TRAINING FOR IMPLEMENTATION OF TOTAL PRODUCTIVE MAINTENANCE IN A SME

PĂMÎNTAŞ Eugen[1]
[1]"Politehnica" University of Timisoara, Integrated Engineering Research Centre
epamintas@eng.upt.ro

Keywords: TMP, SME, training, implementation, tasks integration, stages

Abstract
The total productive maintenance is a desirable solution, but is only a concept if isn't applied accordingly with specific organization structure and culture. To become a real solution, detailed analyses of entire machining process, hardware and software integration, maintenance planning and scheduling based on predictive methodologies and a new approach of the system architecture are needed. Proper understanding of terms and goals, commitment and active involvement of the employees is needed and for this reason this paper is.

1. SHORT INTRODUCTION IN MAINTENANCE

Despite of the research advance in material, technology, design and manufacturing, the technical systems and products are still subject to wear and tear. The effects are reduction of useful life, corrosion, contamination and changes in time-dependent material properties, and so forth, so that, after a certain period of time, whether in use or not, the actual condition of a system will no longer be the intended one and can cause changes in performance, failures and dangerous situations.
This can substantially reduce the functionality, economy and safety of a technical system. Sudden breakdowns disrupt normal operation, and because they are unexpected they require considerable cost to rectify. Not checking the condition of a system until damage has occurred, possibly involving injury is unacceptable from both human and economic points of view.
In a very large meaning, by maintenance it understands all surveyance and monitoring activities for useful exploitation of running parameters, insurance of maintenance, retrieve and repair therefore which a product – machinery, equipment or building – is maintained on all length of its life cycle in such a way so that it can running on the optimum level of designed parameters [6]
Therefore, the maintenance objective is to preserve the product characteristics so that it can carry out the requested functions during all its life cycle. The maintenance is an important part of the product life cycle management and its main goal of is to increase the economical efficiency of the product life cycle [4].
A lot of scientifically papers, presented in different conferences all over the world, have already emphasized the importance of maintenance in manufacturing systems especially. For this reason, a large pallet of maintenance concepts, theoretically and practically training courses, guidelines and their application in connection with the basic rules etc. were conceived, tested and implemented. More recent publications [1], [2] emphasize the importance of an early consideration of maintainability and a systematic approach, and such because maintenance is related to safety, ergonomics and assembly.

2 MAINTENANCE IN THEORY

According to international (e.g. DIN 31051) and Romanian related standards, *maintenance* involves monitoring and assessing the actual condition of a system and maintaining or recovering the intended condition.
Possible measures are:

- *Service*, to maintain the intended condition

• *Inspection*, to monitor and assess the actual condition
• *Repair*, to recover the intended condition.

The type, extent and duration of service and inspection measures obviously depend on the type of system, its intended function, its required availability, its desired reliability, and on any potential dangers. The selected measures determine whether inspection and service has to take place after a fixed period of time, after a specific number of operating hours, or after a particular intensity of load.

The *maintenance strategy* is also influenced by the rate of deterioration of components, for example through wear that reduces operating life. The measures applied to recover the intended condition must be taken before components are predicted to fail. Accordingly, two types of repair are distinguished:

• *Failure repair* that takes place after a component has failed. This strategy is applied, and is often the only possibility, when failures cannot be predicted accurately. It is important that such failures do not cause danger. The disadvantage of this approach is the effect it has on planning. An example is the shattering of a car windscreen. This strategy is not suitable for production plant and in situations where a function must be fulfilled or where danger is involved.

• *Preventive repair* that takes place before a component has failed. This can be determined by either *interval* or *condition*:

- Interval repair takes place after a fixed period of time, a specific distance or a set number of operations.
- Condition repair is based on actual performance measures, such as the loads or temperatures experienced in operation. When an unwanted condition is observed, the service or repair measures must be carried out.

Whether the interval or condition strategy is applied depends on the operating conditions. A combination of the two strategies is also possible.

3. MAINTENANCE IN DESIGN

Maintenance requirements should have been included in the requirements list, [3]. When solutions have to be selected, easily maintained variants should be preferred. Examples are variants that require minimal servicing, include components that can be exchanged easily, and use components with similar life expectancies. During the embodiment phase, it is important to consider accessibility and ease of assembly and disassembly. However, design for maintenance should never compromise safety.

A technical solution [3], should, in principle, require as few preventative measures as possible. The aim is complete freedom from the need for service by using components with identical lives, reliability and safety. The chosen solution should thus incorporate features that make maintenance unnecessary or reduce it substantially.

Only when such features cannot be realized or are too costly should service and inspection measures be introduced. In principle, the following aims are important:

• Prevent damage and increase reliability.
• Avoid the possibility of errors during disassembly, reassembly and start-up.
• Simplify service procedures.
• Make the results of servicing checkable.
• Simplify inspection procedures.

Service measures usually concentrate on refilling, lubricating, conserving and cleaning. These activities should be supported by embodiment features and appropriate labeling based on ergonomic, physiological and psychological principles.

Inspection measures can be reduced to a minimum when the technical solution itself embodies direct safety techniques, and thus promises high reliability. Overloading, for

example, can be avoided by using appropriate principles such as self-help that provide protection against failures and disturbing influences. When service and inspection measures cannot be avoided, embodiment guidelines, discussed earlier, should be applied. In what follows, we limit ourselves to lists and short explanations.
Technical measures that can reduce the service and inspection effort, and should have been considered already in the conceptual phase, include:

- Prefer self-balancing and self-adjusting solutions.
- Aim at simplicity and few parts.
- Use standard components.
- Allow easy access.
- Provide for easy disassembly.
- Apply modular principles.
- Use few and similar service and inspection tools.

Service, inspection and repair instruction documents have to be prepared, and service and inspection points have to be labeled clearly. Guidance on developing maintenance manuals can be found in DIN 31052, and guidance on determining maintenance intervals in DIN 31054.
To facilitate the execution of service, inspection and repair measures, the following ergonomic rules, supported by appropriate technical embodiments, should be applied:

- Service, inspection and repair locations should be easily accessible.
- The working environment should follow safety and ergonomic requirements.
- Visibility should be ensured.
- Functional processes and supporting measures should be clear.
- Damage localization should be possible.
- Exchange of components should be easy.

Finally, maintenance should be part of the total concept. Maintenance procedures must be compatible with functional and operational constraints of the technical system, and must be included in the overall cost along with the purchase and operating costs.

4. MAINTENANCE IN PRACTICE

Especialy in the industrial practice, but also among the scientists, there are well known a lot of assertions addresed to the maintenance activities, vying with each other more acrimonius. Essentially the activities of cleaning, adjusting and repairs of machineryes, instalations and products, are seeing as a necessary evil. Not even the personel of maintenance department of the firm is not rejoice of better treatments, despite the fact that since over 30 years this activities has changed the name into an atractive one like maintenance. The re-labeling of the activities in “maintenance” in the 8th decade of the last century was not only a simple esthetically operation. The term of maintenance has grown rich with a lot of tasks. This fact, most of it is due to the technological evolution: the machine tools has becoming more and more integrated in the manufacturing processes and thus more complex because of the new embedded technologies based on advanced engineering concepts about integration. At the same time, work and additional equipment and in the same time the control hardware – the products of any kind in a general way – has become more reliable especially thanks to a maintenance logistics which are well fitted and continuously updated to the new working condition [5].
Planned maintenance is a maintenance program designed to improve the effectiveness of maintenance through the use of systematic methods and plans. The primary objective of the maintenance effort is to keep equipment functioning in a safe and efficient manner. This allows production to meet production targets with minimum operating cost. All portions of a planned maintenance program interrelate and are necessary for total system

effectiveness. Planned maintenance is not just a planning and scheduling function stuck on the side of a general "firefighting" type maintenance organization. It must be complete to be effective, and leaving one feature out will seriously hamper the program. The most critical components of a planned maintenance system are the following: *Work Orders, Daily Work Schedules, Daily Planning Meetings, PM Task Lists, Equipment History Files, and Backlog Control Boards.* The system is more important than what tool you use to control it or monitor progress. The best software in the world is not a system and it will not necessarily reduce costs. Complex and labor intensive software will frequently increase costs. You can install a good system with any software, but good software can be a valuable tool and can be used as part of a system [1].

A *time planned preventive maintenance strategy*, which were and still is used in Romanian enterprises for manufacturing equipment consists upon:

- technical revision – the ensemble of operation that are made before a planned repairing;
- current repairing is made periodical by a certain planning, being classified into two categories : current repairing of the first rank and current repairing of the second rank;
- capital repairing – is made at the end of the functioning cycle mentioned in the normative of the equipment;
- accidental repairing and the maintenance of the equipment – is made whenever it is necessary, every day by the maintenance team, or by the machinist (equipment operator) (cleaning, small adjustments, lubricating).

In industrial practice, it is well known that, the maintenance activities regularly accomplished minimize the damages caused by faults, pollutant emissions and operating accident. The inspections, adjustments and repaires are maintenance activities which represent only a small part of the whole content of maintenance. With respect to the mechanical processing equipment, usual the maintenance activities are: removal of faults and wearing parts with renewal parts, work fluid and lubricating fluid completation, coarse control and fine control of adjusting pieces and removing of tear and wear factors (water, dust, heat, acids etc).

Equipments are required when they reach the number of hours of functioning as regards the planning ante-established, the periodical technical repairs – equipments are repairs repetitively, in logical succession of the repairment cycle, after a technical revision, a method approved by the quality standards.

The maintenance compartment needs to assure the period of time required until the annulment of the equipment, larger than the normal one, the reducing of the time required for the repairing of the equipment, the using of equipment at maximum efficiency, the proper sizing of the volume of spare parts and materials, the reducing of non-productive cost, the improvement of the exploiting system of the equipment, the improvement of the maintenance activities, the elaboration of the methodology of technical diagnosis of all the equipments involves in all departments of the company.

The planning of maintenance can be done to the necessities, an outran formula in the context of the requirements of ISO 9001/2002; to the planning based upon the conclusion of the diagnosis activities (small firms, with equipment which work in intermittent regime), upon the norms of the functioning hours (TME with the same regime of functioning, automatic lines) [5].

For *implementing a planned maintenance system,* production involvement is extremely important but, if production management is not committed to a maintenance program, then unrealistically high or low requirements may be made of the maintenance forces. The system will go in easily at facilities where the production and maintenance managers work as a team in an effort to achieve common goals. In these cases, the production manager

will want to see what he will receive in service from the maintenance department if such a program is started. An overall maintenance philosophy will be developed by the production and maintenance team leaders. A system to fit this concept will then be developed by the maintenance group.

5. TOTAL PRODUCTIVE MAINTENANCE

Total Productive Maintenance (TPM) is a maintenance program which involves a newly defined concept for maintaining plants and equipment and brings maintenance into focus as a necessary and vitally important part of the business. Maintenance is no longer regarded as a non-profit activity

The goal of the TPM program is to markedly increase production, to hold emergency and unscheduled maintenance to a minimum and at the same time, to increases employees morale and job satisfaction.

In this concept, the down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process. Much more, the machinist will be a part of maintenance team, with specific tasks and responsibilities (see fig. 1).

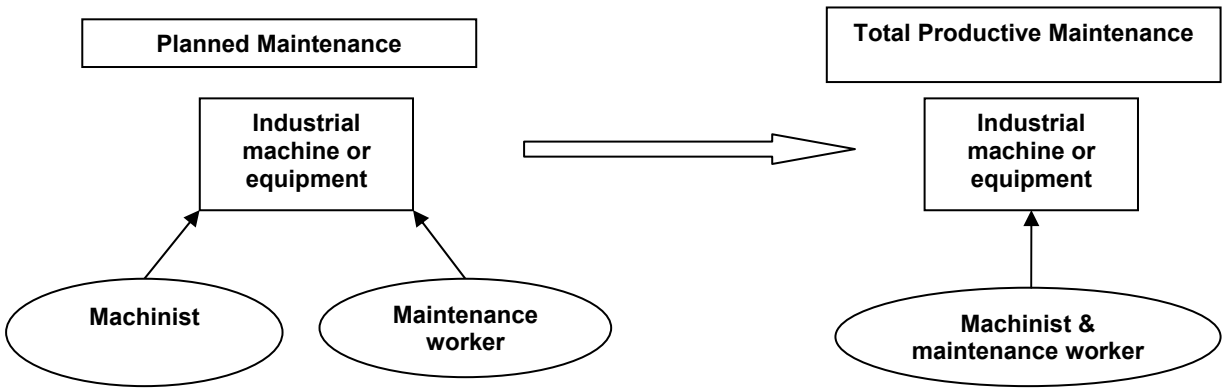

Fig 1 TPM - Passing from spreading tasks to integration of tasks

The implementation of TPM concept in a SME must be done following the steps and stages presented below:

A) - Preparatory Stage:

Step 1 - Announcement by Management to all about TPM introduction in the organization;

Step 2 - Initial education and propaganda for TPM:

Step 3 - Setting up TPM and departmental committees:

Step 4 - Establishing the TPM working system and target:

Step 5 - A master plan for institutionalizing:

B) - Iniciation Stage

C) - Pilot Implementation

D) - Institutionalising Stage

To implement such a mainenance strategy, a new organization structure for SME is nedded, and in figure 2 a proposed one is shown.

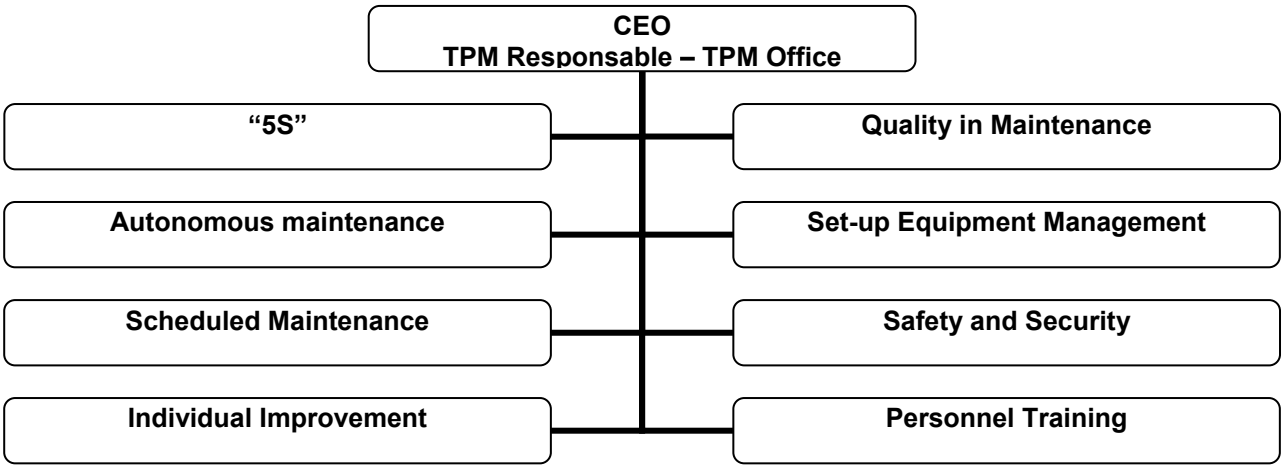

Fig. 2. Organization Structure for TPM Implementation

6 CONCLUSION

It is obvious that the benefits exist and the role of maintenance is dramatically changed into active one, involving automatization based on sensor devices, data acquisition for monitoring and control the manufacturing process, maintenance activities made in real-time etc. All this changes lead to good economical and qualitative results, and open the way for implementation on SME of product life cycle concepts and methodologies.

Today, with competition in industry at an all time high, TPM may be the only thing that stands between success and total failure for some companies. It has been proven to be a program that works. It can be adapted to work not only in industrial plants, but in construction, building maintenance, transportation, and in a variety of other situations. Employees must be educated and convinced that TPM is not just another "*program of the month*" and that management is totally committed to the program and the extended time frame necessary for full implementation. The time of "I work, you fix" is passed, now is the time for everyone involved in any kind of SME, manufacturing or not, for another maintenance strategy - TPM program. The economical results are not at once but they are ease to achieve, spectacular and lasting.

7 REFERENCES

1. Armstrong, D. (2006). *Maintenance planning and scheduling maintenance,* IDCON Inc.
2. Kimura, F.; Hata, T. & Kobayashi, N. (2002). Reliability-Centred Maintenance Planning based on Computer-Aided FMEA, *Proc. of the 35th CIRP-International Seminar on Manufacturing Systems*, Grenoble.
3. Pahl, G., Beitz, W., Feldhusen, J. and Grote, K.-H., 2007, Engineering Design. A Systematic Approach, Third Edition, ISBN 978-1-84628-318-5 3rd edition, Springer-Verlag London Limited 2007.
4. Takata, S. (1999). *Life Cycle Maintenance Management, Computer-Aided Maintenance*, edited by Lee, J. & Wang, B., Kluwer Academic Pub.
5. Vanderspek, P.G. (1993). Pl*anning for factory automation. A management guide to world-class manufacturing,* McGraw-Hill, Inc., ISBN 0-07-066949-X,New York.
6. Wright, P.K. & Bourne, D.A. (1988). *Manufacturing intelligence,* Addison-Wesley Publishing Company Inc., ISBN 0-201-13567-0, Reading, Massachusetts, USA.