TOTAL PRODUCTIVE MAINTENANCE AT PACCAR INC

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ABSTRACT

This paper reports the application of total productive maintenance method at Paccar Inc. truck's plant in Victoria, Australia. The total productive maintenance method and total productive maintenance house are presented. The global equipment effectiveness is computed and exemplified. The production structure and organising maintenance are presented. Resultas of the variation of global equipment effectiveness and autonomous maintenance in a two weeks period of time are reported.

Keywords: total productive maintenance, autonomous maintenance, global equipment effectiveness

1. Introduction

PACCAR is a global technology leader in the design, manufacture and customer support of premium light-, medium- and heavy-duty trucks under the Kenworth, Peterbilt and DAF nameplates. The company also provides customized financial services, information technology and truck parts related to its principal business.

Kenworth Truck Company builds premium commercial vehicles for sale in the US, Canada, Mexico and Australia and for export throughout the world [1].

At Paccar Inc. truck's plant in Victoria, Australia, an effort has been started to implement Total Productive Maintenance. It is a Production management method and Paccar Inc.'s ultimate goal in introducing Total Productive Maintenance is as a means to achieve a leaner production and a calming of the material flow [3].

In Total Productive Maintenance, reliability and availability are the ultimate goals and the way to accomplish the goals is through elimination of the major losses. These losses are only due to mechanical nature and visualised by the key figure General Equipment Effectiveness.

The goal of the paper is to achieve an increase in produced units per hour and employee from 125 to 139. In doing so, global equipment effectiveness should also increase, but any gains in productivity or effectiveness should only be justified through measures in total productive maintenance, not harder labour. Through literature studies, a workshop with an experienced consultant and a visit at the exemplary total productive maintenance implementing company ArcelorMittal in Bremen, the tasks to be performed were set. In order to visualise production losses, a sheet for recording production progress in a timely manner was developed, together with a computer aided analysis, and the possibility to illustrate the data for further evaluation. Meanwhile, the introduction of a task force called TPM-Commando, specialised in eliminating the major losses was to be supported and rendered a continuous improvement process to be applied [2].

Sohal [4] provides two practical examples of Australian quality management studies which have used generative and case study methodologies. Used the generative research strategy to study the quality management practices in the Australian business service industry and finds that not enough players in that industry have implemented quality management procedures. Uses the case study approach to show that in several companies the factors most likely to contribute to the success of a total quality management programme are a clear strategy, a customer focus, successful teams, monitoring procedures, and the implementation of a formal quality assurance system. Suggests there is a link between some of these quality management practices and increased profitability.

2. Total Productive Maintenance

Total Productive Maintenance is based on a combination of productive maintenance, maintenance prevention and maintainability improvement. It can be also described by availability and reliability. Total Productive Maintenance has the power to increase effectiveness and create a more rewarding production environment for management and also staff.

Five major aspects define total productive maintenance:

- the maximisation of overall effectiveness;
- establishes a system for productive maintenance during the entire life of the equipment;
- it should be realised in all compartiments of the company;
- involves all employees from top management to production personnel;
- promotes productive maintenance through motivational management in small grups of employees.

3. The Total Productive Maintenance House

Takahashi [5] has described the Total Productive Maintenance House the principles allowing eliminating losses and maximising productivity as represented in figure 1.

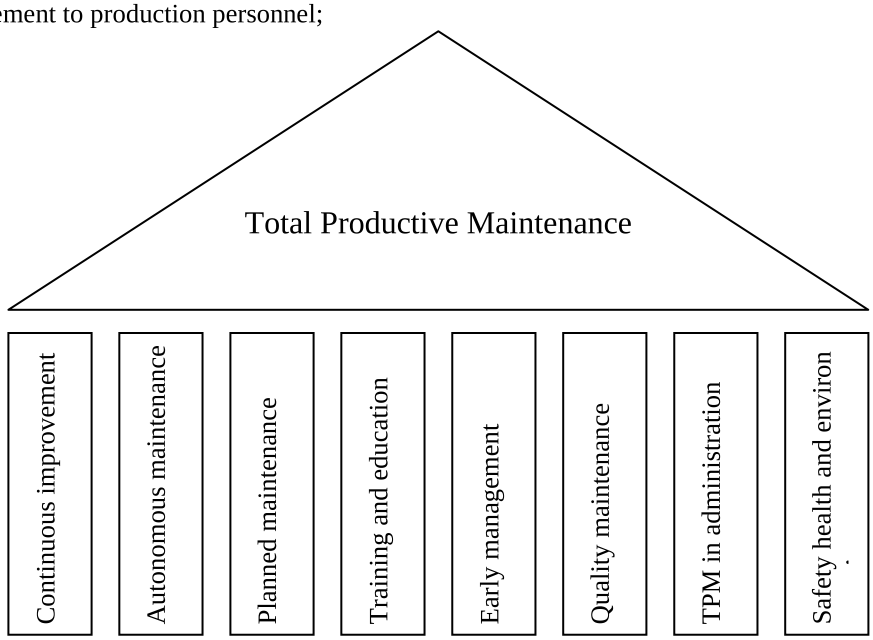

Fig. 1. *The eight columns of the Total Productive Maintenance*

The first column is the technique of continuous improvement, named also Kaizen.

The second column, autonomous maintenance consists in involving operators in cleaning and inspection and falls continuously to column four, training and education.

Column four, training and education, is applied to the whole employees from the enterprise.

Column three, planned maintenance, is addressed to research in improving maintainability and developing standards for the autonomous maintenance.

Column five, early management, means to use total productive maintenance principles as maintainability improvement early into the development of new equipment, which is also required to easily maintain.

Quality maintenance means to eliminate defects and specific standards in order to achieve "zero defects".

Total Productive Maintenance is a company wide philosophy, addressed also to administration, as illustrated in column seven.

Safety, health and environment, in nowadays are of most importance in companies. It means to equipped workers with appropriate means for each task and to dispose of environmental hazards.

4. Global equipment effectiveness

Equipment able to run 24 hours a day and 365 days in each year theoretically has the maximum capacity. But, due to the holidays and other managerial decisions equipment is never at maximum capacity exploited. Therefore, the report between the actual numbers of produced units against the maximum capacity represents the effectiveness of the equipment as a mechanical component. But also here occur many looses due to the human aspects.

The calculation of Global equipment effectiveness GE, can be done as:

$$GE = AV \times PF \times QU \times 100\ \% \qquad (1)$$

Where:

AV = Availability
PF = Performance
QU = Quality

The Availability can be defined as:

$$AV = \frac{Available\,Time}{Planned\,Production\,Time} =$$

$$= \frac{Planned\,Production\,Time - \sum Down\ Time\ Loss}{Planned\,Production\,Time} \qquad (2)$$

So, the Availability is equal to the planned production time minus the accumulated down time loses divided by planned production time.
The, performance is computed as:

$$PF = \frac{Ideal\,Cycle\,Time\ x\ Parts\ Produced}{Available\,Time} \qquad (3)$$

The ideal cycle time is the quickest time at which the machine could produce a single part. Multiplied by parts produced it gives the least amount of time needed. This result divided by available time represents the performance.

The quality can be computed as follows:

$$QU = \frac{Good\ Units}{Total\,Unists\,Started} =$$

$$= \frac{Total\,Units\,Started - Defective\,Units}{Total\,Units\,Started} \qquad (4)$$

A concrete example of calculus is the following:

$$AV = \frac{604\,min - 47\,min}{604\,min} = 0{,}922 \qquad (5)$$

$$PF = \frac{0{,}4\,min\ x\ 950\,units}{557\ min} = 0{,}682 \qquad (6)$$

$$QU = \frac{950\,units - 28\,defects}{950\,units} = 0{,}970 \qquad (7)$$

With these results Global equipment effectiveness can be computed as:

$$GE = AV\ x\ PF\ x\ QU\ x\ 100\ \% = 0{,}992\ x\ 0{,}682\ x\ 0{,}970\ x\ 100 = 60{,}99\ \% \qquad (8)$$

After some mathematical manipulations the global equipment effectiveness can be computed as follows:

$$GE = \frac{Good\ Units\ x\ Ideal\,Cycle\ Time}{Planned\,Production\,Time}\ x\ 100\% =$$

$$= \frac{922\,units\ x\ 0{,}4\,min}{604\,min}\,x100 = 60{,}99 \qquad (9)$$

5. The production structure

The production lines of Paccar Inc. Victoria are highly automated. The production is divided in three shifts per day and runs for five days a week. The shifts are 7 hours and 45 minutes duration with a 30 minutes break time. Each line has a group of employees assigned to it, which has a leader with additional duties as a communication link from the workers to the management and data collection.

The system for a continuous improvement process is a red and green card system. Each type of card represents a different kind of problem which are filled out and hung on a board for the group leader to evaluate. Green cards are used for optimizations while the red cards represent a deviation from a standard. The cards are attached to a board for further evaluation as seen in figure 2. The board contains multiple areas for the different status of cards: new cards, reviewed, approved or rejected cards by group leaders.

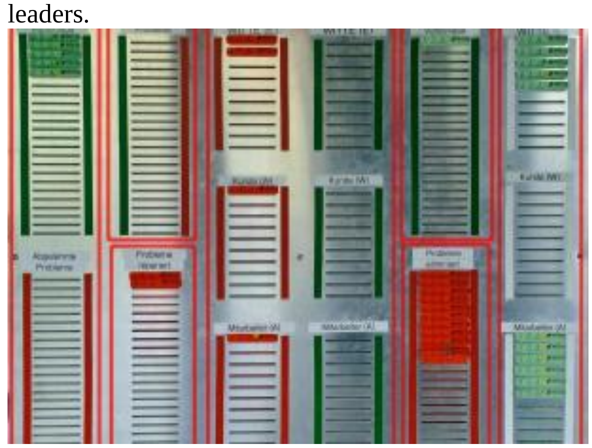

Fig. 2. *The board with the cards*

At the end a card is filled out with information about the moment of the solution integration, by whom, and if the solution is applicable in other compartments of the company. Due to this new system providing an easy way to brin issues to the attention, the average number of implement proposals has increased dramatically.

6. Organising maintenance

The essential part of total productive maintenance consists in organising maintenance. In most cases maintenance begins with cleaning. A clean production facilitates the detection of waste and reduces the risk of break downs.

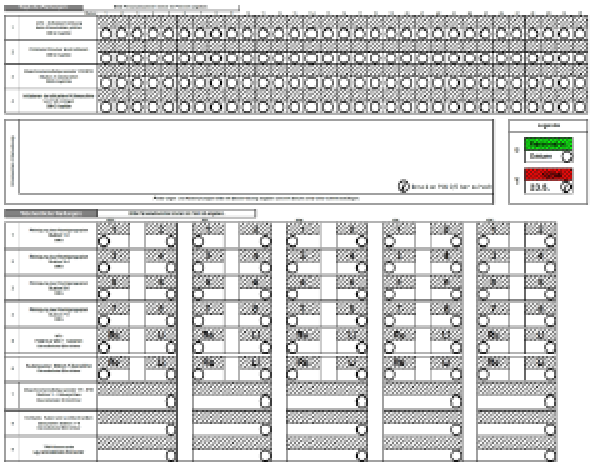

Fig. 3. *Schedule sheets*

The total productive maintenance columns continuous improvement and autonomous maintenance are initiated with employees groups. A regular schedule is needed in order to achieve a standardised way of conducting maintenance. There are schedule sheets for daily and weekly scheduled maintenance (figure 3).

The schedule sheets have a best visual effect being very simple with as much as possible less written text. If a issue has been found a number is entered in the little circle from the field which is accompanied by a number and an explanation in written text placed in the comment box.

In order to bring structure and regularity to the cleaning process has been established a maintenance circuit starting from the maintenance schedule. An interference can be observed between the maintenance schedule and the maintenance circuit. As example the regular checks of machine parameters are confirmed on the maintenance schedule, while the circuit provides assistance to locate the pressures to be controlled. The cleaning tasks are treated similar. The maintenance schedule has separate boxes for each station in the tour that is to possibility to identify the stations individually.

7. Results and discussion

We appreciate that global equipment effectiveness has increased quite significant from 50,1 to 73,4 as shown in figure 4.

Besides the increase in productivity and effectiveness, workers have been speaking positively of total productive maintenance, because over time noticed problems begin taken more seriously as before. With relevant results, the employees can exert pressure on management in order to solve more problems and to achieve better production results in future.

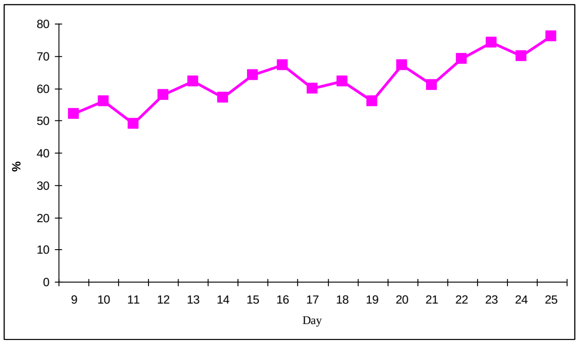

Fig. 4 *The variation of global equipment effectiveness*

According to the eight columns of the total productive maintenance in this paper only two have been studied: continuous improvement and autonomous maintenance and the third column training and education have been started by creating the important first understanding of machine losses with the operators.

At the beginning of introducing the workers to autonomous maintenance the start value was 125 produced units per hour and employee. After a two weeks period a value of 139 produced units per hour and employee has been reached, representing an increase of over 11 %.

8. Conclusion

After application the total productive maintenance at Paccar Inc. truck’s plant in Victoria, Australia we may conclude:

- Three columns of total productive maintenance have been started: continuous improvement, autonomous maintenance, training and education
- Workers have accepted the new methods of total productive maintenance
- An upper trend in global equipment effectiveness has been established

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