Written by Christer Idhammar, IDCON, Inc.
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Stepping up improvement efforts will require you to go ever deeper into lean. As this expert concludes, the payoff is well worth it.

The first installment of this article ended with a brief look at over-manufacturing—*the greatest sin in lean manufacturing*. Over-maintenance also is a sin. Performing more of it than is needed or before it's needed should be considered a waste or an opportunity to improve. This concluding installment picks up with some of the biggest improvement opportunities a maintenance organization has.

Optimizing preventive maintenance

Much has been written—*and can still be written*—about the optimization of preventive maintenance (PM). This discussion, however, focuses solely on how PM optimization relates to lean maintenance.

Optimizing your PM can provide one of the fastest returns on investment you'll ever realize. If you have a PM system that has all activities documented under each equipment identification number, optimization can be done relatively quickly. If you have a system where all PM activities are documented in a work order, the work becomes much more extensive, if not impossible. If you want to optimize your PM, you must have a system that can collect all PM efforts in a lucid way under respective identities on the maintenance object. This is important because more than 95% of all PM activities are performed as route-based activities while the manufacturing process is running. As a result of increased integration of what lubricators, mechanics, electricians and operators do, the system must always change—*and be able to change easily*. If your existing PM is based on work orders, the simplest way to begin your optimization efforts is by establishing a route-based system (which can be set up at a very low cost).

Today, it's surprising to find some PM systems continuing to operate much like they did when they were first implemented 30-40 years ago. The distribution of work among different groups is still the same as it was back then. Granted, in many of these companies, operators have become involved in preventive maintenance, but their efforts are combined with other PM measures. Herein lies a great opportunity to optimize numerous PM activities.

As an example, in one chemical plant, most pump units still had the following PM measures done:

- Lubricators lubricate everything, except electric motors.
- Electric motors are lubricated by electricians. (Even if it's old-school and a waste of the electricians' skills, it is still happening.)
- A mechanical PM inspector performs mechanical inspections.
- Gear couplings are overhauled during annual scheduled shutdowns. (This could be moved to inspections as the equipment runs, with repairs done as needed.)
- Electricians and instrument technicians inspect electri-cal components and sensors.
- Technicians perform vibration analyses.
- Operators conduct general inspections of units.

After optimizing this system, PM activities were reduced by 50%—*and the new activities were considered more effective than before.*

It can be a good idea to take photos of several pieces of the equipment and show what PM is performed and by whom. Then show how to integrate and optimize all PMs. After that, you can determine costs and savings.

Lean shutdown management
Depending on the industry, a "shutdown" can vary dramatically in scope, including, for example:

- Several weeks for a stop in an oil refinery
- Days for a longer chemical-plant shutdown
- Hours for a recurring shutdown in many process industries
- Minutes for manufacturing-operation adjustments and tool changes
- Seconds for automobile-racing pit stops

NASCAR is a good example of what can be accomplished through precision planning, scheduling and execution. Major contributors to pit-stop—*or shutdown*—performance include communication between operations and maintenance and continuously working on improving the basics of planning and scheduling, execution and root cause problem elimination. In the 1950s, a good pit stop lasted approximately 240 seconds. If nothing had been done to improve these events in the years since (because everyone thought four-minute pit stops were good), we would still be watching them. On the other hand, a crew that could bring those old 240-second pit stops down to the shorter times seen in NASCAR today has the potential to win races.

Interestingly, a NASCAR driver is in constant contact with the pit crew. He/she doesn't suddenly show up in the pit and complain about a problem with a right front tire, only to have the crew answer: "Let us go to the store and check on a replacement tire." Unfortunately, this happens daily in most plants. In NASCAR competition, there's a strong motivation to win races; in our plants and facilities, there might be completely different factors driving motivation.

In addition to driving Planning and Scheduling to precision and excellence, NASCAR pit crews are continuously working on improving the basics. This includes, among other things:

- Analyzing problems and successes
- Training 20 hours per week for 20 seconds of work on Sundays
- Doing work right before doing it fast

Regardless of the length of a shutdown, the same principles apply in making these events more effective—*or leaner.*

- First and foremost, problem-free operation should be possible between scheduled shutdowns. Mean time between production losses (MTBPL) including quality, time and speed should be as long as possible.
- Shutdowns should be performed with the right quality on all jobs, as quickly as possible.

The combination of how many shutdowns you have and how long they are affects both your production volume and your ability to deliver product on time. It is a given that the shutdown must be scheduled (when and who executes what) and that all the jobs must be planned (what,

how, all tools, spare parts and materials, lockout/tagout, etc.) before the shutdown begins. In addition, all shutdowns should have a set time for freezing the schedule. After the freezing point, no new jobs will be accepted without harsh criticism.
Two measurements can be used to challenge your organization and measure and show improvements. They are as follows:

1. Number of added-on and changed jobs...
Define a freezing point for a scheduled shutdown that is to be done within an agreed-upon time frame. Then determine how many jobs are added or changed after the freezing point and during the shutdown. Scrutinize all the added or changed jobs within three days of the shutdown's completion. Seek explanations for them and learn how they can be avoided next time.

2. Relationship between scheduled and unscheduled shutdowns...
With the same definition as in the previous paragraph, we can measure the relationship between scheduled and unscheduled shutdowns. For many process industries, the quota of the equation is over 1—
and should steadily increase. This is on the condition that scheduled shutdowns are not programmed and based on old habits, but rather based on market factors and condition monitoring of process and equipment.

Determining what jobs actually must be done during a shutdown
Many jobs are performed during a shutdown only because they have always been done—*and no one has ever questioned if they actually need to be done*
. To know if what you are doing is right, you should have a good understanding of the expected life of each respective component. For example, to regularly change out a roller bearing after 8000–10,000 hours of operation can't be right. Still, it is a common preventive recommendation from manufacturers.

Consider the following issue that came up at a production facility recently: It concerned an OEM's recommendation to change a centrifuge bearing once per year. The rationale? "The centrifuge rotates with a high rpm, and if a bearing breaks, the rotating unit can cause severe damage, including bodily injury." According to bearing OEM calculations, the life for a bearing is between one and 15 years (L10–L90 life span). In this application, it's calculated that 10% break within one year of operation, 10% last longer than 15 years. This fact alone indicates it is wrong to change the bearings on an annual basis. A bearing that is changed could potentially last for more than 10 years, whereas the replacement bearing might not last more than three. Moreover, there is always a risk that a problem will be induced when a component is changed.

Within reliability theory, bearing failures are defined as random failures—*you don't know when they will occur.* That also means you can't know when the component needs to be changed out. "Even though I know it isn't right to change the bearings, I still do it," noted the maintenance manager at the facility in question. As he explained, despite his plant manager championing lean manufacturing, becoming lean in maintenance isn't always comfortable.

You should also ask if jobs that are done during a shutdown could be done during production. One good example of innovation/new thinking involved changing joints of high-voltage lines. With the aid of a helicopter and dynamite, the old joints were improved without disruptions in the power supply [Ref. 1] .

Lean- and reliability-based spare parts and materials management
In about 50% of operations, spare parts and materials stores reports to the maintenance organization. In the other 50%, it is part of the purchasing function.

When an organization wants to become lean, one of the first areas of attack is materials and spare parts. By reducing the value of spare parts and material in storage, you can reduce costs. There are often big opportunities to lower the value in many stores, but such efforts can be very costly if not done right.

As an example, one of the most common mistakes is to discard parts that haven't been used in the past five years or more. This tactic is simplistic and risky—*but it's still being used in many plants today.* Incorrect and expensive cutbacks like this often happen as a result of individuals responsible for the stores pursuing the goal of reducing store value. They may not be concentrating on the consequences of not having the right part in storage when it is needed, which is a real problem for those responsible for operations and maintenance.

Most stores, especially in plants that are 10 or more years old, can reduce their value by 10 to 20% without negatively affecting production reliability. To successfully—*and sustainably*—reduce the value of parts and material kept in stores, you must focus on measures that drive down the cost, not only on reducing the store value. You should also set up a measurable goal for this effort. It could, for example, be something like "With a service factor maintained at 97%, we will

reduce value of inventory kept in stores." In this case, the service factor would be the percent of occasions the right parts/material have been available when needed for a maintenance job.

1. Knowing what parts and material are in your stores...

This is the first information you need. Do a quick evaluation of how accurate the inventory list is. Randomly choose 300 to 500 articles and compare how correct the balance is, the location in the stores, etc. While it may be typical for the inventory catalog to be 70% accurate, 98%+ would be better. But even if your accuracy value is 100%, it doesn't mean that the stores are cost-effective. Do you have the right articles? Do you have too many?

2. Determining how many articles exist in undocumented storage...

If the inventory catalog and/or the plant register—*including component record and spare parts documented for each piece of equipment* —aren't accurate and reliable, users will not trust that the articles they need are going to be available in the store when they need them. This is one of the reasons people start building up their own stores. Such activities can become extensive and very expensive. The costs are invisible. More articles are purchased before they are needed, often in greater quantities than necessary. Even worse, articles frequently are stored in bad environments where they can be damaged by corrosion, dirt, vibrations, etc. It's imperative to clean up, sort, organize and document all articles in such storages. The store manager will probably not want to take all these items back into the central stores, as they would increase stores value and take up costly space.

(Note: Undocumented stores might best be characterized as "emotional stores." If you make an effort to document them, then take these parts away from the people who have amassed them and put the items in central stores, you'll understand why the term "emotional" applies.)

3. Deciding what to have in storage...

While known and traditional methods and data used to decide what should be kept in storage (i.e., delivery times, economic purchasing quantities, consumption statistics, etc.) may or may not always be available, it also is not uncommon that information on risk for breakdown of a component, cost if an article is not in storage when it is needed, condition-monitoring-based storage, number of identical parts used in the plant equipment, etc., to be missing. Then, only guesses can be made as to what should and should not be kept in storage.

It is important to conduct an analysis on what production equipment is critical and which components within each piece of this equipment could cause a breakdown. The breakdown cost compared to the cost of keeping parts in storage is a crucial piece of information that should be taken into consideration when store levels are decided.

With good condition monitoring, you can often avoid keeping parts in storage if the so-called failure-developing period is longer than the delivery time of the parts being monitored. A practical example is chains and sprockets made of steel. They wear down over a longer time period, are easy to inspect with objective methods and the delivery times for replacements are typically short. If you monitor wear of sprockets and chains, you can order them when you need them instead of keeping them in storage.

Working with an accurate inventory catalog and/or the plant register, including component record and spare parts documented for each piece of equipment, you will know how many identical articles are included in the production equipment. This is necessary and important information to have when evaluating suppliers' recommendations and decisions on what to keep in stores. The absence of this documentation can lead to storing the wrong parts and quantities.

Standardization can also reduce storage substantially. If you have a production line with 22 or so different (and critical) motors, you might decide to keep one of each type in storage. You can often standardize on about five different motors, or even a single type. Then, only five motors—*or maybe just one*—would need to be stored.

Maintaining stored items...

You need to keep parts you store in the right environment, free of dust and other contaminants and safe from vibrations. Rotating equipment like electric motors and pumps should have their shafts oriented toward the aisles in the store, so they can be easily rotated to avoid sagging of shafts and damage to bearings. V-belts and other belts made of rubber and similar material should be kept away from daylight (preferably in a dark location). Bearings should be stored flat and turned on a regular basis.

Striking greatness

Stepping up from good to great in your organization via lean maintenance requires drilling down to the core principles of lean. Understanding and embracing them can help you leverage countless improvement opportunities in your maintenance operations and elsewhere. **MT**

Reference

1. "Reliability Tips / March 2008 / Power line workers," www.idcon.com

Highly respected, award-winning reliability and maintenance-management expert Christer Idhammar is the founder and executive vice president of IDCON, Inc., based in Raleigh, NC. For more information, e-mail info@idcon.com .