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FACTORS DETERMINING MAINTENANCE ACTIVITY DEVELOPMENT

Marius ROMOCEA
University of Oradea, mromocea@yahoo.com

ABSTRACT—Approaching the maintenance developments in the industrialized countries, it can be concluded that these are not limited to the development of content maintenance. This trend is manifested by taking into account the imperatives of maintenance in the stage of design and choosing new equipment, regarding their reliability and maintainability. This paper presents the factors that determine the evolution of the maintenance function of the industrial units, namely: technological factors, economic factors and human factors.

***Keywords*—**factors, evolution, maintenance, repair

I. INTRODUCTION

INDUSTRIAL maintenance represents a set of measures and actions that allow the prevention, the good maintenance or the reestablishment of an equipment in a foreseen state or capable to ensure a certain service in the conditions of minimizing the maintenance costs.

Considering these definitions, [1] the following conclusions can be drawn:

1) Here "to restore" means "to correct", a meaning imposed by the change of the initial value of the device's functioning parameters;

2) Appointed state or determined service involves the predetermination of the functioning parameters or the service to reach, with the quantification of the characteristic levels;

3) To minimize the maintenance costs reflects the business' economical aspect;

4) Prevention – a set of operations used in order to avoid the device's unavailability state;

5) The good keeping in a given state consists in the application of some methods, procedures, proceedings and actions which contribute to the progress of maintenance in the four main directions .

The maintenance function evolved within industrial units, being subject to a continuous refining process, considering the compromise which needed to be performed between needs and exigencies, from the technical, economical and human point of view.

II. FACTORS DETERMINING MAINTENANCE ACTIVITY DEVELOPMENT

Factors determining the approach to the development of maintenance in industrial enterprises are:

1) Technological factors;

2) Economic factors;

3) Factors related to human behavior.

1) *Technological factors*. Ensuring a dynamic development of industrial enterprises required a basic requirement introducing technical progress in all areas of their activity. Increasing the competitiveness of industrial enterprises could be achieved only by scientific research and technological development. The rise of the technical level and quality of work of industrial enterprises was achieved by introducing new technologies, based on recent developments in computer science and microelectronics. Electronics and informatics broke into workshops and in production facilities: the machines are equipped with numerical control, industrial robots have been expanded, flexible manufacturing workshops are developing and automation is present everywhere. There are more numerous the enterprises in which the assembly line is programmed by a computer using software archive of the manufacturing sector, thus achieving aided manufacturing.

Thanks to advances in the technology of components, the electromechanical subassemblies require fewer interventions for maintenance and troubleshooting, due to the increased reliability of electronic circuits. However, such equipment failures can be prevented by new techniques for fault detection (sonic analysis, vibration analysis etc.).

Modern electronics allow the use of new equipment surveillance technology and application of conditioned maintenance, in which:

a) should be established and strictly complying with the inspection program to verify the compliance with operational norms, the control of the technical condition of equipment, which are becoming increasingly complex;

b) diagnostic operations on the technical condition of the equipment must be performed as accurately as possible.

2) *Economic factors*. The importance of maintenance activity is determined by the major influences that it have on the most important economic indicators characterizing an industrial activity, regarding its profitability. The amount of expenses needed for the maintenance and repair of the equipment is influenced by two factors: the number of repairs performed and the volume of the prophylactic maintenance during operation. To obtain reducing overall equipment maintenance and repair costs, we have to act on the two factors.

To reduce the cost of maintenance and repair [1] can be used the following ways:

a) Centralization and specialization of repairs;

b) Improvement of methods and forms of repairs, use of advanced technologies;

c) The scheduling of maintenance and repair in order to reduce the residence time of the machine;

d) Providing the repair of spare parts through a centralized manufacturing, which reduce their cost;

e) Determining the optimal number of operators for reducing maintenance labor;

f) Reducing the consumption of materials used for repairs;

g) Improving the design of machines to make easy and quick the detection of faults, their removal, and the operational control of the technical condition

Reducing maintenance costs and repairs require the liquidation of the poor repair execution because lower quality leads to increased maintenance. Lower quality control repairs may be due to inadequate technical control and the poor provision of the repair unit with machinery and jigs and tools necessary for the execution of some quality repairs.

A factor, by which the economic efficiency is growing, is the emergence and development of maintenance companies, capable of performing many tasks instead of the maintenance of the traditional departments of industrial units.

With the development of services, the maintenance is oriented towards services. This ensures two key goals:

i) the beneficiary (the user of the maintenance process) does not need to keep in "stand by" the teams of specialists, so as a consequence there is a reduction of the maintenance costs , while increasing the level of quality of maintenance processes, which are performed by specialists.

ii) there can be constituted specialized teams to perform maintenance operations which can act both in their own enterprise and other enterprises.

Performing maintenance work by specialized enterprises is one of the fundamental changes that are recorded in industrial maintenance work. They are suppler, flexible, able to adapt to new requirements, they can provide periodic specialist benefits for which there is no justification, in economic terms, maintaining the traditional compartments of maintenance with new maintenance facilities.

3) *Behavioral factors*

An important factor in ensuring the efficiency of maintenance and repair is the maintenance staff and the exploiting staff and also the nature of the relationship between them. In the field of human relations, the organization of maintenance work involves preparing forecasts of labor requirements by level of qualification, selection of resources, clearly defining workstations and accurate evaluation of the results of the activity, the formation of a training program, the application of participatory methods, the stimulation of voluntary employment of production operators to maintenance activities, improved working conditions etc. .

It appears that all three factors of influence are found or will be found in all industrial units [1] and therefore maintenance function will acquire a new dimension characterized by:

1) *A transfer of tasks to production and specialized manufacturing enterprises***.** Optimal maintenance policy adopted in a company seeks to establish all the measures to be taken to ensure the functioning of the equipment fleet of equipment in optimal condition, based on established technical and economic criteria, among which the most important are the operational safety and low maintenance and repair costs.

These objectives can be achieved by transferring to the production staff of some maintenance activities of level I, including: cleaning the equipment and work area, keeping a tidy workplace, lubrication, adjustment of operating parameters, checking fluid levels, the clamping voltage of various components, the extent of transmission belts, warning of failures which need to be addressed to specialists etc. These activities, which traditionally were in the charge of maintenance operators, not requiring special skill and specific training, which is why, under the proper motivation, can be transferred to production operators.

Complex maintenance work will be carried out by specialized companies that have jigs and tools, advanced controlling and technological equipment, and specialized personnel. The specialized repair units concentrated on models or types of machinery are performing any kind of repair, but only for certain types of equipment, such as: lathes, drilling machines etc. The staff in the specialized unit knows better the repair machine, the specific characteristics of repair, causes of damage and is able to liquidate faults in short time.

Adopting this policy of maintenance will lead to gradually lower the personnel performing the maintenance work, within the manufacturing enterprises

2) *Allocation of new tasks to the maintenance department.*

The cooperation with specialized units and the transfer of some maintenance activities to the production staff lead to a limited reduction of the maintenance staff, but not to the abolition of this section.

The tasks of the maintenance [2]-[4] department will be oriented on the following main areas:

a) Formation of joint teams consisting of production and maintenance personnel responsible for the provision and consultancy in difficult situations;

b) Selection of specialized units for cooperation under the economic and quality criteria, contracting interventions;

c) Collecting, structuring and valuing the information on equipment behavior in service in order to improve maintenance programs, reducing the consumption of materials, spare parts inventory optimization, optimal timing of equipment replacement .

These activities can be carried out by a maintenance compartment,[5]-[8] with diminished capacity, but with a high level of professional competence, consisting of:

i) experts: staff with polyvalent training consisting of engineers and technicians able to contribute to the effort of the department, to provide special technical assistance to the production teams and to evaluate the quality of work executed by third parties;

ii) methods agents: whose functions are: to establish and follow maintenance programs, preparation of maintenance specifications, analysis of data from the equipment history etc. .

Industrial enterprises, as any trader agent, through management teams, are focused on ensuring profitability through: maintaining the production potential, efficient operation of technical infrastructure, economic growth security of persons and property, protection of the environment etc.

Achieving this essential goal can be assured only through good organization of maintenance activities, whose management includes:

1) The overall objectives of maintenance

2) Restrictions to be respected and in particular, rules relating to security

3) Variables of action available to achieve the objectives, methods and means of maintenance;

4) Assessment and control variables

The overall objectives of maintenance depend on many partners involved in the conception and design stage of the equipment, their use and maintenance.

III. Case Study

The object of the study is to evaluate the performance of human resources in the maintenance department and the analysis of the performed activity.

In terms of methodology, the study is based on the questionnaire stood in Table I, which was distributed to 21 companies with different specializations. To interpret the results of the analysis concerning the management of maintenance, it was used the "method of points". The giving of the points was made in the following way:

TABLE I
THE MANAGEMENT OF THE MAINTENANCE PERSONNEL

Crt. No.	The management of the maintenance personnel	No	Rather no	Rather yes	Yes
1	Is there a positive working climate?	0	3	12	33
2	Maintenance workers are distributed in accordance with professional competence?	0	8	6	3
3	It is made a current analysis of the problems of maintenance?	0	2	14	33
4	The staff that performs work maintenance is enough?	0	3	18	21
5	Do you consider that maintenance personnel have satisfactory technical competence?	0	2	8	6
6	In the current activity, do you consider that the maintenance personnel have the necessary initiative?	0	10	2	6
7	It is provided a regular improvement of the workers regarding the technical maintenance?	0	3	16	30
8	It is provided a training of the foremen, technicians and engineers from the maintenance department regarding the news in the field?	0	5	14	21
9	Is there performed a training on protection and safety on a regular basis?	0	1	22	27
10	The training of the maintenance personnel is the responsibility of the maintenance department?	0	5	14	27
11	The qualifications and ability of the maintenance personnel are rigorously pursued?	0	7	16	15
12	There is a non-significant planned time usage of the maintenance workers due to delays, unexcused absences?	0	6	14	18

1) for the answer "NO" - 0 points,

2) for the answer "RATHER NO" - 1 point,

3) for the answer "RATHER YES" - 2 points,

4) for the answer "YES" - 3 points

The differentiation of scores is achieved depending on the complexity of the works, after the qualification level of the maintenance operators and depending on the work duration, as set out in the Standard [9].

After processing the received responses, it resulted in a percentage of the management of the maintenance personnel within the range 30% - 65%. The percentage distribution of the maintenance personnel's management is systematically presented in Table II.

TABLE II
THE PERCENTAGE DISTRIBUTION OF THE MAINTENANCE PERSONNEL'S MANAGEMENT

The percentage distribution of the maintenance personnel's management	≤ 35%	35,01 -40%	40,01 – 45%	45,01-50%	50,01-55%	55,01-60%	> 60%
Number of enterprises	2	1	3	6	5	2	2

It follows that 6 companies (28.57%) of those surveyed have the maintenance personnel's management rate below 45%, 11 companies (52.38 %) were having the percentage of between 45-55% and only 4 companies (19.04 %) have a higher percentage of 55 % , which shows that in this area there are many weak points.

Analyzing the responses to the questionnaire, is noted that:

1) If for the questions " Is the staff for the maintenance works enough?" And "Is there performed a training on protection and safety on a regular basis?". The responses indicated a rate of 76.19% and 95,23% for the variants "Yes" or "Rather yes", but the situation changes in other aspects of management of the maintenance personnel.

2) Thus, for the questions "The maintenance works are distributed to the workers according to their professional competence?" And "Do you think that the staff has a satisfactory technical competence?, issues concerning the quality of the work carried out only by 19,04% of the businesses surveyed, which responded with the variants "Yes" or "Rather yes" to the first question, respectively 28.57% to the second question.

3) *With regard to the maintenance personnel's initiative, we encounter a similar situation. Thus, for the question "In the current activity, do you consider that the maintenance staff has the necessary initiative?, only 3 companies (14.28%) indicated the variants "Yes" or "Rather yes".*

Following the responses received can, we can draw the following: it is not performed a rigorous tracking of the maintenance personnel's qualification and skills, it is not ensured a regular training of the workers, foremen, technicians and engineers, in their field of specialty. In the questions regarding the aspects of the questionnaire, the majority of companies surveyed answered with NO or RATHER NOT variants.

Regarding other aspects of the maintenance personnel's management (work climate, relations of the maintenance staff with the production), we cannot draw a general conclusion, there are different nuances in each company regarding the respective issues, and the conclusions vary from one enterprise to other.

IV. CONCLUSIONS

The overall objectives of maintenance depend on many partners involved in the conception and design stage of the equipment, their use and maintenance.

In the literature of specialty are highlighted five categories of measures to prevent accidental breakage of equipment, measures involving the above mentioned factors and on which depend the maintenance objectives, namely: compliance with basic maintenance tasks, the conditions of use, restarting after failure, correction of conception and design defects and human error prevention.

REFERENCES

[1]V. Deac *Management of the industrial maintenance(Managementul mentenanței industriale)*, Eficient Publishing House, Bucharest, 2000, pp. 8-14.

[2] A. Boroiu, M. A. Titu, *Management of reliability and maintenance of systems(Managementul fiabilității și mentenabilității sistemelor)*, Agir Publishing House, Bucharest, 2011, pp. 248-250.

[3] I. Ceausu, , N.G., Potirca, *Organising and leading the activities of maintenance and repairs(Organizarea și conducerea activităților de întreținere și reparații)*, Technical Publishing House, Bucharest, 1980, pp. 233-235.

[4]I.Vasile,G.Moldovanu,*Repair technology andreliability(Tehnologia reparării și fiabilitatea)*,, Didactical and Pedagogical Publishing House, Bucharest, 1982, pp. 610-669.

[5] V. Narayan, , *Effective Maintenance Management. Risk and Reliability Strategies for Optimizing*, Performance. Industrial Press, New York, 2004 , pp. 92-97.

[6] D. Palmer, *Maintenance Planning and Scheduling*, Handbook, McGraw-Hill, 2006, pp. 167-168.

[7] I. Verzea. M. Gabriel, D. Richet, *Management of the maintenance activity(Managementul activitătii de mentenantă)*, Polirom Publishing House, Iasi, 1999, pp. 131-144.

[8] Traian Mutiu, Le management d'une service de maintenance(Managementul serviciului de mentenantă) 9 th International Symposion in Management , Timisoara, 2007

[9] Unified Standard on economy of time for the maintenance and repairing of the cutting machine-tools NT-84(Normativ unificat pe economie de timpi pentru întretinerea si repararea masinilor unelte aschietoare NT-84).