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Piloting Total Productive Maintenance Program in Manufacturing

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Abstract
This paper outlines the implementation of Total Productive Maintenance (TPM) on the Grit Blaster machine, focusing on two key steps: selection of a pilot area and equipment restoration. The Grit Blaster machine was chosen due to its simplicity, historical reliability issues, and critical role in manufacturing. The TPM plan streamlines maintenance procedures, standardizing processes, timing, and tools. A checklist of 16 tasks was developed, specifying necessary tools, Personal Protective Equipment, duration, and expected outcomes. An equipment layout and task labels enhance efficiency by minimizing waste and reducing time needed for daily checks. Daily Shift logs are used to record maintenance results, with both production and maintenance teams signing off to ensure accountability and communication. The TPM program significantly reduced unplanned downtime by 37%, creating a positive mindset shift among operators and management.

Keywords: TPM, Maintenance, OEE, Equipment

1. Introduction - Total Productive Maintenance

Total Productive Maintenance (TPM) is a maintenance methodology designed to engage all organizational levels in maximizing the effectiveness of production equipment.

Unlike traditional maintenance strategies that focus on reactive repairs, TPM is a proactive strategy that emphasizes preventive maintenance. The ultimate goal of TPM is to achieve "perfect manufacturing," a state where breakdowns, accidents, and defects are completely eliminated [1]. Total Productive Maintenance (TPM) focuses on proactive and preventative maintenance to optimize equipment efficiency [2].

The concept of Total Productive Maintenance (TPM) was pioneered by Seiichi Nakajima in the 1960s. It was first implemented by Nippondenso, an automotive parts supplier to Toyota. This innovative approach integrated maintenance with production processes, emphasizing the importance of proactive and preventative measures to enhance overall equipment effectiveness and operational efficiency [3].

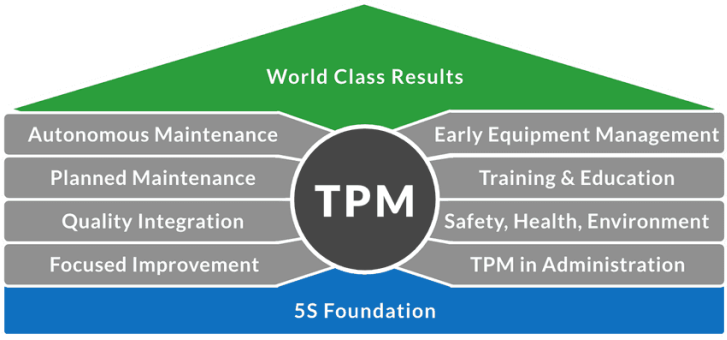


Figure 1: Total Preventive Maintenance [2]

Benefits of Total Productive Maintenance

Implementing Total Productive Maintenance (TPM) offers a wide range of both direct and indirect benefits:

Reduced Unplanned Downtime: By transitioning from reactive to proactive equipment maintenance, TPM significantly reduces unplanned equipment failures and associated downtime. This shift leads to an increase in Overall Equipment Effectiveness (OEE).

Improved Product Quality: TPM enhances product quality by identifying and eliminating defects, resulting in higher-quality products and fewer customer complaints.

Reduced Manufacturing Costs: By maximizing equipment reliability and efficiency, TPM lowers manufacturing costs. This increase in profitability is achieved through minimized expenditures on equipment repair and replacement.

Enhanced Workplace Safety: TPM fosters a culture of preventive maintenance and hazard identification, thereby promoting workplace safety. This proactive approach reduces the risk of accidents and injuries.
These benefits underscore the value of TPM in achieving optimal production and operational efficiency while ensuring a safe working environment [2].

Foundations of TPM

The foundation of Total Productive Maintenance (TPM) is the concept that all levels within an organization should actively participate in maintenance activities as shown in figure 2. This collaborative approach is structured as follows:

Autonomous Maintenance: Operators are empowered to perform routine maintenance tasks such as cleaning, inspecting, lubricating, and repairing equipment.

Planned Maintenance: Maintenance activities are scheduled based on historical data and predictive analytics to optimize resource usage and minimize downtime.

Quality Management: Integrated defect prevention measures are implemented in production processes to ensure consistent product quality.

Early Equipment Management: Equipment is designed and installed with a focus on reliability and maintainability, thereby reducing future maintenance requirements.

Safety, Health, and Environment: Environmental sustainability and safety are prioritized throughout the entire maintenance process to create a safe and hazard-free workplace.

TPM in Administration: Administrative functions, such as order processing and procurement, are streamlined to maximize production efficiency and minimize delays.

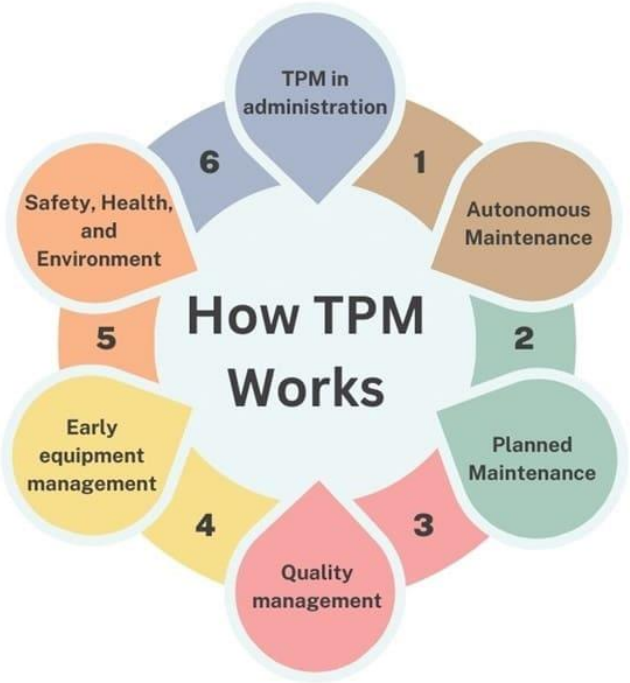


Figure 2: How TPM works [1]

By ensuring that everyone, from management to operators and maintenance personnel, is involved in the maintenance process, TPM creates a culture of continuous improvement and collaboration. This holistic approach leads to enhanced equipment effectiveness, improved production quality, and a safer working environment [1].

2. **Methodology**

There are five major steps in implementing TPM which are as follows:

(a) Selection of a Pilot Area - Identify a specific area or piece of equipment that will act as a test bed for the implementation of Total Productive Maintenance (TPM) principles.

(b) Restoration of Equipment to Prime Operating Condition - Utilize the 5S method to organize the workspace and educate operators on performing autonomous maintenance.

(c) Measurement of Overall Equipment Effectiveness (OEE) - Assess areas of improvement and evaluate equipment performance by measuring Overall Equipment Effectiveness (OEE).

(d) Addressing Major Losses - Form cross-functional teams to identify and address the root causes of downtime, developing effective solutions.

(e) Implementation of Proactive Maintenance Techniques - Adopt proactive maintenance techniques based on wear analyses and failure predictions to enhance equipment reliability and longevity.

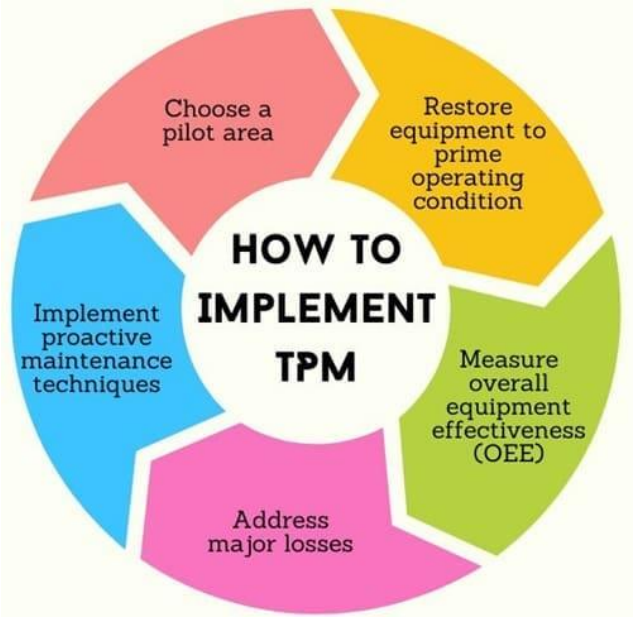


Figure 3: Implementing TPM [1]

TPM Plan

The Total Productive Maintenance (TPM) plan is designed to streamline these procedures, standardizing the processes, timing, and tools needed. By following this guide, operators can ensure maintenance activities are carried out efficiently, consistently, and with minimal downtime. This guide details the specific what, how, and where of performing maintenance checks.

A TPM checklist the Grit Blaster machine was devised which consisted a total of 16 tasks routine tasks which needs to be carried out by the operator as shown in figure 4 below. Each task describe what needs to be done, which tools to use, Personal Protective Equipment required, how long it should take, and the acceptale outcomes.

Work Points			Task(s)		Expected outcome	Materials & tools	Time (MM:SS)	Warnings and PPE
T1		Lifting sling	Visual inspection	Check due date	Within 6 months validity	-	0:10	STOP
T2		Crane	Fill out Crane inspection checklist	-	Refer to crane checklist	-	2:00	STOP
T3		Profilometer	Visual inspection	Check calibration date	Within calibration due date	-	0:10	STOP
T4		All 6 EMO buttons	Functionality check	-	All emergency stop button work	-	2:00	STOP
T5		Blast hose	Visual inspection	-	Not ruptured or no blisters	-	0:10	STOP
T6		Blast nozzle	Check orientation	-	Facing down	-	0:10	STOP
T7		Nylon sleeve	Check OD	-	2.7 ± 0.01 inches	Callipers	0:30	STOP
T8		Air gun	Visual inspection	-	Not damaged	-	0:10	
T9		Hydraulic oil pressure	Check pressure gauge	-	500 to 1000 PSI	-	0:10	STOP
T10		Dust collector gauge	Check reading	Purging noise is audible	Less than 3	-	0:10	STOP
T11		Air pressure supply	Check air pressure	-	Between 100 to 120 PSI	-	0:10	STOP
T12		Grit feed bin	Check grit level light and sight glasses	-	Green light is on and grit is visible	-	0:30	STOP
T13		Clean screen	Visual inspection	-	Not clogged	Portable ladder	1:30	STOP
T14		Grit bin auger screw	Check screw rotation	-	Screw is rotating	-	0:30	STOP
T15		Waste grit barrel	Level check	-	Less than 2/3 full	Hammer	0:30	STOP
T16		Air supply filter	Check filter indicator	-	Below yellow zone	-	0:10	STOP
						Total time	9:00	

Figure 4: Grit Blaster TPM Checklist

To augment the TPM routine checks, a corresponding equipment layout indicating the location of each work point is provided to the operators (illustrated in figure 5). Moreover, task labels were used to clearly identify the work point location for every routine tasks on the grit blaster as shown in figure 6. This would make the daily routine TPM checks more efficient and effective for the operators as it eliminates waste and minimizes time required to complete them.

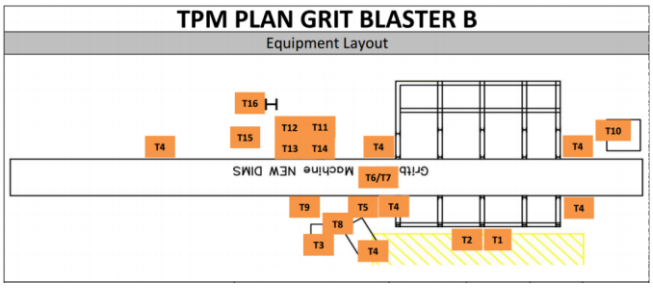
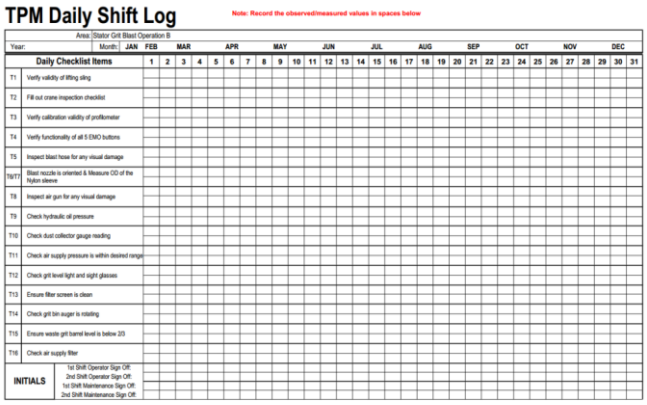


Figure 5: Grit Blaster TPM Plan

Figure 6: Task labels

The Daily Shift log (as shown in figure 7) is utilized to meticulously record the results of daily maintenance checks. Both production and maintenance teams are required to sign off on it every day. This practice ensures accountability, maintains clear communication, and provides a reliable record of all maintenance activities, contributing to the overall efficiency and safety of the operations.


TPM Daily Shift Log

Note: Record the observed/measured values in spaces below

Year:	Month:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

	Daily Checklist Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
T1	Verify validity of lifting sling																															
T2	Fill out crane inspection checklist																															
T3	Verify calibration validity of profilometer																															
T4	Verify functionality of all 5 EMO buttons																															
T5	Inspect blast hose for any visual damage																															
T6/T7	Blast nozzle is oriented & Measure OD of the Nylon sleeve																															
T8	Inspect air gun for any visual damage																															
T9	Check hydraulic oil pressure																															
T10	Check dust collector gauge reading																															
T11	Check air supply pressure is within desired range																															
T12	Check grit level light and sight glasses																															
T13	Ensure filter screen is clean																															
T14	Check grit bin auger is rotating																															
T15	Ensure waste grit barrel level is below 2/3																															
T16	Check air supply filter																															
INITIALS	1st Shift Operator Sign Off 2nd Shift Operator Sign Off 1st Shift Maintenance Sign Off 2nd Shift Maintenance Sign Off																															

Figure 7: Daily Shift Log

3. Conclusions

In conclusion, the pilot implementation of Total Productive Maintenance (TPM) on the Grit Blaster machine has demonstrated significant benefits and has laid a strong foundation for future TPM initiatives. By carefully selecting the Grit Blaster as the pilot area, restoring the equipment to its prime operating condition, measuring Overall Equipment Effectiveness (OEE), addressing major sources of downtime, and adopting proactive maintenance techniques, we achieved a notable reduction in unplanned downtime by 37%.

The development and adherence to a standardized maintenance checklist, coupled with the use of detailed equipment layouts and task labels, enhanced the efficiency and effectiveness of daily routine checks. Moreover, the implementation of daily shift logs facilitated clear communication and accountability among the production and maintenance teams. This holistic approach not only improved the reliability and longevity of the Grit Blaster machine but also fostered a positive mindset shift among operators and management.

The success of this pilot project underscores the potential of TPM to drive operational excellence and can serve as a model for broader application across other equipment and processes within the organization. Future efforts will focus on expanding TPM practices to other critical areas, further solidifying our commitment to continuous improvement and operational efficiency.

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