The Four Steps to Total Productive Maintenance

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Total Productive Maintenance or TPM is a system designed to significantly improve equipment utilization and profits for manufacturing plants. TPM was invented by the General Electric Corporation in the 1950's. The Japanese learned the concept, improved it and began using it in their manufacturing facilities with much success. Today, large and profitable manufacturing companies such as Toyota and Dupont are using TPM and reaping the benefits of cost reduction, increased quality and production. This article simplifies the concept of TPM by breaking its implementation down into four simple steps.

Step One- identify utilization losses

Production equipment is normally the largest asset of most manufacturing plants (next to land and buildings). Wall Street pays attention to a company's return on assets (ROA), as ROA is a widely used measure of financial performance. Asset utilization is the single most important factor that influences ROA. If manufacturers improve the utilization of their equipment, they become more profitable.

To improve equipment utilization, you first need to understand what causes equipment problems that reduce utilization, or in TPM terms, "utilization losses." TPM uses a measure called Overall Equipment Effectiveness, or OEE, to quantify these losses, allowing you to monitor and improve the efficiency of your equipment. These are three factors that affect equipment utilization:

1) Loss of availability means that the equipment is down and therefore not available for production. Machine set ups and adjustments, although they are a necessary part of production, fall into this category. Changeovers, operator shortages and unplanned downtime are also considered losses of availability.

2) Loss of Performance includes factors that cause the machine to operate at less than the maximum speed, such as minor stoppages, material shortages, operator inefficiency and machine wear. Here, the equipment is not broken down, it just performs less efficiently. These are referred to as "hidden losses" because maintenance is not contacted and the losses are not recorded as downtime. These "little" problems can cause some of the biggest losses.

3) Loss of Quality results from product that does not meet quality standards or requires rework. If a part is rejected or must be reworked, the equipment time producing it is lost. These losses are typically smaller compared to other equipment losses, and as equipment is better maintained under TPM, quality losses are usually reduced.

To improve equipment utilization, it is necessary to determine what your current utilization is. Fortunately, there are measurements for this. You can measure the Availability of a machine for production, the Performance of the machine while it is running and the Quality of the machine's output. When these three measurements or metrics are multiplied together, you will derive the equipment's Overall Equipment Effectives, or OEE. The OEE is the most traditional and widely used measurement of equipment performance.

Step Two- Measure the effectiveness of your machines

During this step you will record data on the performance of each machine and any losses the machine may experience. You need to observe the equipment over a period of time to get a true sense of how

it is operating. An observation time of about four hours has been recommended, however, a longer observation period will provide a more reliable measure. If the machine's production schedule varies according to shift, you may want to schedule several shorter observations during each shift. Simple forms can be created to record the data. Data collection will be the most time-consuming portion of your TPM implementation. Fortunately, this step is done only at the beginning 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 a temporary staff to observe and record the data.

If you have been entering work related data in a Computerized Maintenance Management System, you can run reports for each machine which will tell you (for a specific period of time):

- Total downtime for a specific period of time
- The number of emergency/corrective work orders performed during a specific period of time
- Total cost of labor and parts

You may intuitively know which machines are causing the most problems and can begin by observing those machines. If downtime is a primary concern at your plant, then start observing the machines with the most downtime. If you are focusing on cost control, then start observing the machines which cost the most money to maintain.

After completing your initial observation and calculating your OEE, you won't just have one magic number, you will actually have four numbers- your overall equipment effectives along with the three factors that it based on-Availably, Performance and Quality. The chart on the following page shows results obtained during two different shifts at a manufacturing plant. We can see from the numbers on the next page that the primary issue to focus on is the performance of the machine. Comparing measurements from both shifts may reveal additional valuable information. Here, during the second shift, the operator was a new hire and it took him much more time to setup for each run than the experienced first shift operator. It wasn't until these numbers were presented to management that they decided to invest in additional training for the second shift operator.

OEE Factor	Shift 1	Shift 2
Availability	86.2%	88.3%
Performance	58%	51.6%
Quality	86.7%	87.2%
OEE	43.3%	39.7%

Breaking down the OEE into its three components allows you to compare your performance in each area with world class standards. Accepted world class goals for each factor are:

OEE Factor	World Class
Availability	90.0%
Performance	95.0%
Quality	99.9%
OEE	85.0%

According to the "OEE Quick Guide" by Vorne Industries

These "world class" numbers certainly can vary among industries. 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. According to Robert Williamson of Strategic Work Systems, "OEE is a measure of equipment effectiveness, not a measure of maintenance effectiveness." Maintenance, however, certainly affects equipment effectiveness. Improving OEE is a joint effort of Production, Quality Assurance and Maintenance, hence the term Total Productive Maintenance. In addition, Williamson points out; OEE should not be used to compare one machine or process to another unless they are identical. Calculating OEE helps identifies the problems areas of equipment performance so that you can begin to determine the root-causes of those problems. Think of it as taking the "temperature" of your plant equipment.

Step Three- Design a maintenance program for each machine.
Analyze the maintenance performed in the past as well as repair and emergency work orders. If you have been entering work order data into a computerized program, this will be easier. Based on the OEE data, you will know if you need to do more preventative maintenance. Keep in mind that all machines are not equal - critical machines will require a different maintenance program than redundant equipment (more than one machine of the same kind.) Your program for each machine should be a mix of preventative and predictive maintenance, keeping in mind there will always be some emergency and corrective work done.

Step Four-Teach equipment operators to perform basic maintenance on their equipment.
Here is a typical scenario that occurs regularly in manufacturing plants: a piece of equipment fails and the operator contacts maintenance. While the operator waits for the technician to arrive, the machine is down. The cost of downtime is significant and can affect an entire production line.

With TPM, equipment operators are trained to perform basic maintenance on their equipment, such as cleaning, lubrication and regular inspections. This will free up your maintenance technicians to focus on more complicated problems and will result in less downtime, because the machines will be regularly maintained by their operator. It will also give your operators a sense of owning the machine they operate. Trainers can come from the maintenance, engineering, production departments or even equipment vendors. Training will be a major expense of installing TPM, but it is well worth it.

In summary, TPM is designed to utilize equipment to its fullest capacity by identifying utilization losses, measuring the effectives of the machines, developing a maintenance program tailored to each machine and training equipment operators to perform basic maintenance. If this is done well, equipment utilization will increase significantly and will improve your company's bottom line