Maintenance Management
Strategies for Achieving Excellence in Maintenance
SEPTEMBER 2000
NUMBER 2609

Total Productive Maintenance: Your Facility's Road to World-Class Performance?

Would you like to be able to make a concrete contribution to your company's profitability — something beyond the fire fighting that goes on in all too many maintenance operations? One way to get there is to embrace the concept of Total Productive Maintenance (TPM). Some proponents claim efficiency improvements of 50 percent or better — and near-perfect uptime. Here is an overview of TPM, showing you how it works and what it can do for your operation.

First, a little background: In the late 1950s, American engineer George Smith introduced preventive maintenance (PM) concepts to manufacturers in Japan. There, it was dramatically enhanced by integrating quality techniques and new methods for achieving superior equipment reliability. The term "total productive maintenance" was coined by General Electric. Smith then introduced this Japanese-style TPM to the U.S. and later founded the Marshall Institute (Raleigh, N.C.), which eventually became a TPM training center.

Why have manufacturers been embracing TPM? Because as Marshall Institute's current president, Preston Ingalls points out, "They realize that PM alone is not adequate for world-class plant maintenance. It doesn't take into account all forms of equipment loss and deterioration."

The basic TPM concept is simple, stemming from an obvious maintenance fact: Machinery deteriorates due to both normal wear and tear (factors such as friction, heat, and corrosion) as well as exceptional causes that accelerate damage (factors such operator misuse and faulty maintenance). To protect against ordinary factors, technicians apply PM — but few techs know how to find and systematically correct the human factors that cause *accelerated* deterioration.

Operator Responsibility

Human lapses often turn out to be caused by over-specialization and the resulting inflexibility brought on by craft rules and their strict division of labor. One person is often designated as strictly an "operator," and another as a "maintenance tech." A large or complicated machine often needs constant, skillful monitoring, but the designated maintenance person can rarely give such sustained and intensive care.

TPM resolves this problem by inducing the organizations to revert to the organization of "pre-specialization" days. Operators assume responsibility for cleaning, lubricating, inspecting, and even doing minor repairs on their own machines. This is a natural arrangement in that the operator already "lives" with the equipment day in and day out. It makes sense to train and empower that person to take much greater charge over the upkeep — the way things used to be.

When that operator is also well supported and fully accountable, the

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NFPA Has Hot Info for You

Fire protection is no longer just hanging fire extinguishers and occasionally checking exits and stairways. There is more to solving fire and safety-hazard problems — and to complying with standards for public safety. And helping you learn how to use the latest fire-prevention technology and techniques is the chief mission of the National Fire Protection Association International (NFPA).

Formed in 1896, the Association established the first U.S. national standards for fire sprinklers. Now the organization covers all aspects of safety and writes both the National Fire Codes and the NFPA Fire Prevention Code. These are widely used by states and municipalities, and have been adopted as law in many jurisdictions.

If your organization's fire prevention and safety habits are not based on applicable codes, the result could be costly litigation.

Check Codes

Robert V. Miller, a former fire marshal and now manager of NFPA's activities in 13 western states, recalls a recent case that brings home the need to follow applicable fire codes. A college was required — by code — to have a certain minimum distance between fire extinguishers. When fire injured a student, his attorneys sued the college. They based their case on the fact that the distance to the nearest available fire extinguisher was greater than the code allowed. That mistake cost the college — and it could have been avoided with simple compliance checks.

Even if you are not negligent you may still be liable. "Deep pockets are going to pay whether they're responsible or not," says Miller.

He praises regulations that require devices such as fire extinguishers and smoke and CO_2 detectors. These have cut deaths from fire and smoke inhalation from the 12,000 per year of 20 years ago to 4,000 per year at present. But he cautions that equipment should be checked regularly. A study in Idaho showed that 45 percent of deaths from fire or smoke inhalation were in structures where smoke detectors were not working.

Naturally, you should replace equipment when it ages. For example, Miller recommends replacing smoke detectors older than 10 to 15 years.

Miller also recommends that you and your people study and discuss the results of inspections in the light of code provisions. NFPA courses on fire prevention can familiarize your people with a wide variety of compliance measures so that you can choose those most suitable for your situation.

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resulting reliability gain is often astounding. "It's not unlike the difference between renting an automobile and being the owner," Ingalls says. In place of carelessness comes diligence and pride.

Under TPM, an entire plant is eventually reoriented around the notion of each operator's personal stake and equipment "investment." Each learns to perform all cleaning, lubricating, topping-off of fluids, adjusting, tightening of fastenings, inspections, looking for signs of wear, doing scheduled PM, and making minor repairs.

"You can remove as much as 60 percent of your equipment problems by keeping machines extremely clean, properly lubricated, with parts tightened and adjusted to spec," Ingalls observes.

Effective Support Systems

Operators are hardly expected to go it alone. A second key TPM concept is applying supportive resources for fully optimizing equipment efficiency. Everyone — from Plant Purchasing, Engineering, and Maintenance to senior management — becomes mobilized for this purpose.

Dedicated support teams made up of maintenance techs, engineers, and operators are created to oversee equipment welfare. These teams draft customized maintenance standards and procedures. They also schedule rigorous PM and planned maintenance. Their collective wisdom supports operators, who know whom to call or what to do for each condition.

Extensive training also occurs so operators learn to troubleshoot many of their own repairs. This knowledge

Maintenance Management (ISSN 1080-188X) is published monthly by the Bureau of Business Practice, a division of Aspen Publishers, Inc., 7201 McKinney Circle, Frederick, MD 21704. Subscription rate is $219 a year. Editorial comments may be directed to 125 Eugene O'Neill Dr., Suite 103, New London, CT 06320. For information on reprints, photocopy requests, or multiple subscription discounts, call 1-800-243-0876. Postmaster: Send address changes to *Maintenance Management*, Bureau of Business Practice, 7201 McKinney Circle, Frederick, MD 21704.

accumulates with experience and can result in tremendous uptime improvement.

The oversight team also stands ready to assist in larger problem-solving using techniques such as root-cause failure analysis.

All of this effort basically aims at a single goal, which is constant improvement of a TPM index called overall equipment effectiveness. The OEE is comprised of up to 14 negative indicators in three categories. They are:

✔ **"Availability" losses –** the deficiencies in usage caused by breakdowns or by setup and adjustment time.

✔ **"Performance" losses –** seen when equipment is running but is below par. It may be idling while it waits for other events up- or downstream; or suffering brief stoppages; or running at reduced speed. "At slower speeds, the machine tends to run better, but it costs you in decreased production," Ingalls notes.

✔ **"Quality" losses —** measures of production that is unusable, such as make-ready losses, rejects, reworking, seconds, and flawed output.

Using these measures, you calculate an OEE figure by which you can compare your factory with others. Multiply the "availability" figure times "performance" times "quality." If the resulting number is 0.85 or better, you are definitely world-class. For example, you would rank there if your aggregate machine availability were, say, 90 percent (0.90), with performance at 95 percent (0.95) and quality at 99 percent (0.99).

Next, by using raw OEE measures in a Pareto analysis, you can pinpoint various loss trends in each category, and direct your organization's resources intelligently towards improvement.

Another virtue of this numerical approach is that efficiency levels of 60, 75, or 80 percent (or whatever) can always be represented in dollars. For example, "If you can improve one of these measures by 30 percent, it usually translates into 'x' amount of additional units produced. This adds 'y' amount of income to the bottom line" — giving you a cost justification for making an investment.

Efficiency, Not Cost-Cutting

Yet another benefit is that TPM focuses on minimizing each loss category rather than on merely slashing payroll. "By improving efficiency to a world-class standard, you will naturally cut your waste, because you have identified how all of your time, effort, and materials are being used," he says.

"TPM doesn't fix every problem. It does, however, give you the tools to focus on improving equipment efficiency. This makes it a great complement to other initiatives, like Six Sigma, just-in-time, lean manufacturing, or total quality. Whatever you undertake, you will need to improve equipment availability. TPM is the best program for focusing on that."

How Tough Is It to Implement?

"To succeed with TPM," says Ingalls, "your initiative must be bottom-driven, but top-supported."

The proven method is to begin with a steering committee made up of key managers and labor representatives. They must construct a well-integrated, comprehensive plan. They also provide leadership, oversight, monitoring, and auditing, along with ensuring adequate resources. They set policies, do training, devise rewards programs, and establish an implementation schedule. Below the steering committee are separate implementation teams organized around each equipment system.

"You should start with one or two pilot projects," says Ingalls. Pick a machine for which the improvement potential is likely to be dramatic — this inspires confidence in the teams joining you down the line. Build on your initial successes and experiences progressively.

"You don't need to hurry the process," he advises. "Your initial pilots may require a year or more to complete before they produce the desired gains."

Results of successful pilot project implementations are usually spectacular. Recently, a Texas Instruments plant deferred $6.5 million in capital in one year. Harley Davidson earned a 10-fold return. MRC Bearings (Jamestown, N.Y.), a division of SKF, reduced unplanned downtime by 99 percent in a year.

And a TPM study of 100 implementations showed an average 85 percent gain in productivity; and a reduction in downtime to a minuscule 1 percent.

"Keep in mind that this is not primarily a cost-reduction process," says Ingalls. "Nor is it simply a maintenance program. It's a large-scale, operational improvement process."

It's also a major cultural change. "It means getting people to choose to do the right things, the right way, at the right time. You will not always find," he concedes, "that this is easy to do. The toughest part of TPM won't be fixing equipment, but correcting people's attitudes."

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Get Smart

If you're not already an expert on fire prevention — and not that many maintenance and facility managers are — the NFPA offers handbooks, videos, CD-ROMs, and disks, as well as training on fire prevention, fuel and combustibles safety, evacuation procedures, and the latest on fire suppression and alarm protection. Use their know-how to help you increase the safety of those for whom you provide security.

◆ *For more information, contact Miller at 909-941-2505 or e-mail him at* rmiller@nfpa.org, *or contact the NFPA at (800) 344-3555.* ■