

# **Maintenance Integrated System: the right recipe of TPM and RCM**

**Graziano Perotti**

**ST ENGINEERING**

S.S 24 km 16,2 – Alpignano (TO) Italy

Tel. +390119665763

Fax +390119665795

E-mail [gperotti@servizitecnologie.it](mailto:gperotti@servizitecnologie.it)

[www.terosonline.it](http://www.terosonline.it)

Keywords: maintenance, predictive, on-condition, TPM, RCM

## **Introduction**

Over the two last decades of the 20<sup>th</sup> century, maintenance has known a stage of rapid increase of interest due to the need for improving effectiveness, safety and environmental compatibility of production systems and services. It became clear to managers that keeping a process under control means to control the system devoted to operate the process itself. Since systems are usually made up by machines, among other resources, they suffer from different kinds of failures; for such a reasons maintenance plays a very important role in assuring good system performance over the time. Moreover, maintenance department, that complex apparatus formed by maintainers, jigs, tools, spare parts, etc., needs to be properly structured and organized in order to have an high capability level. It is a matter of maintenance strategy and tactics to reach such a capability. It's clear now why when talking about maintenance policies two aspects are dealt with: technicality and organisation. Trying to solve maintenance problems simply acting on the technical side or, alternatively on the organizational one is a nonsense; both of them have to be considered jointly.

It is well known that the most popular maintenance policies, those developed in the second half of '900, take in account just both the aforesaid aspects; nevertheless they do not give them the same importance. Indeed a policy privileges technicalities, another organization, so how to choose the best one, the most suitable for own company?

## **Total Productive Maintenance versus Reliability Centered Maintenance**

Among several policies of maintenance, two have been very successful and applied everywhere in the world, they are: Total Productive Maintenance (thereafter TPM) and Reliability Centered Maintenance (thereafter RCM). The first one comes from Japan, it was first developed in manufacturing industry, where only poor maintenance practices were applied, based on: "I fix after machine have broken"; in other words preventive actions were not carried out at all. It is easy to understand why TPM were very successful in that kind of companies; as soon as preventive techniques were implemented a great benefits came out. At the beginning of TPM implementation very simple methods, like fulfilling the five s' discipline, is enough to reach important results, but it is necessary that they enter the mentality of all the people working for the company, not just maintainers. A new way of thinking and acting, TPM based, have to be spread and absorbed throughout the company.

The second policy, that is RCM, originates in a completely different environment, it was the American aircraft industry which had the objective of reducing the expenses due to an heavy scheduled discard tasks maintenance, thought as the only way to assure the aircrafts high reliability. The dominant criterion was: "the more frequent components are replaced, the less failures occur" that is: a component is likely to fail if it has been working for long time.

Such a direct proportional relationship between failure likelihood and working time revealed not to be right for multicomponent systems with no predominant failure mode, as the majority of systems are. It is understandable that here the problem to solve had nothing to do with the introduction of preventive method, since it was already a common practice in those companies ; it was rather a question of choosing the right prevention technique, without losing money and time in working out maintenance activities with no

reliability increase for the aircraft. RCM response were: drawing up maintenance tasks based on the reliability of each component.

In order to pursue such an objective, it is necessary to investigate failure modes of each component or at least those significant for reliability, with respect to its working conditions and the functions it has to carry out. This approach is a deep engineering approach, that require failures data history of the machine under investigation, together with not banal knowledge of failure mechanics. Organizational aspects seem not to be very important. Is it really true?

To discuss in more detail pros and cons about TPM and RCM let's have a look at their fundamentals.

TPM rests on the famous "five pillars" stated by Mr. Nakajima in the eighties, here they are:

1. Maximize overall equipment effectiveness.
2. Establish a thorough system of preventive maintenance for the equipment's entire life span.
3. Implement TPM by involving all departments (e.g. engineering, operations, maintenance).
4. Involve every single employee, from top management to workers on the floor.
5. Promote TPM through motivational management (autonomous small group activities)

RCM proceeds by answering the "seven basic questions", stated by Mr. Moubray in 1990, here they are:

1. What are the functions and associated performances standards of the asset in its present context?
2. In what way does it fails to fulfil its functions?
3. What causes each functional failures?
4. What happens when each failure occurs?
5. In what way does each failure matter?
6. What can be done to predict or prevent each failure?
7. What should be done if a suitable preventive task cannot be found?

At a glance it seems that TPM is more management oriented than RCM, which is notably engineering oriented. Note that the second pillar just mentions preventive maintenance, but do not give any suggestions about how establishing it; furthermore this pillar seam to disagree with the seventh question, since the latter gives the chance that preventive task could not be found.

On the basis of this short discussion it may be wrong to conclude that TPM and RCM are two incompatible maintenance policies, to bear such a conclusion, a deeper analysis should be worked out. Nevertheless we may say that TPM and RCM have nothing to do each other; they propose different way to reach the same goal.

If it would be true, than what policy to choose for own company? Does each of them worth to be applied? Which one does work better in a given company? What are the key elements to operate the right choice?

These issues will be the subject of the next paragraph.

## A deeper look at TPM and RCM

Apart from pillars and basic questions, we have to analyse in detail these two maintenance policies before discovering their relationship.

TPM implementation program highlights very simple and effective Japanese principles like: eliminating the six big losses, reaching zero defects, developing autonomous maintenance (maintenance tasks done by operators), promoting small group activities, etc..

Such approach improve the awareness of each employee about failures and about what to do to fight them. As far as technical subject is concerned, TPM leverages on the ability of expert maintainers and technician to train low level maintainers and even operators, especially through one points lessons . This policy concentrates also on several aspects linked to maintenance, that is: human engineering, logistics (for spare parts and jigs), management at a glance. To take care to all these aspects has a positive feed-back on maintenance performances, particularly because they create a stimulating environment for workers, so they are motivated to do the best of them. TPM is aimed to give both maintainers and operators the ability of finding out malfunctioning and fixing them as soon as they appear. Continuous improvement is the motto of TPM.

On organizational side TPM adopts a very strong structure, where every employee is assigned a clear role to play, as stated by the fourth pillar; it is better represented by the following pyramid.

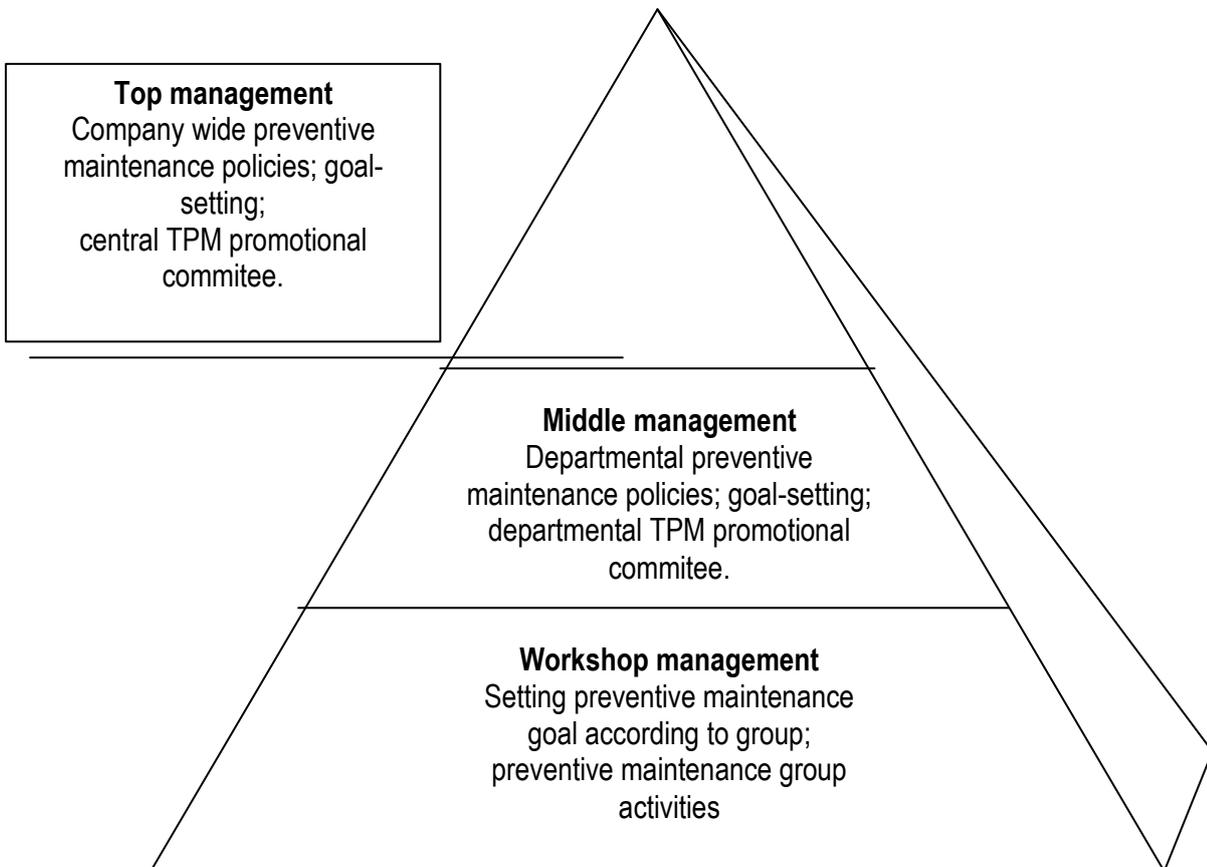


Fig. 1 **TPM** promotional structure (Source: Introduction to TPM – Productivity Press)

To ensure information to descent from top to bottom and vice versa, TPM promoters recommend to adopt the Likert proposed network of overlapping small groups, organize ad every level from top management to the work floor. Each group leader participates as a member in a small group at the next level; in that way group leaders serve as a link between levels, facilitating vertical as well as horizontal communication.

**B** is leader of the group **2** and member of group **1**

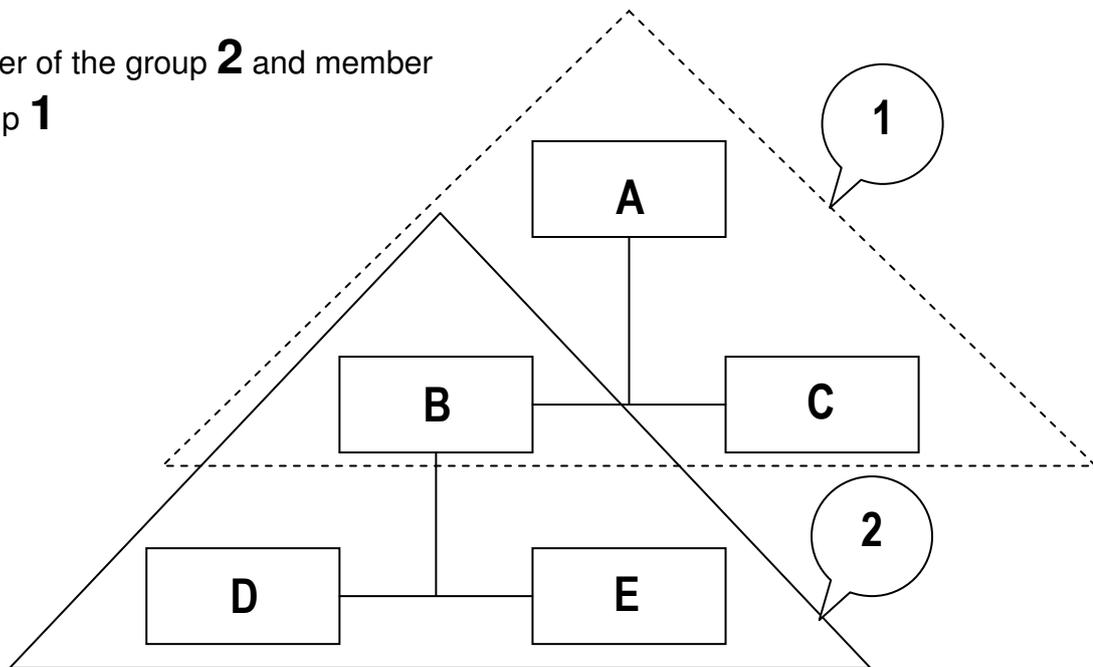


Fig. 2 **Likert** small group connection (Source: Introduction to TPM – Productivity Press)

RCM approach begins by investigating the functions of the machines involved in the implementation project, than it follows going through failures analysis and consequences, a wide description of predictive and preventive techniques are dealt with, together with failure-finding and default actions. From this point ahead RCM moves to managerial and organizational aspects such as: decision diagram, implementation recommendations, RCM achievements.

It is easy to see that the first topics are of engineering nature, whilst the last ones are implementation related advices; from this point of view RCM is more similar TPM to a degree.

It is interesting to compare RCM team structure (Fig. 3) against TPM one (Fig. 2). Albeit RCM recommend the commitment of the top management, it does not specify any link to lower level team; on the other hand it define the working group structure accurately . The facilitator plays a crucial role, he knows RCM because he has been previously trained, so has to lead the group toward the target.

The number of groups to proceed in parallel depends on the amount of machinery involved in the project.

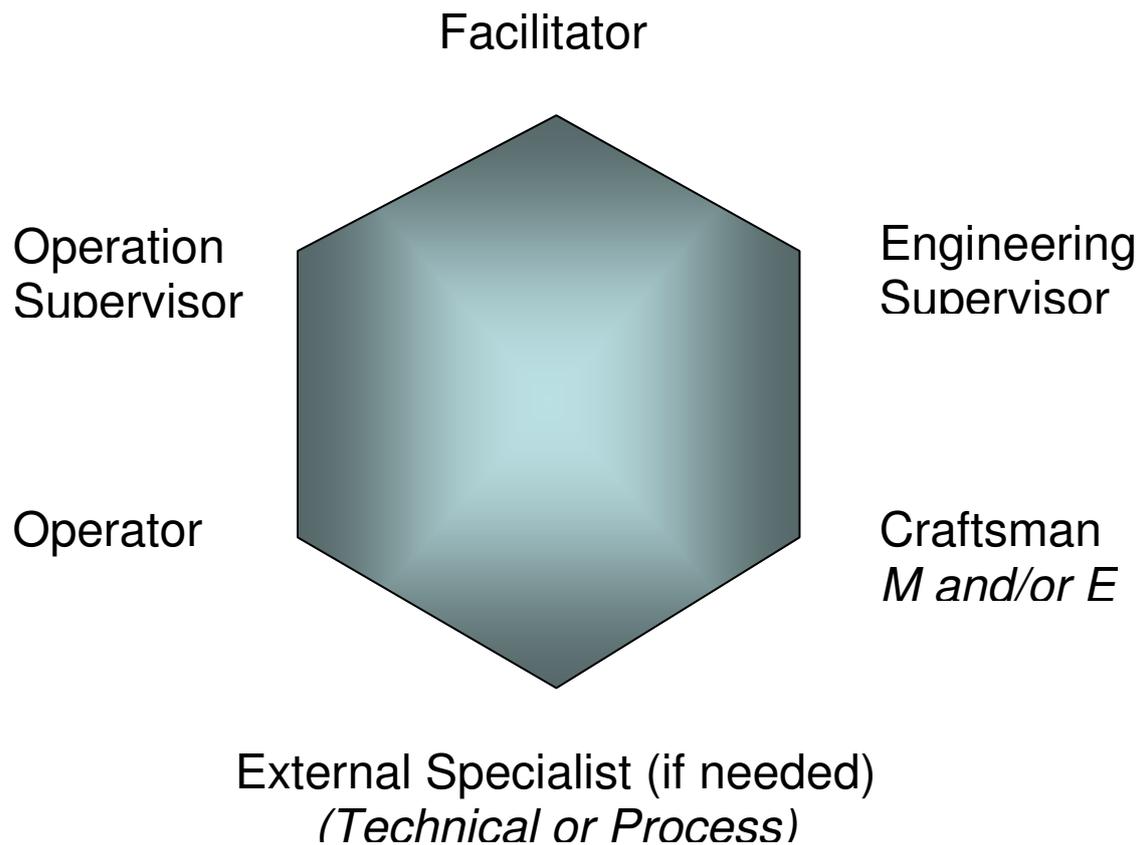


Fig. 3 **RCM** review group (source: RCM II – Industrial press)

### The Integrated System

The analysis above reveals that it is incorrect to conclude that there is no way to match TPM and RCM; we simply have to get aware about which is important to improve first in a company: cleanliness, tidiness, automated processes, preventive / predictive maintenance, safety and environment, workers involvement. After having listed and ranked the priorities to reach, decision could be taken about TPM or RCM or even both of them, adopting the latter in the frame of TPM that is, using RCM to set preventive and predictive maintenance standard and letting TPM to manage the overall improvement project. This is the Integrated System proposal; it is oriented to gather the best from each maintenance policy, according to the company present status and goals. As table 1 shows, some items are better treated with TPM, while others are with RCM. No conflict should arise since the strengths of TPM makes up to the lacks of RCM and vice versa

TPM	RCM
cleanness	automated processes
tidiness	preventive / predictive maintenance
workers involvement	safety and environment

Tab. 1 **RCM & TPM** compliances

## **The outstanding role of predictive maintenance**

As said before RCM profits from every maintenance technique, corrective included; nevertheless predictive one is privileged. This is made evident on the decision diagram where the counter measures to a failure are first sought between the predictive solution and only afterward between preventive ones and between corrective at the end.

To promote predictive maintenance (also known as on-condition) ST ENGINEERING) has set up a service based on vibration and thermography as predictive techniques named TEROS. With respect to traditional services, TEROS leverages on a strict participation of the customer, who is charged of collecting data from machinery than, via the web, sending them to TEROS portal. Here data are analysed from ST ENGINEERING specialists that report the results to the customer and creates a data base accessible to the customer through the web.

Operating in this way all companies may benefits from very special technique, without ambitious investments in personnel training and inspection instruments acquisition, since the latter may be borrowed from TEROS.

Such predictive maintenance service offers also maintenance engineering consultancy, based on the analysis of the data stored in the aforesaid database; in this way the customer benefit from first hand information to be exploited both to improve plant effectiveness and to address suggestions relevant to new equipment under construction.