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PILLARS OF STRENGTH

A four-step guide to total productive maintenance

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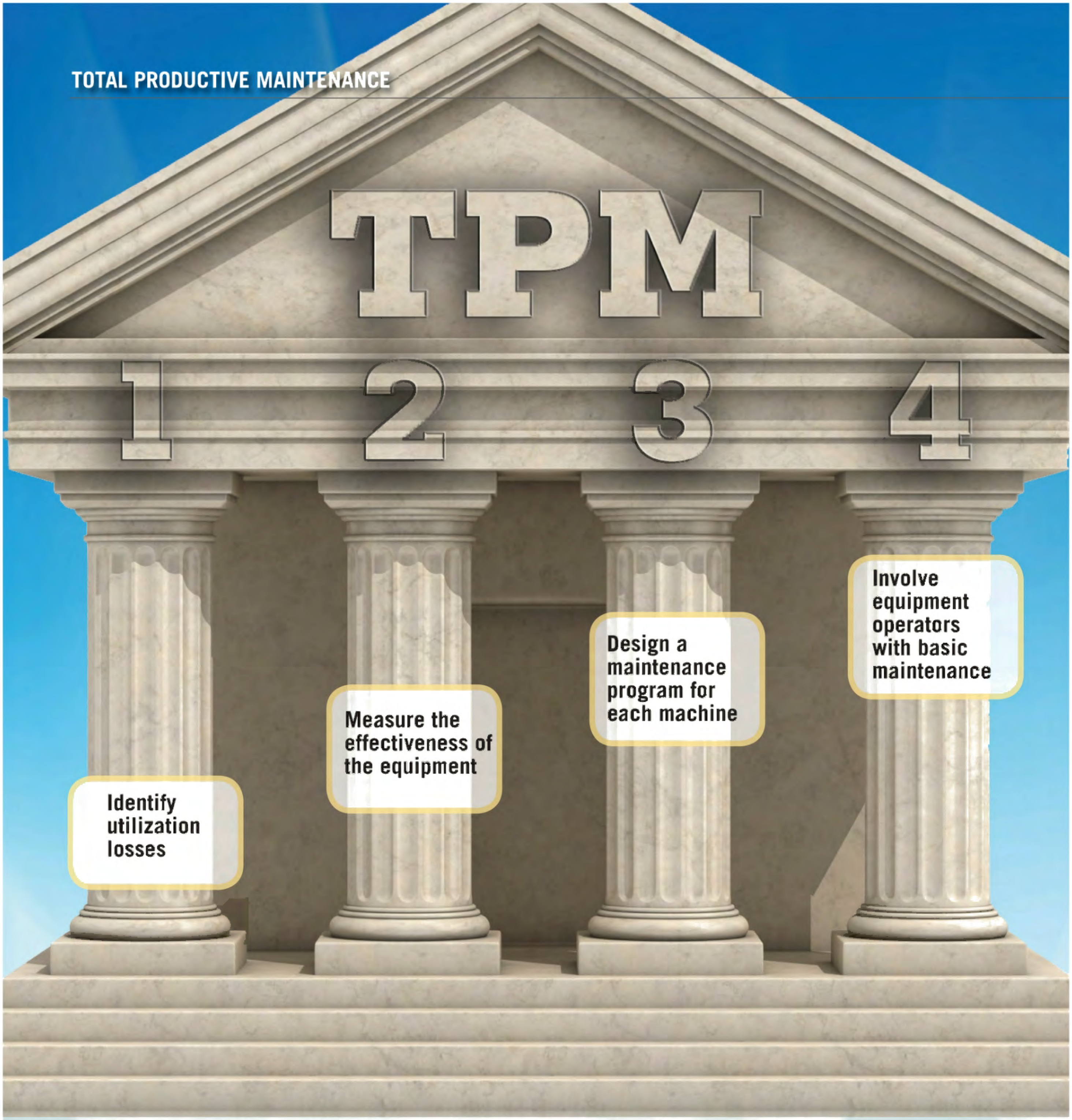

Pillars of Strength

A four-step guide to total productive maintenance

BY JENNIFER OHL

AFTER THE General Electric Corporation created the total productive maintenance methodology in the 1950s it had a significant impact on improving the overall productivity and reliability of the Japanese manufacturing industry. Today, TPM methodology, which was designed to improve equipment utilization and profits for manufacturing plants, continues to be used by companies known for high quality production and profitability such as Toyota. In North America, however, small- and medium-sized companies have been slower to embrace TPM due to the perception that it could be costly and cumbersome to implement. In fact, TPM can be affordable and simple to implement.

TPM can be simplified by breaking down its implementation into four basic steps. The primary measure that TPM provides is overall equipment effectiveness (OEE), which is the product of availability, performance and quality.

STEP ONE
Identify utilization losses

The first step is to identify losses that may occur in each of these categories that lead to reduced equipment utilization. Production equipment is usually the largest asset in most manufacturing plants (next to land and buildings). Stock markets pay attention to a company's return on assets (ROA), as it is a widely used measure of financial performance. Asset utilization is the single most important factor that influences ROA – better equipment utilization increases profitability. The measure of Equipment Utilization incorporates the following three factors: loss of availability, loss of performance and loss of quality.

Table 1. A sample "Equipment Observation Form"

Equipment No: Printer-023 Date: 6/23 Shift: First	Observer: John Smith						
Start	End	Downtime	Product Defects	Set up/Adj.	Reduced Speed	Material Shortage	Reason
8:00	8:10			10 Minutes			Printer set up
9:20	9:45					25 minutes	Waiting for envelopes
10:45	11:05			20 Minutes			Changeover to 2nd run
1:25	1:45		20 Minutes				Smeared letters – printer jam
2:25	3:40	1:15					Printer malfunction
Total		1:15		30 Minutes		25 Minutes	20 Minutes

Table 2. Results of OEE for two different shifts

DEE Factor	Shift 1	Shift 2
Availability	89.2%	81.3%
Performance	78%	61.6%
Quality	86.7%	87.2%
OEE	60.3%	43.7%

Loss of availability: When the equipment is down it is not available for production. There are various reasons for machine downtime; some of them are planned (scheduled maintenance, setups and adjustments) and some are unplanned (failure, unavailable operator or part shortages). TPM differentiates between these different causes for machine downtime and provides important insights for the reasons for the loss of availability.

Loss of performance: Is the production equipment running at maximum capacity? LOP includes factors that cause the machine to operate at less than the maximum speed, such as minor stoppages, operator inefficiency and machine wear. Here, the equipment is not broken down – it just performs at reduced capacity. These are referred to as "hidden losses" because maintenance is not contacted and the losses are not recorded as downtime. These "little" problems can add up to large losses.

Loss of quality: This factor incorporates equipment-related factors that result in below-standard quality products, which would either need to be rejected or fixed. The equipment time used to produce a below-standard product is a loss of equipment time. These losses are typically smaller compared to other equipment losses. Since equipment is better maintained under TPM, quality losses are usually reduced.

Measuring the three components of equipment utilization is necessary for determining current utilization level. OEE is the most widely used measure of equipment utilization effectiveness.

STEP TWO

Measure the effectiveness of the equipment

Measurement of equipment utilization is based on data and records collected during an observation period. Data should include records on downtimes and product reject rates for each machine. The observation period should be tailored to the type of equipment being evaluated and should be long enough to sample occurrence of failures. In general, a longer observation period will provide a more reliable measure. If the machine's production schedule varies according to shift, observations during each shift should be done separately. An example of an Equipment Observation Form is shown in *Table 1*.

Data collection is the most time-consuming component of any TPM implementation. Fortunately, this step is done only at the initial phase of the implementation and at infrequent follow-up intervals. The person collecting the data should not be the same person who operates the machine. Observing the machine takes time and attention and it may compromise the operator's ability to run the machine. Companies often hire temporary staff to observe and record the data.

The computerized maintenance management system (CMMS) can be an important resource for records related to the equipment downtime and scheduled maintenance. Examples of useful CMMS reports are:

1) Total downtime for a specific time period.
2) The number of emergency/corrective work orders performed during a specific time period.
3) Total cost of labour and parts for these work orders.

It may be most beneficial to start observing equipment that is known to cause the most problems. If downtime is a primary concern, then start observing the machines with the most downtime. If cost control is the primary focus, then start observing the machines that cost the most to maintain. After completing the initial observation and calculating OEE, four separate numbers to measure and compare will be on hand; the OEE along with the three factors that it is based on – Availability, Performance and Quality.

Table 3. An example of common standard values for OEE Factor World Class

OEE Factor	World Class*
Availability	90.0%
Performance	95.0%
Quality	99.0%
Overall OEE	85.0%

* "The OEE Quick Guide," Vorne Industries, 2008.

WORLD-CLASS NUMBERS SHOULD BE TREATED AS A REFERENCE THAT HAS BEEN REACHED BY THOSE WHO HAVE INVESTED EFFORT IN THIS AREA; THEY ARE PROVIDED HERE BECAUSE TPM COURSE ATTENDEES ALWAYS ASK "WHAT IS GOOD OEE?"

Table 2 (on page 13) shows an example of results obtained from observations made during two different shifts at a publishing manufacturing plant. The results clearly indicate that the primary issue that needs to be addressed first is a suboptimal equipment performance. Comparing measurements from both shifts may reveal additional valuable information. Here, the operator during the second shift was a new hire and it took her longer to set up the machine for each run than the more experienced first shift operator. It wasn't until these numbers were presented to management that they decided to provide additional training to the second shift operator.

Breaking down the OEE into its three components permits the comparison in each area with world-class standards. Accepted world-class goals are specific for each industry. One example for commonly used standards is shown in *Table 3* above.

World-class numbers should be treated as a reference that has been reached by those who have invested effort in this area; they are provided here because TPM course attendees always ask "What is a good OEE?" It is important to remember that OEE is affected by many parameters and not only the performance of the maintenance staff. "OEE is a measure of equipment effectiveness, not a measure of maintenance effectiveness," according to maintenance and manufacturing expert Robert Williamson of Strategic Work Systems, a North Carolina-based consulting firm that helps manufacturers and facilities increase the reliability of their equipment. Maintenance, however, certainly affects equipment effectiveness. Improving OEE is a joint effort of production, quality assurance and maintenance, hence the term Total Productive Maintenance. Williamson says that OEE should not be used to compare one machine or process to another unless they are identical. Calculating OEE helps identify the problem areas of equipment performance so that root causes can be determined. Think of it as taking the "temperature" of the plant equipment.

STEP THREE
Design a maintenance program for each machine

Analyzing OEE results often provide indications on whether current preventative maintenance needs to be modified. For example, a more extensive preventive maintenance program is required when only one machine is available for performing a critical function compared to plants where several of these machines exist and a failure of one of them will be less disruptive and costly. The program for each machine should be a mix of preventative and predictive maintenance, keeping in mind that emergency and corrective maintenance would not be fully eliminated.

STEP FOUR
Involve equipment operators with basic maintenance

A typical scenario in manufacturing plants is that a piece of equipment fails and the operator contacts maintenance. While the operator waits for the technician to arrive, the machine is down. With TPM equipment operators are encouraged and trained to perform basic maintenance on their equipment where equipment complexity level allows for it. Simple tasks such as cleaning, lubrication and regular inspections performed routinely by the operator will free up maintenance technicians to focus on more complicated problems and will result in less downtime because the machines will be more regularly maintained. It will also give equipment operators a reason to be more accountable in the maintenance of the machines they operate. Training operators to perform simple maintenance and inspection tasks can be done by the maintenance, engineering, production departments or even the equipment vendors. While training may utilize a significant portion of the TPM implementation cost, it typically pays for itself in reduced losses of availability, performance and quality. **PEM**

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