The Management of the Industrial Maintenance at the International Level (I)

Vasile DEAC
The Bucharest Academy of Economic Studies, Romania
E-mail: deac_vasile@yahoo.com
Telephone/Fax +4 021 319 19 00
Gheorghe CÂRSTEA
The Bucharest Academy of Economic Studies, Romania
E-mail: gheorghe.carstea@man.ase.ro
Telephone/Fax +4 021 319 19 00
Constantin BÂGU
The Bucharest Academy of Economic Studies, Romania
E-mail: cbagumaster@yahoo.com
Telephone/Fax +4 021 319 19 00
Florea PÂRVU
The Bucharest Academy of Economic Studies, Romania
E-mail: parvu.florea@yahoo.com
Telephone/Fax +4 021 319 19 00
Florica BADEA
The Bucharest Academy of Economic Studies, Romania
E-mail: florica_badea@yahoo.fr
Telephone/Fax +4 021 319 19 00

Abstract

When defining a maintenance policy, it must be held in mind the fact that there isn't such a thing like "good maintenance policy" in itself; instead, for each industrial equipment should be adapted a particular maintenance method, coming to a technical-economic compromise through its products, through its market, its equipments, its people, the managers' psychology, the organizational culture and, as a consequence, the industrial maintenance will be different.

The present article will pursue to highlight the position of the maintenance activity having in mind the imperatives imposed to this activity, the maintenance methods applied at the international level and the methods that can be applied in our country.

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JEL classification: D24, M11, M21, O12

I. The mission and the responsibility of the maintenance system

The traditional industrial organizing led, both in our country and in the whole world, to the grouping of all the maintenance missions inside a behaviour whose tasks can be grouped into four main categories:

a. Maintaining the production potential

The production equipments represent important investments for which the assuring of a high availability and the obtaining of a maximum performance are the company's main objectives and, in the first place, of the maintenance's department.

The maintenance department is mainly responsible for the following:

- the permanent diagnosis of the equipment's condition, repairing the constant failures;
- the repairing and the putting into operation again the devices when necessary;
- the accomplishment of new activities: of construction, installations, technological trails, etc;
- the modernizing of the production equipment, which aims to the increasing of the capacity of production, of the quality of production, of the automation of production;
- the providing of the replacements management.

b. The exploit of the technical infrastructure

The supplying of various categories of energy, water, steam, compressed-air, represents also a domain whose responsibility is assumed by the maintenance compartment, his responsibility referring, from one side, to the rational usage of these kinds of utilities and, on the other, to their maintaining or solving the drawbacks of the systems of delivery with these utilities.

c. The environment's protection

The fight against the pollution, the remnants' and of the industrial waters' elimination are more vigorously implemented by law. Through its technical vocation, the maintenance department is the one that must solve these problems.

d. The security of the persons and goods

Protecting the workers from accidents is the objective of numerous laws, which are necessarily completed by internal instructions and actions to carry on, in accordance with the equipments' particularities. In our country a department of labor protection is responsible for this activity, but in the countries with a developed economy, the maintenance department is responsible for this, who knows better each device's particularities.

Having in mind this diversity of activities undertaken by the maintenance staff, which affects the expenses budget of the maintenance function, there is necessary, before scheduling a method or another of organization, the "cleaning" of the equipment's maintenance budget. It often involves some expenses with activities that have nothing to do with maintenance. The maintenance compartment

functions as a supplier and can't be considered these activities' manager, these activities having to be related to different budgets. There is necessary to apply a codification, according to the nature of the work or activity, in such a way to allow the classification of expenses that are adequate to various activities and the distinct highlight of those who really refer to maintenance. The ground rule: „bien gérer, c'est d'abord connaître" mustn't be forgotten, a ground rule which must be held in mind by any good organizer and a good management.

How can be understood the mission of the maintenance compartment? We'll try to answer this question considering three possible options: [Deac, Badea, Dobrin, 2010]:

1. **The suppliers of services and suggestions (recommendations).** In this case, the production is the one to lead the activity of maintenance of the equipment. It must define its objectives, schedule and the maintenance budget. The maintenance department is a supplier that intervenes to the production's demand; its responsibility is limited at supplying a good or service that corresponds to a demand, at the solicited moment, with the best possible costs having in mind the means it disposes.

Having in mind that the production concentrates all its efforts on its essential mission of producing a certain quantity, of a certain quality and at the smallest possible costs, the maintenance is performed according to the needs and events. This policy inevitably leads to a short time maintenance policy, which may prove to be valid in the industrial companies in which the maintenance's costs are insignificant and there aren't justified any actions and investments in the maintenance's organizing.

2. **Manager of the equipment and its maintenance**. When the maintenance department is the manager of the equipment and its maintenance, being responsible of objectives defined by the unit's management or established with its approval, it defines the methods, the schedule and the maintenance budgets of the equipment. This situation, which implies responsibilities and budgets, involves two major drawbacks:
   - it assumes the responsibility of the production cost of the manufactured product, the maintenance having to proceed the optimization of various expenses that are part of the production cost;
   - the production isn't motivated regarding the problems and the maintenance costs.

This solution is valid in the industrial units with mass production, which has high maintenance costs.

3. **Responsible warrantee and production manager.** In this third option, the production is responsible for the production costs of the manufactured objects and optimizes the various expenses it comprises, including the ones with the maintenance. According to that optimization, it defines the objective of the maintenance compartment,

which must determine the methods, program and maintenance budget. This budget is discussed with the production and constitutes a "maintenance contract" between two parts. The maintenance department is responsible for the good achievement of this contract. Production is the one who pays it and it's highly interested to facilitate its partner's activity and to supervise the maintenance costs. This solution is prognosticated, in particular, for all the industrial companies with discontinuous production processes and with economics of scale.

The maintenance methods can be adopted for each type of tool, industrial equipment, conjunctly with the maintenance compartment and the production subunits.

Besides the contracts according to the events, four types of contracts must be formalized between maintenance and production, which are:

- annual contracts for: the defining of the objectives, the determining of the maintenance methods, the schedule and the maintenance budget; the discussing and the adopting of this budget. All the eventual disputations will be submitted to the arbitration of the company's leadership;
- biannual contract or once a month for: an eventual rectification of the objectives, of the program and of the maintenance budget; the analysis of the abnormal costs (the weak spots) and the high costs (high points);
- the decades for: defining primary activities from a day to another, security procedures.

The responsibility for the maintenance compartment is manifested in the following three directions:

- providing the management of the equipment's maintenance (maintenance budget);
- performing the various activities as supplier (modernizations, activities related to the labour protection, modifications);
- providing the management of the maintenance means (staff, workshops and offices, maintenance machines and tools, materials and replacement).

II. Maintenance methods

Making a review of the maintenance methods presented in the world's specialty literature, there are different opinions related to maintenance methods that can be applied, an aspect that results from the practical reality of the companies from a country or another or even in the same country. This way, we meet a variety of maintenance methods starting from traditional systems of maintenance and repairs (practiced in our country) and ending with the method of "Total Productive Maintenance" (practiced in Japan).

We think desirable a succinct presentation of the maintenance methods that can be applied, dealt with in the specialty literature, having in mind that **in defining a maintenance politics it must be also considered the fact that it doesn't exist a "good maintenance method" in itself, but that for every type of**

industrial equipment it must be adopted a particular maintenance method, making a technical and economic compromise of optimization, standardizing and progress. Each industrial company is different from another through its products, its market, its equipment, its people, the managers' psychology, the organizational culture. As a consequence, the maintenance will be different, too.

Having in mind that, after 1990, in the industrial enterprises from our country there wasn't any obligation of performing the activity of maintenance and reparations in the preventive-planned system, many of the industrial enterprises renounced at this system, choosing a maintenance and reparation system according to their needs, in spite of all the negative consequences.

If then, in the general confusion, this attitude was somehow justified, now, having in mind the international competition in which the industrial units from our country are involved, it's absolutely necessary a rethinking of this activities. Unfortunately, the current economic and financial crisis with which the industrial companies is confronting with, had marked the maintenance activity, under the pressure of the costs' decrease, this activity being performed, in this moment, at the minimal necessary level.

The factors that determine the maintenance's evolution on the international level are being seen in the companies from our country, too (especially the perfecting of the manufacturing technologies and the necessity of optimization of the maintenance budget), which will determine the rethinking of the current systems of maintenance and reparations.

1. Types of maintenance and repairs systems practiced in our country

In the specialty literature from our country, many years ago, the maintenance activity began to draw the specialists' attention, being approached as being interdependent of the rest of the activities performed inside the industrial units, based on an excessive rigid planning.

Now, there are several opinions referring to the possible systems for maintaining and repairing the equipments.

In one of the first papers, there are presented the following systems [Barbulescu, 1983]:

1) **The system of repairs which are performed according to the necessities;**
2) **The system of repairs based on observation;**
3) **The system of planned preventive repairs;**
   - ✓ **after the standard method;**
   - ✓ **after the method of the technical periodic revisions.**

This method had the widest spread, until 1990, being applied in all the industrial companies, and it continued to be planned, in the present, in several industrial companies.

The planning of the repairs' execution according to this method is based on a system of technical regulations (there were elaborated some technical regulations at the branch level), which anticipate the kinds of categories of technical interventions that are performed, the time interval between the two technical interventions of the same type, the standing time and the level of the expenses, given as a percent of the of the equipment's inventory value. According to these regulations, the categories of technical interventions that are performed inside this method are: the technical inspections (Rt), degree one current repair (Rc_1), degree two current repair (Rc_2), and capital repair (Rk).

From the studies dedicated to this aspect [Deac, 2000], it resulted the fact that the introduction preventive-planned repairs systems, didn't have in many cases the wished economic effects, having in mind that it wasn't applied with an appropriate technical and with a material and organizational preparation.

This way, the regulations of maintenance and repairs were elaborated, but it didn't exist:

- schedules of the replacements and repairing materials on types of equipments;
- detailed technologies, scientifically substantiated on types of equipment and categories of workings;
- a scientific substantiation of the materials and replacements which are necessary for repairs and the stocks of replacements;
- an attempt to manage the technical planned interventions and an updating of the repairs plans according to the effective working time;
- an adequate informational system, which to allow the knowledge of the critical points of the equipments, the usage of the available time, the level of the maintenance and repairs expenses, etc.

This deficiencies hall-marked the efficiency of the maintenance and repair activities per whole, respectively long stand periods, a lot of improvising, frequent accidental failures, high repair costs, etc.

In other specialty papers [Borza, 1995] there are suggested the following maintenance and repair systems:

1) **The preventive maintenance and repairs**, with the following variants:
   a) preventive maintenance and repairs as technical revisions and planned repairs of the type: RC_1, RC_2 and RK.
   b) preventive maintenance and repairs as periodical revisions, partial and general revisions;
   c) maintenance and repairs on groups of equipment through establishing the interventions' frequency.
2) **The maintenance and repairs system according to equipments' condition (predictive maintenance);**
3) **Maintenance and repairs systems according to the necessities (reparation maintenance).**

Related to the types of maintenance and repairs systems presented in the specialty literature, we can draw the following main conclusions:

- the wide range of types of systems makes even more confuse their concrete content, the application circumstances, the advantages and the disadvantages they have even;
- even if they contain common elements referring to the content of the workings they perform, common planning and prevention elements, they are presented as distinct systems.

2. Maintenance methods practiced in the world

In the foreign specialty literature, having in mind the changes in the traditional activity of maintenance and repairs and its evolution to the industrial maintenance, there are presented several options related to the maintenance methods that can be applied inside the industrial companies.

Therefore, in France, AFNOR norms 60-010 define two maintenance methods[1]:

1) Preventive maintenance, which, in its turn, can be of two types:

a) systematic maintenance;

b) conditioned maintenance;

2) Corrective maintenance.

1. a) The systematic preventive maintenance represents the maintenance that is performed having in view a schedule established according to the time or to the number of usage units.

The systematic maintenance's objectives are:

- the diminishing of the failures and of the unpredicted situations in order to reduce the maintenance costs (the reliability's increasing);
- the improving of the production's quality;
- the equipment life prolongation;
- the improving of the activity of planning and programming:
- the improving of the work's security.

1. b) The conditioned preventive maintenance represents the preventive maintenance related of the evolution of a characteristic symptom, like the usage's measure, the information derived from a receiver, etc.

This method is applied just in the case in which there is a progressive and visible degradation and there can be found a correlation between a measurable parameter and the equipment's condition.

The conditioned preventive maintenance's objectives are:

- avoiding the sometimes inutile demounting of the systematic preventive maintenance, that can constitute a source of supplementary damage in itself;

[1] xxx- Norme NFX 60- 010- Vocabulaire de maintenance et de gestion des biens durables, Afnor Gestion, Paris, 1984

- increasing of the persons and goods security, reducing the corporal risk or the risk of damage;
- avoiding some urgency interventions, following the evolution of the abnormality from the startup of the equipment and intervening in the most favourable moment. This is the advantage given by "time" dimension, which enriches the conditioned maintenance from the "preventive" point of view.

2) Corrective maintenance. The norms 60-010 define the corrective maintenance as the maintenance performed after the failure and it covers two types of interventions: urgency repair service and repair.

Corrective maintenance can array various levels of maintenance, a temporary urgency repair being different from a stable repair, with malfunctioning elements, performed from well-defined quality criteria.

In the French specialty literature [Boucly, 2007], there are discussed other maintenance methods:

- **predictive maintenance**, following the evolution of a symptom or degradation;
- **improvement maintenance**, following the improving of the reliability and durability in order to tend to „zero defects".

In the American specialty literature[1], two maintenance methods are estimated as possible to apply:

1. **Productive maintenance;**
2. **Corrective maintenance.**

1. The concept of „**Productive maintenance**" belongs to the American specialist John Smith, a concept that allowed the development in Japan of the „Total Productive maintenance".

The productive maintenance can be defined having in mind the following main characteristics:

- It aims at obtaining a maximum global efficaciousness of the equipments;
- It assumes the establishment of a global maintenance system on the whole equipment's life span;
- It assumes the approach of the maintenance activity on the whole equipment's operating life;
- It assumes the involvement in the maintenance activity and of the departments of research and the ones of exploit of the equipments.

2. **The corrective maintenance** consists in the re-establishment of the technical condition of the equipments after its failure. It is recommended, not to affect the development of the production process and in order to reduce the unavailability's cost, the maintaining of some

[1] Rosaler, R.C., Rice, J.O.- Industrial Maintenance Reference Guide, Mc. Graw-Hill, Haidoihead, 1983

supply equipment, the defect ones being repaired in an organized and programmed way.

In the Japanese specialty literature, we meet the following maintenance methods:

- Corrective maintenance;
- Productive maintenance;
- Total Productive Maintenance (T.P.M).

Having in mind the changes produced by the „Total Productive Maintenance", in the approach of the maintenance activity at an international level (more and more Occidental industrial companies inspiring in approaching their own maintenance out of this method's conceptions), we won't perform a descriptive presentation of this method, but we're going to analyze this method highlighting the possibilities of the perfecting of the industrial maintenance activity inside the industrial companies from our country, starting from this method's conceptions.

3. Total Productive Maintenance (T.P.M.)

a) A short history of the concept. Definition

The Japanese method TPM produced changes in the maintenance activity, a new concept about this activity. **It's, in fact, a method of global and integrated inventory of the equipments in order to obtain the best results.** It has in mind and it reformulates the best known techniques of increasing the availability and the performance of the equipments: the systematic and conditioned maintenance, the maintenance on the computer, the reliability tests, the costs inside each equipment's life cycle. More than this, its essential particularity, characterized through the term „total", stands in the extension of the maintenance function. It's all about a true activation of rigid structure, in such a way that to be obtained the best equipment's performance. Characteristics like auto-maintenance, order, cleanliness are essential elements of the TPM method.

How was born this new concept of industrial maintenance?

It belongs to the Japanese Institute of Plant Maintenance, an institute created in 1969, in the famous „Japan Management Association" (J.M.A.).

The Japanese industrialists and the J.M.A. created in 1964 an award, P.M. (Productive Maintenance), for awarding the people who were going to implement with the best results their maintenance „doctrine", a „doctrine" inspired from the American specialist John Smith, a concept known as „productive maintenance".

J.I.P.M. kept awarding this prize every year, to one or two Japanese companies after putting them to an exam, on the spot, from a jury. In the seventies there were spread the ideas related to quality, especially under the special influence of Toyota school. A manufacturer of constituents for Nippon Denso automobiles uses techniques of involvement of the directly productive workers at the maintenance activity and he obtains this way, in 1971, „P.M." prize. The Japanese

Institute of Plant Maintenance (J.I.P.M) decides to transform its „American" methods of „productive maintenance" into a Japanese method of „total productive maintenance" (T.P.M). From this moment on, no company can be awarded the „P.M." prize if it doesn't implement T.P.M. This way, T.P.M. was born!

His main initiator is Seichi Nakajima, vice-president of J.I.P.M. and executive vice-president of J.M.A., who elaborated two papers about this method [Nakajima, 1988, 1989].

What is T.P.M.?

According to the conception of the author of the method, T.P.M:

1. **It aims at obtaining a maximum global performance of the equipment;**
2. **It tries to establish a global productive maintenance system on the whole life span of the equipment;**
3. **It involves all compartments' involvement, especially the conception one (research and design), production and maintenance;**
4. **It implies involvement, on all the hierarchical levels, from managers to workers;**
5. **Using as a means of motivation the autonomous activities of the staff regrouped in circles** [Nakajima, 1989].

The concept of „productive maintenance" already involves, under the American influence, the ideas about the reliability and durability studies for equipment, the idea related to the cost of the equipment's life cycle, but two essential elements make „T.P.M." totally different from the „productive maintenance", and these elements are:

- auto-maintenance, respectively the participation of the production staff to the equipment's maintenance. These are the best located for detecting the weaknesses and the small failures and they can offer the necessary remedies as soon as possible. The
  maintenance compartment's work is sensibly eased by the small interventions made by the production staff (the equipment's cleaning, inspections, level I maintenance);
- approaching the problems through circles, through „quality circles".

In proportion as this method is applied inside the Japanese companies, the concept is enlarged, the method's author thinking that there were two stages in T.P.M., the first stage corresponding to the previous version, slightly outdated, and the second stage, more recent, in which all the compartments belonging to an industrial unit have the responsibility of obtaining the highest efficiency in the equipments with which the unit's equipments. It's about the obtaining in the conception and projecting of the equipment of the highest level of availability, of finding in the activity of the product's design of the best adaptation at the unit's means of production. In the same time, the supplying compartment will organize the procedures of supplying with raw materials and replacements according to the

means of production and the maintenance's needs. The human resources' ***compartmentalization*** will obviously play a key role in assuring this maximum efficiency.

Launching a implementing program for T.P.M. is a very important operation, T.P.M. covering more than a maintenance function, it's a **global management method, at which all the people from a company must contribute.**

b. T.P.M.'s quantitative approach

First action of T.P.M. is the analysis of production losses. An equipment of production is manufactured in order to function in his nominal rhythm in the available time. The production, which should be obtained in this time, is diminished, having in view "the six great losses" of time, as the method's authors call them.

The "six great losses" (of time and implicitly, of production), are of various kinds, are caused by various things and refer to:

1. Accidental failures in the equipment's functioning.

It's about the equipment's accidental failures, the available time being diminished because of the time of corrective maintenance necessary for eliminating these accidental failures;

2. The time needed for the equipments' adjustment and for their adapting for manufacturing other products (changing the fabrication series) or replacing the tools. In this time, the equipments don't produce, like in the case of the failures, and this time can be important (especially in the case of small-scale production and unique products), which means that it's necessary to concentrate on the activity of production's design (optimal fabrication lots).

3. The small interruptions or the lost motion, determined by a series of causes like: the equipment's cleaning, the putting back of the product on the equipment, the disposal of a defect product, the equipment's supply, the absence of a worker for various reasons, etc. This category of time loss is very difficult to measure, because it doesn't appeal to maintenance and as a consequence, it can't be recorded. It is estimated, in most cases, making a comparison between the equipment's supposed output and its output while it functioned.

4. The slowing down of the equipment. There are circumstances in which the workers don't stop the equipment, but they don't let it running emptily, but they are content to make it function slowly, for a certain amount of time. There are some cases in which the slowing down of the equipment is imposed, in the circumstances in which an element of the equipment is damaged and it must be slowed down in order to be capable to continue the functioning of that equipment. If it can be determined the average functioning speed, it can be also calculated the loss as a result of a decrease in speed.

5. The rejects resulted from the production process, due both to the equipment's quality and to the productive staff.

6. **The rejects resulted when an equipment is put into operation.** In the moment in which an equipment is put into operation, it's possible that a certain quantity of products don't meet the qualitative demands. Starting from the volume of the rejects, it can be determined the time needed for producing these rejects.

Starting from this category of losses, according to T.P.M. method, there must be done a lot of efforts in order to reduce them, using a lot of means, specific to each category, from which we mention:

- the time dedicated to the accidental defects can be reduced: through a better activity of the maintenance compartment; a better collaboration of the maintenance staff with the production staff; through the implementation of auto-maintenance;
- the time of changing the tools and the time for adjusting them can be diminished through a better organization of this changes of tools and these tunings. In order to meet this requirement, it was created the S.M.E.D. technique (Single Minute Exchange Die), a technique of changing the manufacturing, its objective being achieving this in less than 10 minutes;
- the small interruptions and the diminishing of the production rhythm aren't, theoretically, part of the maintenance department. But their existence justifies the real fact that an equipment that went beyond the stage of the failures from his life cycle, the level of failures being very low, doesn't produce at its nominal performance. It's considered that, through the implementation of auto-maintenance, this loss can be significantly reduced;
- the quality defects due to the equipment will be considerably diminished through T.P.M. method, both through the maintenance deployed in the maintenance department, and through implementing auto-maintenance, and those of them which are caused by the directly productive workers will reduce through the programs of total quality;
- the start-up losses will be able to be reduced through an improvement of the start-up procedures and perfecting the equipments.

In all cases it will be tried a perfecting of the equipments in order to reduce these time wastes or to improve the activities that contribute to these losses' reduction.

These six categories of time wastes, regrouped two by two, generate the following indicators specific to the method of T.P.M. (figure 1).

- **the rough functioning coefficient,** calculated as a ratio between the rough functioning time and the available time, characterizing the equipment's availability (its unavailability is generated by the defects that can appear or by the equipment' cease to function for adjustments).
- **the performance coefficient,** calculated as a ratio between the net functioning time and the rough functioning time, characterizes the equipment's performance (the small interruptions, the lost motion, the slowing down are the causes of non-productivity);

- **the quality coefficient,** calculated as a ratio between the due time and the net functioning time, as its name suggests, characterizes the quality of the obtained production (the non-quality of the production is given by the rejects that result, not considering their cause: incidents related to the equipment or workers, start-up rejects, etc.)

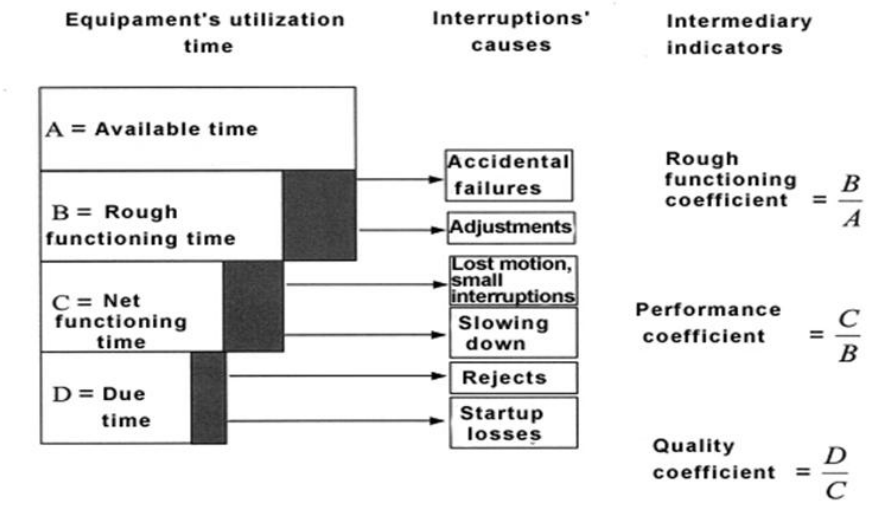

Figure 1 Method T.P.M.'s indicators

Based on these intermediary factors, it can be calculated the main indicator of T.P.M. method, respectively the synthetic performance coefficient (CRS), that measures an equipment's global performance (of a device, of a flowing production line, production department or industrial company).

This is calculated as a product of the three intermediary factors, respectively:

$$CRS = \frac{B}{A} \times \frac{C}{B} \times \frac{D}{C}$$

It's obvious that, performing the simplifications of this factor, it can be calculated in a synthetic way as a ratio between the effective functioning time and the available time or in other modalities, but this simplistic way of calculating would blur the path that should be taken for increasing this factor, and the main objective of T.P.M. method is the maximizing of the global performance of the equipments available in the industrial unit, respectively:

- the rough functioning coefficient can be increased diminishing the number of failures and/or diminishing the time in which they are remedied. This thing can be achieved through a systematic preventive or conditioned maintenance, through a better cleaning, through a

permanent surveillance of the equipments by the directly productive workers, through the modernizations brought to the weaker components of the equipments, as a result of the study of their behaviour;

- furthermore, it can be reduced the standing period in which the defects are remedied, through a better organization of the maintenance action, a more effective inventory of the replacements, the participation of the directly productive workers at troubleshooting activities (generally at the level I maintenance activities), improving of the technical maintenance documentation, etc);
- the performance coefficient can be increased through measures of prevention of diminishing the production rhythm and preventing the interruptions performed by the directly productive workers. T.P.M. method stipulates the separate analysis of the two factors. This indicator can be decomposed in the product of two factors, which are:
  - the net functioning coefficient, calculated as a ratio between the real functioning time (after subtracting the interruptions) and the rough functioning time;
  - the rhythm coefficient, which is calculated through the ratio between the real functioning time and the normal rhythm.

It results that:

The performance factor = The net functioning factor x The Rhythm factor

In order to calculate the net functioning factor, it must be known the total time of small interruptions, which is very hard to achieve.

Having in view this aspect, it is recommended to be calculated as a ratio between the real functioning time (easy to calculate as a ratio between the obtained production and the real rhythm of production) and the rough functioning time.

So, increasing the performance coefficient it involves the increasing on one side of the net functioning factor and on the other side the rhythm factor. These results can be obtained through a better organization of the production activity, through better equipments' surveillance, through their modernization correcting the small defects that imply, in one way or another, the equipment's slowing down or its ceasing to function. The quality of the raw materials also plays an important role in many circumstances, a better defining of the specifications, an active involvement of the supplying compartment in T.P.M. allowing these factors' growth.

- the quality coefficient. All the techniques of the method T.Q.C. (Total Quality Control) contribute at this factor's growth. A special importance must be also given to the start-up losses, having in view the fact that, due to the new trends of flexibility in manufacturing and small-scale production, even unique products, this loss can be important. Techniques like S.M.E.D. not only allow the diminishing of

the adjusgting timings and replacing the equipment, but also diminish the start-up rejects.

c. The five „S" of T.P.M.

The industrial equipment's and the industrial company's cleaning is one of the most spectacular aspects of T.P.M. method. The five "S" are five qualities, which act in the same way, producing a clean and well maintained company.

This five qualities are:

SEIRI: arrangement, eliminating the useless things;

SEITON : order, methods;

SEISSO: control, surveying;

SEIKETSU: cleaning;

SHITSUKE: discipline, moral education, respect towards the others.

The people who visited Japanese companies in which the TPM method TPM was applied, were surprised by the cleanliness and the well-kept aspect of everything. The technical and psychological advantages (which aren't less important than the technical ones) of these five categories of requirements are obvious and we won't focus on them (they are commented in detail in all the papers that exemplify this method), considering that it's more interesting to present the way the five S are put into effect.

It's common knowledge that many industrial companies clean a lot all the rooms and the equipment they possess. This fact can be considered to be good for the rooms, but not always for the equipments. What the maintenance staff that clean the equipments overlook is the fact that their interventions for cleaning the equipments can be dangerous (causing further failures), the cleaning procedures needing to be done according to well done cleaning plans.

It's admitted, for some years, that this cleaning of the industrial equipments must be done by the directly productive workers that use the respective equipment.

In order to do that, two issues must be solved:

- ✓ finding time for performing this operation;
- ✓ convincing the directly productive workers of this task 's necessity and obtaining their adhesion related to this issue.

The first issue can be solved only through including this necessary time for the equipment's cleaning in the production time, which will result in a diminishing of the producing time and implicitly of the production. The hope of compensating for this time waste through a better productivity is often hard to accept by the production managers, convincing the entire staff of the advantages of T.P.M. being in fact a stage in implementing this method.

Assuming that the staff was convinced, it can be launched an action of applying on levels (of cleaning and order) of the workshop and of the equipments. Experience proves that in the majority of cases this kind of action isn't a lasting one, T.P.M. suggesting a total action that associates this cleaning action to the

other actions. This is one of the method's strong points, but before applying it, it's interesting to get to know which are the reasons why the cleanliness of an equipment is hard to be maintained, in order to fight with this causes. We specify that, according to TPM method, when it comes to the equipment's cleanliness, we don't mean the occasional operations of cleaning the equipment, but it's an activity developed in a systematic way, based on a rigorously established plan, based on some cleanliness norms.

In order to implement the five "S", we must be aware at least of the following aspects:

- **Avoiding the most severe causes that provoke the dirtiness** (for example: the oil leakages). The way of obtaining a durable cleanliness isn't represented by eliminating the dirt, but avoiding it. This message of T.P.M. highlights the fact that this aspect must be had in mind from the early stage of designing the industrial equipments, an aspect characteristic for this method. It's obvious the fact that it's almost impossible to clean perfectly a workshop of mechanical processing in the circumstances in which the process of manufacturing the parts involves producing them through oil jets;
- All the cleaning tasks are tiresome, dirty and not too interesting.

It's something normal for the staff that performs this action to have the tendency not to perform it or to perform it in a superficial way. The only way to motivate them is to improve this task, to make the staff be interested in the cleaning tasks. It's exactly what T.P.M. method involves, transforming these cleaning tasks in operations of equipments' surveillance and maintenance.

- **Order and cleanliness involve a powerful will of the entire staff of a company.**

A worker, if he isn't appreciated otherwise than analyzing the short time production, will manifest a low interest in assuming some tasks that affects his production time. At the first opportunity (an urgent order, delay, etc.), he will neglect this task and it will become difficult to find a remedy, after the staff's neglect began to increase. Any neglect of the workers related to the surveillance and maintenance of the equipments transforms into an irrecoverable degradation of the equipments. The staff's auto- discipline has its own limits. We must admit that it's easier for a maintenance technician to verify the equipment's cleanliness and to criticize the worker from the respective equipment than to stay in his office to solve some technical issues or to take some administrative actions. But all the fight against the "small bosses", most of them absurd, have a single purpose: to decrease the discipline (shitsuke!), or, as it was emphasized before, auto-discipline has its own limits.

Related of the fact that this order and cleanliness involves a will of the entire staff, we want to highlight the fact that, even if nobody expects the maintenance manager, a department's manager or the general manager to perform the cleanliness of the industrial equipments, it's crucial for them to allocate a period of time in order to launch a campaign in this purpose. Their offices must

reflect exactly what the company must become and it's enough to see the managers' offices to judge the chances of success of a T.P.M. campaign!

- **The staff's training is an indispensable requisite to put this policy into effect**. Cleaning a device has some strict rules, which must be obeyed, in the contrary existing the risk of deteriorating it. In fact, the low training level about the auto-maintenance of the workers which are directly productive, including the "simple" cleaning, is one of the limits of putting T.P.M into effect;
- **Establishing the staff represents another requisite**. The relative frequent changes of the staff (changing the functions of the staff, the workshop, the work place) make even harder the implementation of this requisites of T.P.M.

d. Auto-maintenance

Auto-maintenance is the most innovative concept of T.M.P. The preventive maintenance is put into effect for a while in the majority of the Occidental companies, there are a lot of clean companies, which constantly seek to improve the availability of their equipments. All these elements aren't very innovative. Instead, auto-maintenance is a new concept, insofar as it involves a new work's organization, imposed by the automation of the production processes. It represents in fact the most difficult part of T.P.M. Auto-maintenance is best understood into the context of a automatic company, where the great majority of the directly productive workers don't participate directly in the production process.

A worker's assignment is to supervise more devices, having to:

- supervise the normal developing of the production process;
- charging the devices, if this things aren't automated;
- solve all the incidents: noises, unexpected interruptions followed by anomalies etc;
- solve the incidents signaled by the automatic control devices;
- detect all the functioning problems;
- replace the parts which wear off fast, etc.

Auto-maintenance will add to these tasks the cleaning, inspection and several tasks of preventive and corrective maintenance. The directly productive worker will have at his disposal a certain amount of time, in order to perform these operations: for example: 10 minutes a day, 30 minutes a week or an hour a month, or an hour each Monday morning, before the equipment is called into operation. These tasks must be performed in short time, having in mind that T.P.M.'s objective is the company's global increasing, but the effect of spending time for these operations have a reverse effect. Having in view this aspect, the permanent efforts will be focused to reduce the causes that generate the inappropriate condition of the equipment.

Many companies want to put into effect auto-maintenance, but the idea that they have to allocate the necessary time for the operations it involves doesn't serve

their purposes. All these tasks of cleaning, inspection and maintenance are written down on the standard employment card. In the same time, there can be some specialized staff's inspection cards, in order to ensure a connection between the production and maintenance and to stimulate the directly productive workers to perform the scheduled inspections. In this case, they have a stock of colored labels which they stick on the equipment in the place in which they notice a defect that they couldn't remedy.

When a failure occurs, the directly productive worker must be capable to establish a first diagnostic and to know how to remedy a certain number of failures' cases. In order to do that, he must be trained and to have available, in his working place, an inventory of necessary replacements and tools, to be able to remedy the failure in a short time, the failure couldn't be repaired for good through a preventive maintenance or through a device's improvement.

The method's advocates quote, in this respect, the case of Nissan robots, which had a pretty low average functioning time (L.A.F.T.), and for increasing the operating time, the solution was to reduce the average repair time (A.R.T.), to seconds, each standing being less than a minute, which involved a training of the production staff and putting to their disposal a stock of replacements at their working place.

In case in which a failure involves the intervention of the maintenance department, the production staff will assist the maintenance staff and, more than that, while they're expecting it, will prepare the eventual intervention: putting it out of pressure, demounting it (according to their training).

The auto-maintenance's putting into effect is the most delicate part of T.P.M. In order to solve these issues, J.I.P.M. suggests a very organized process, but which involves certain flexibility. The experience of the companies that implemented this method proved that the actions are pretty diversified, but a number of common actions are shared by all, which can be organized in a different way in time and space. This way, some companies started through a cleaning action inside some workshops or at the level of the whole company, others started instructing the staff, others through quality circles related to some critical equipments (or production subunits).

Is the TPM's introduction possible in an industrial company from Romania? The optimistic people will answer "YES", the pessimistic will answer "NO" and the people with a sense of humour will say: "Yes, if the company is a Japanese one!"

Reflecting upon this aspect, we can affirm that all indisputable successes of this "doctrine of industrial maintenance" have something in common: the presence of a personality, of a man who wants this transformation and who organizes it. Are there these kinds of personalities? In this case, the answer can be only a positive one, but this requisite isn't always enough. Each industrial company is different from another through its products, its market, its equipments, its people, the managers' psychology, the organizational culture, etc. Having in mind these aspects, we consider that, before making a decision, it must be performed a

previous analysis, to highlight the possibility of the company to involve itself into these kinds of wide scope actions. In our country it isn't enough that an industrial company's manager to be enthusiastic about this method, in order to involve the entire unit into this kind of wide scope actions. Let's not forget the fact that T.P.M. and any other action of improving the maintenance, must meet first of all that company's strategic objectives, the economic objectives being essential.

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