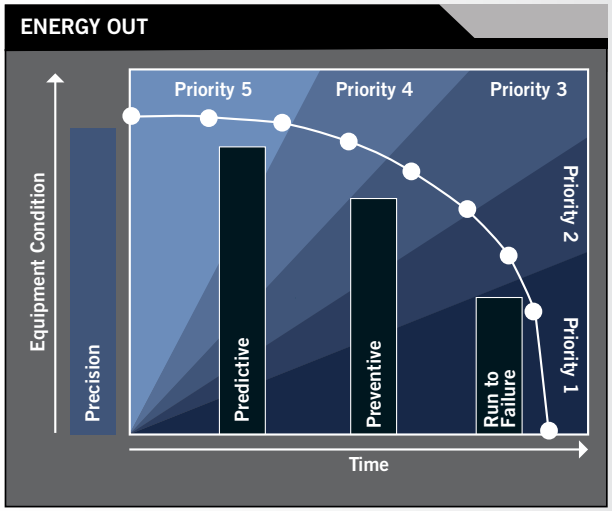

Figure 1. This P-F curve assigns maintenance priorities and suggested maintenance strategies for the various stages of degradation.
(Source: Green Energy Engineering Services)

cadre of well-trained technicians before rolling the program out to the larger workforce. These individuals will become the nucleus of the PdM program. Having written procedures for each PdM work order will reduce confusion and eliminate guesswork about the tasks to be performed."

Install as much monitoring as possible, along with well-thought-out warning and alarm levels, suggests Machinery Management's Taylor. "A common mistake is to make alarms too sensitive, so the human gets overwhelmed by the number of alarms," he says. "Build common repair work orders ahead of time, so they're ready when needed and so you don't have to do it under pressure. Develop written work instructions and procedures and use them. Keep them up to date. Airline pilots use check lists, why shouldn't we?"

PMs should highlight areas of concern for each machine, says Smartware's Lachance. "Before acting on those areas, perform more detailed research," he says. "For example, a CMMS with asset life-cycle analysis capabilities can show how effective an asset is based on its age, mean-time-between-failures and cost trends. If the asset appears in jeopardy, you easily can drill down into the individual asset's trend analysis and work order history to reconcile against erroneous data entry or other human errors. CMMS-based maintenance history is important and a good tool to identify errors.

Digital teamwork

Just as it's important to get the people involved in PdM working as a team, it's equally important for the technologies selected to work together smoothly. "The best way to integrate the CMMS and the PdM technology," says Therma-Tru's Neubauer, "is to connect the online data collection into a condition-based inspection that alerts a subject-matter expert when there's an abnormal condition, as signaled either by a trend of data points or a single reading. The alarm gives the option to issue a work order either to do a corrective action or to monitor the situation, or ignore it altogether if the alarm was false or incorrect."

PdM work should be issued from the CMMS, recommends Applied Facility Solutions' Wallace. "This ensures the cost of repairs, and corrective actions are being captured in the work order history," says Wallace. "Problems found as a result of PdM work orders should be followed up and issued as corrective work orders in the CMMS."

Smartware's Lachance agrees. "PdM is an integral part of a CMMS and should be part of a cohesive module, not a bolted-on tool," he says. "It should reside directly in the system. A quality CMMS program provides one-click analysis to see various PdM-oriented reports."

Machinery Management's Taylor has a slightly different take. "I think you should use the CMMS to plan and schedule the monitoring," he says. "Then use the PdM software to collect data and do analysis. The information, not the data, should go to the CMMS for job planning and history collection."

The best way to use CMMS, says Allied's Trulli, is to use it to the fullest extent possible. "We discussed being able to track metrics associated with your PdM, maintenance and reliability programs," he says. "The plant CMMS should be the method used to track a vast majority of the metrics associated with your PdM program. The plant CMMS system with enable you to track time associated with PdM/PM activities, as well as corrective actions generated to ensure proper work flow to support your desired proactive work models. In addition, failure coding and equipment information, as well as repair history, should be entered and used for reliability and continuous improvement initiatives. It's desirable to persuade your CMMS system to function as a common reporting system for applied CBM technologies. These considerations and many more should be used to produce a central hub for comprehensive maintenance and reliability program management."

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