TOTAL PRODUCTIVE MAINTENANCE IS NOT FOR THIS COMPANY

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Many companies employ maintenance practices that result in reduced throughput, increased inventory, and poor due-date performance. Typically these firms view maintenance as an operating expense to be minimized, and accordingly they avoid the expenditures for preventive and predictive maintenance which would improve their process reliability. These companies do not achieve the benefits of total productive maintenance (TPM).

TPM offers a systematic approach to achieve zero losses—zero equipment failures and zero defects. The firms who won the Productive Maintenance prize in Japan from 1984–1986 achieved the following:

- Monthly equipment failures were reduced from 1,000 to 20
- Quality defects were reduced from 1% to .1%
- Warranty claims from clients were reduced by 25%
- Maintenance costs were reduced by 30%
- Inventory on hand was reduced by 50%
- Productivity was increased by 50% [5].

TPM works in the United States as well as in Japan. For example, John Deere is reducing its required maintenance hours by 2% a year by expanding the operator's responsibility to include routine maintenance. This increases their process reliability and allows them to complete 40% of their jobs within 24 hours—an extraordinary competitive advantage in a market where turnaround time is critical [2].

TPM is a system (culture) that takes advantage of the abilities and skills of all individuals in an organization. At Eastman Co. in Kingsport, Tennessee, only 20% of the maintenance tasks require a highly skilled mechanic. Forty percent could be performed by the machine operator with minimal training and another 40% could be performed with additional training that does not require certification. But, extensive change is necessary for the operator to assume responsibility for even the first 20% of maintenance tasks. Everyone's attitude must change from "that's not my job" to "this is what I can do to help [4]." This transformation does yield rich rewards. Teresko estimates that at Eastman, TPM saved $24 million and employees typically accepted the changes required to obtain them [9]. TPM benefits are real and achievable, but come at a price. In this article we will identify what is required of a firm to implement TPM and describe the characteristics of a firm that is not ready for TPM.

REQUIREMENTS TO IMPLEMENT TPM

Successful TPM implementation requires top management support and commitment. Management must promote and establish a team culture and use these teams to implement the TPM system. TPM requires employee empowerment and the attitude that TPM is not a "maintenance" program—its everyone's program [1, 6, 7, 9]. To achieve maximum benefits TPM requires total participation of the entire work force [8].

Under TPM, production workers assume ownership of their work area. They become responsible for routine maintenance of machines and equipment including cleaning and maintaining the work area for maximum efficiency. The workers are trained to identify problems, determine solutions, and implement improved work methods through their small groups/teams [10].

This autonomous maintenance concept starts by assigning the lower level maintenance tasks to the production group. As their skill levels increase, additional responsibilities are progressively transferred. Transfer of these responsibilities to the production worker allows the maintenance specialist to spend more time on high-level predictive maintenance, engineering improvements, and operator training [7].

Nakijima outlines and describes the four stages of developing a TPM system [5]:

1. Breakdown maintenance (equipment is repaired only when it breaks down).
2. Preventive maintenance (PM) (causes of breakdowns are known, and maintenance is performed before breakdowns occur).

3. Productive maintenance (operators are responsible for the maintenance of the machines they operate).
4. Total productive maintenance (operators give direct input on equipment maintenance to machine designers and product designers, and unforeseen failures are eliminated).

Many firms are currently at either stage 1 or 2, with only a few venturing as high as stage 3. Nakajima reports that companies who progress through all four stages and fully adopt TPM attain the following benefits:

1. Improved equipment eliminates the root cause of defects.
2. Defects are prevented through planned maintenance.
3. Preventive maintenance costs are reduced as equipment operators conduct autonomous maintenance.
4. Improved equipment designs ensure that new equipment naturally produces fewer defects.
5. Simplified product designs and a redesigned process produce with few defects.
6. Engineers, technicians, and managers are trained in maintenance and quality [5].

These TPM benefits are impressive, but not within reach for every firm. To fully implement TPM requires a great deal of preparation, patience, persistence, and perseverance. Some firms are not prepared to do this.

THIS COMPANY IS NOT READY FOR TPM

There are some organizations where TPM is not likely to be successful. Implementing TPM often requires the firm to change its culture, and some companies will not make this change. For TPM to be successful, decision-making responsibility must be pushed to the bottom levels of the hierarchy. The authors encountered one company that is not prepared to make the necessary changes. The attributes that are incompatible with TPM are described below.

First, the firm based its wage payment on the number of units produced by the individual operator above a set minimum. This provides no incentive to a slow operator. When her machine is waiting for repair or being repaired the operator is paid the base rate since she has not attained the preset target rate. This may be more than a slow operator is paid for the parts produced, thus eliminating any incentive to fix her own machine or to improve its performance. This undermines the team concept necessary for successful implementation of TPM.

Second, some of the operators do not want to take on more responsibility in addition to the minor adjustments they already make on their machines. They feel this is maintenance's job.

Third, some managers do not trust operators to make any repairs on the machines. They feel that the expensive equipment will be damaged by operators making adjustments. These managers do not want to incur the expense of training the operators in minor repairs or provide any incentive for them to do repairs. The top operators trained themselves to make the minor machine adjustments. Managers look the other way and allow this to go on as long as production increases without machine damage. Despite the success of these high performers, managers resist training other operators. They justify this by viewing the top producers as being exceptional and different from most operators.

Fourth, the mechanics like their indispensable "fix-it" person role. While the maintenance mechanic in a TPM system still uses his technical skills, he must also develop management and people skills. A fix-it mechanic often works alone (or with a helper) to get the broken machine up and running again. But a TPM mechanic may act as a consultant whose job it is to help avoid breakdowns by training the operator to perform preventive maintenance. The maintenance mechanic must also be able to plan and predict workloads, as well as to prioritize all the work waiting to be done. In the traditional structure the maintenance technicians do what they are told. But, in the TPM system they must determine which job to select next.

Fifth, some maintenance technicians resist the change to TPM because they feel it threatens their job. Statements such as Gledhill's that Dow Chemical's "goal is better maintenance and less of it [13]" suggests layoffs of maintenance people—a source of anxiety for maintenance mechanics.

Sixth, maintenance personnel resist being asked to do a manager's job. Often with the current system, the mechanics may be waiting for the next fix-it call and can spend a great deal of their workday pitching horseshoes. While they are a major information source, they refuse to use their expertise to help equipment vendors redesign equipment.

Seventh, management does not analyze maintenance records in order to facilitate continuous improvement. The time a machine breaks down, the machine identification, the operator's name, the times of the start and completion of the repair, and the reason for the repair are recorded. But nothing further is done with these records, thus a tremendous opportunity to improve the maintenance operation is squandered.

Eighth, the plant manager considers maintenance

an expense to be minimized. For example, a review of the maintenance records showed that often machines waited two hours for a five-minute repair that could have been performed by the operator. When informed, the manager dismissed the potential savings as insignificant.

To determine the potential impact of TPM on production costs at this company, the company's maintenance data is analyzed below. This data reveals the cost to the company of not implementing TPM.

EXAMINING THE DATA

Nine days of maintenance records were analyzed, showing an average of 39 repairs per day (362 calls in the nine days), with an average waiting time for maintenance of 88.6 minutes per repair (517.4 hours total waiting time). We analyzed only the maintenance costs of the present system and did not estimate the additional cost of defects. The total repair time was 189.9 hours, of which 38.70 hours were jobs which took 20 minutes or less to repair. Table 1 summarizes the data.

Average applicable costs of $502 per day represent the potential savings TPM could offer this firm. Note the repair times are categorized as either short (the operator might repair) or long (those requiring the mechanic). Savings potential included only the short repairs. Equipment costs for 7.7 machine equivalents at $6,000 per machine is $46,200.

Using the average daily costs of $502 for 200 days per year, the potential annual savings are $100,400 without considering the time value of money. If equipment cost of $46,200 is depreciated over 5 years, the excessive equipment amounts to $9,240, driving the total costs of not using TPM to $109,640. Note that in the above calculations, we assumed that the number of breakdowns needing long repair times would not be shortened as a result of operator training.

This company's management is too busy dealing with the day-to-day problems of meeting the production targets to seriously consider taking preventive measures, let alone launching a program like TPM. They are caught in the trap of feeding problems and starving opportunities.

TABLE 1: Daily Waiting Times, Machine Equivalents and Labor Costs

Reason for Wait	*Hours Waiting*	*Machine Equivalents*	*Labor Costs*
Start of repair	57.5	7.2	$467
Finish of repair (short)	4.3	0.5	$35
Finish of repair (long)	21.1	2.6	NA

SUMMARY AND CONCLUSIONS

TPM offers many companies the opportunity to enrich employees' jobs while improving responsiveness to their customers through reduced lead times and improved product quality. The benefits of good maintenance include lower inventory costs, higher availability of equipment, and higher quality. TPM is a system to achieve these benefits.

Many companies that have successfully used TPM have found that it has helped in reducing maintenance costs substantially, has improved quality, and has been well received by employees. In order to enjoy the benefits, the company must be committed to bringing about the necessary culture changes. Successful implementation of TPM depends on everyone in the organization.

The road to successful TPM implementation begins with forthright answers to some tough questions. How does this company reward operators? Will the operator's expanded role be compensated? Do you trust operators to adjust their machines? Why should mechanics become team players? How can we reduce anxiety about layoffs? Why should maintenance assume management's responsibilities? What is the cost of our current approach to maintenance?

John Deere and Eastman have decided the benefits are there and that they are worth the investment required to achieve them. Success in global markets requires a reliable production system and implementing TPM is one of the ways to safeguard dependability.

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