

# **1. CONCEPT OF TOTAL PRODUCTIVE MAINTENANCE**

## ***Introduction***

Total Productive Maintenance (TPM) is productive maintenance carried out by all employees through small group activities. Like TQC, which is companywide total quality control, TPM is equipment maintenance performed on a companywide basis.

## ***The New Direction in Production***

TPM is the new direction in production. In this age, when robots produce robots and 24-hour automated production is a reality, the unmanned factory has become a realistic possibility. In discussing quality control, people often say that quality depends on process. Now, with increasing robotization and automation, it might be more appropriate to say that quality depends on equipment. Productivity, cost, inventory, safety and health, and production output – as well as quality – all depends on equipment.

Production equipment has become unimaginably sophisticated. We see equipment for automation, such as robots and unmanned production; we also see equipment for superprecise processing of micron-size objects and processing that requires speeds, pressures, and temperatures challenging current technology.

Increased automation and unmanned production will not do away with the need for human labor – only operations have been automated; maintenance still depends heavily on human input. Automated and technologically advanced equipment, however, requires skills beyond the competence of the average maintenance supervisor or worker, and to use it effectively requires an appropriate maintenance organization. TPM, which organizes all employees from top management to production line workers, is a companywide equipment maintenance system that can support sophisticated production facilities.

The primary goals of TPM are zero breakdowns and zero defects. When breakdowns and defects are eliminated, equipment operation rates improve, costs are reduced, inventory can be minimized, and as a consequence, labor productivity increases. One firm reduced the number of breakdowns to 1/50 of the original number. Some companies show 17-26 percent increases in equipment operation rates while others show a 90 percent reduction in process defects. Labor productivity generally increased by 40-50 percent.

Of course, such results cannot be achieved overnight. Typically, it takes an average of three years from the introduction of TPM to achieve prize-winning results. Furthermore, in the early stages of TPM, the company must bear the additional expense of restoring equipment to its proper condition and educating personnel about the equipment. The actual cost depends on the quality of the equipment and the quality of maintenance. As productivity increases, however, these costs are quickly replaced by profits. For this reason TPM is often referred to as “profitable PM”.

## ***Challenging Limits***

Following World War II, the Japanese industrial sectors borrowed and modified management and manufacturing skills and techniques from the United States. Subsequently, products manufactured in Japan became known for their superior quality and were then exported to the Western industrial nations in large quantities, focusing world attention on Japanese-style management techniques.

### ***From PM to TPM***

The same has happened in the field of equipment maintenance. Almost fifty years have passed since Japan imported preventive maintenance (PM) from the United States. Later adoptions include productive maintenance (PM), maintenance prevention (MP), and reliability engineering. What we now refer to as TPM is, in fact, American-style productive maintenance, modified and enhanced to fit the Japanese industrial environment.

TPM is now well accepted by the Japanese industrial sector, and is attracting the attention of Western industrial nations, China and various Southeast Asian countries.

### ***Four Developmental Stages of TPM***

Preventive maintenance was introduced in the 1950's, with productive maintenance becoming well established during 1960's. The development of TPM began in the 1970's. The period prior to 1950 can be referred to as the "breakdown maintenance" period.

The growth of TPM in Japan can be divided into the following four developmental stages:

Stage 1 : Breakdown Maintenance

Stage 2 : Preventive Maintenance

Stage 3 : Productive Maintenance

Stage 4 : TPM

Until the 1970's Japan's PM consisted mainly of preventive maintenance, or time-based maintenance featuring periodic servicing and overhaul. During the 1980's preventive maintenance is rapidly being replaced by predictive maintenance, or condition-based maintenance. Preventive maintenance uses modern monitoring and analyzing techniques to diagnose the condition of equipment during operation – to identify the signs of deterioration or imminent failure.

### ***Definition and Distinctive Features of TPM***

TPM is often defined as "productive maintenance involving total participation". Frequently, management misconstrues this to mean workers only and assumes that PM activities are to be carried out autonomously on the floor. To be effective, however, TPM must be implemented on a companywide basis. Unfortunately, some firms abandon TPM because they fail to support workers fully or involve management.

### ***A complete definition of TPM includes the following five elements:***

1. TPM aims to maximize equipment effectiveness (over all effectiveness).
2. TPM establishes a thorough system of PM for the equipment's entire life span.
3. TPM is implemented by various departments (engineering, operations, maintenance).
4. TPM involves every single employee, from top management to workers on the floor.

- TPM is based on the promotion of PM through motivation management : autonomous small group activities.

The word “total” in “total productive maintenance” has three meanings that describe the principal features of TPM:

- Total effectiveness (referred to in point 1 above) indicates TPM’s pursuit of economic efficiency or profitability.
- Total maintenance system (point 2) includes maintenance prevention (MP) and maintainability improvement (MI) as well as preventive maintenance.
- Total participation of all employees (points 3,4, and 5) includes autonomous maintenance by operators through small group activities.

The first principal feature of TPM, “total effectiveness” or “profitable PM”, is also emphasized in predictive and productive maintenance. The second feature, a “total maintenance system,” is another concept first introduced during the productive maintenance era. It establishes a maintenance plan for the equipment’s entire lifespan and includes maintenance prevention (MP: maintenance-free design), which is pursued during the equipment design stages. Once equipment is assembled, a total maintenance system requires preventive maintenance (PM: preventive medicine for equipment) and maintainability improvement (MI : repairing or modifying equipment to prevent breakdowns and facilitate ease of maintenance). The last feature, “autonomous maintenance by operators” (small group activities), is unique to TPM (Figure 1).

In American-style PM (also in India), the maintenance department is generally responsible for carrying out PM. This reflects the concept of division of labor, an important feature of American labor unions, Japanese-style PM, or TPM, on the other hand, relies on everyone’s participation, particularly autonomous maintenance by operators.

If a company is already practicing productive maintenance, TPM can be adopted easily by adding autonomous maintenance by operators to the existing system. If a company has not yet implemented preventive or productive maintenance, however, a sudden shift from breakdown maintenance to TPM will be extremely difficult, although not impossible.

	TPM features	Production Maintenance Features	Preventive Maintenance features
Economic efficiency (Profitable PM)	O	O	O
Total system (MP-PM-MI)*	O	O	
Autonomous maintenance by Operators(small group activities)	O		

TPM = Productive Maintenance +Small Group Activities

MP = Maintenance Prevention  
PM = Maintainability Improvement

### ***Nine Essentials of TPM***

- 1) Self maintained work place
- 2) Elimination of the 6 big losses
- 3) Zero Breakdowns
- 4) Zero Defects
- 5) Optimal life and availability of tools
- 6) Self-improvement
- 7) Short production-development time and low machine life cost
- 8) Productivity in indirect departments
- 9) Zero Accidents

### ***Eight Pillars of TPM***

1. Autonomous Maintenance
2. Continuous Improvement
3. Planned Maintenance
4. Quality Maintenance
5. Materials planning, design and equipment control
6. Education & Training
7. Office TPM
8. Safety, Hygiene and Environment Control.