CONTRIBUTION TO THE PERFORMANCES IMPROVEMENT OF A MACHINE BORING MILL OPERATION

Rachid CHAÏB[*], Ion VERZEA[**], Mohamed BENIDIR[*]

[*] Mechanical engineering Department, Mentouri University, Constantine, Algeria

[**] Technical University Gh. Asachi Iasi, Romania

Abstract. The performances requested from the production equipment and the associated economic issues bring the originators and the users of production means to be interested in the failures of the materials, with their consequences and the organizations which result from it. Among the tools used for the evaluation as of these performances, one finds the history file. Today, its exploitation became a technique of rigorous analysis consisting in exploiting the experience feedback. It is an approach of maintenance aiming providing the function and at maximizing the availability of the credit at the best possible cost, while proceeding to the good maintenance and the good moment. This approach enables us to know, to evaluate, envisage, measure and control the failures, to even accompany the operating condition of the machines. These concerns are expressed and treated through the concepts and the methods of RMAS (reliability, maintainability/maintenance, availability, safety) [1]. These files contain the failures types and their chronologies as well as the maintenance actions recorded in the form of the costs of maintenance, from duration and nature of failure. By exploiting these types of files, one can evaluate the operation parameters and the health condition of the machines, thus managed to apprehend the plans of maintenance to the needs for the production in real-time and for each machine, objective of this work. For better characterizing the breakdown and well evaluating its consequences, a coefficient called proportionality factor of the breakdowns "*Fp*" has been introduced. This coefficient enables us to determine the relationship between the breakdown and the duration lost to cure this breakdown. In this work one is interested in a series of boring mill.

Keywords: proportionality factor of the breakdowns, Ishikawa diagram, availability, maintainability, history file, failure

1. Introduction

With today's industrial competition, the companies are increasingly sensitive to the importance and the interest of the control of the costs induced by the accidental failures of the systems of production. From now on, maintenance became one of the strategic functions of the company. It constitutes a factor of competitiveness and decisive perennially for the company aiming at answering the industrial requirements to knowing to improve the reliability of the equipment and quality of its products while reducing the costs [2]. The companies which survive and prosper are those which knew with each time to evaluate and reposition their maintenance to adapt permanently to the new conditions imposed by the production materials age and the competition of the market. In order to maintain this opportunity and to set up a powerful management system of maintenance, the Algerian company is brought to assess its existing system compared to what it would owe the being on the one hand and to make the strategic decisions priority of maintenance which is essential on the other hand, objective of this work.

The audit of maintenance, essential stage of any progress of control of the function maintenance, even control and removal of the breakdowns, will allow the company by using the experience feedback, to diagnose its existing system of maintenance, to highlight its forces and its weaknesses while determining in a clear way and specifies the priorities to be undertaken and the actions to be carried out. Among these actions, one can quote:

- The enrichment and the refining of right and relevant information necessary for the control of the operation parameters;
- Improvement of the equipment availability and safety;
- Control of the spare parts management;
- Priorities in work to be carried out in the company;
- To contribute to ensure the production envisaged,
- To contribute to maintain the level of quality of the product manufactured,
- To contribute to the respect of the deadlines,
- To respect the human objectives: work conditions and of safety,
- To preserve the environment.

The objective of this work allows, by re-using the previous experiments, to improve the resolution of the current problems, to detect the most critical components, to determine the set of priorities of the maintenance actions to carry out and to direct the procedure of exploitation towards the links more penalizing in the company [3], to even define the recommendations necessary to the maintenance service, to draw up the suitable maintenance plans [4] and thus to engage in a process of continuous improvement.

2. Presentation of the machine

Among the machines which take part in the machine-work, the boring mill, figure 1, constituted of the following elements, table 1. This machine is essential in the workshop of machining shovels and cranes factory (CPG), Ain Smara, Constantine. It makes it possible to bore, to ream, mill and even sometimes to filter. Its dysfunction makes it possible to cause rejects, even to increase the cost price and to delay the production.

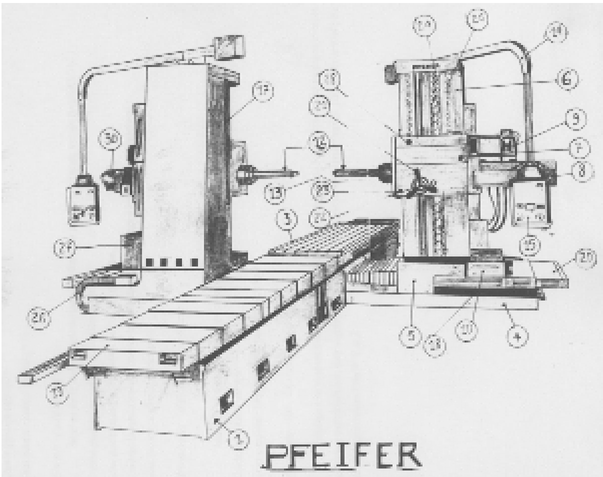

Figure1. The diagram of the machine boring mill (PFEIFER)

To ream: it is to carry out a boring or to recess then to give it a given minimal diameter; it is also to widen a diameter.

To mill: it is one of the fundamental processes of mechanical machining it allows the completion of the very diverse work since a simple raising until the cutting of the gears.

Another operation consists in bevelling the edges of a hole in drilling and removed by trimming. The parts of bored pig iron and cast iron and forging mill are worked with the borer-strawberry dish to obtain the heads of bolts. It is a machine of a major importance for the company.

3. The work methodology

The method used in this work is based on the determination of the various operation parameters,

Table 1. Nomenclature of the boring mill PFEIFER

N° of part	Designation	N° of part	Designation
01	Bed 1	**16**	Indication of position canters X
02	Bed 2	**17**	Indication of position centers Y
03	Count of tightening	**18**	Indication of position centers W
04	Side bench of the machine	**19**	Lids out of steel centers X
05	Saddle and toolhead	**20**	Lids out of steel centers W
06	Lying of the machine	**21**	Crank in central cross
07	headstock	**22**	Lever of selection ABC
08	Arrow	**23**	Pushbutton for the automatic tightening of the tool
09	Principal drive with dc current	**24**	Lids with spring in spiral
10	Drive of the advance of amounts with DC current	**25**	Chain of counter weight
11	Drive of the advance table with dc current	**26**	Flexible device of supply energy
12	Stitch boring	**27**	Protection (hydraulic tightening and centralized greasing)
13	Stitch milling	**28**	control of oil for greasing by circulation of the headstock
14	Directional	**29**	Cupboard of the orders of the amounts
15	Suspended desk	**30**	Motor of the tool tightening

namely reliability, maintainability and availability while all based on the study of the history file, to even know to decipher the needs and to translate them into research project [5]. Consequently, the exploitation of the feedback experience constitutes a robust support of the function method, brain of a maintenance service [6]. This chronology enables in determining the health condition of the machine. What enables in targeting and thus determine the priority actions of maintenance. Then using the Ishikawa diagram finding the solutions suitable and finally to draw up a plan of maintenance for the machine. For better characterizing the breakdown and well evaluating its consequences, a coefficient called proportionality factor of the breakdowns «*Fp*» has been introduced [6]. This coefficient enables in determining the relationship between the breakdown and the duration lost by the latter.

$$Fp = \text{Lost hours/breakdowns number} \quad (1)$$

This study will have as favours to bring the production and maintenance personnel on the one hand and to increase the probability of quickly covering the true cause with a faulty operation on the other hand [7]. The study is made for a period of six years from the year 2004 until the 2009.

4. Study of the times evolution and the number of breakdowns

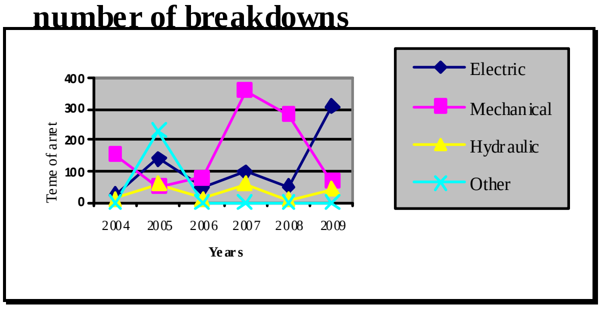

Figure 2a. Evolution of the downtime of machine

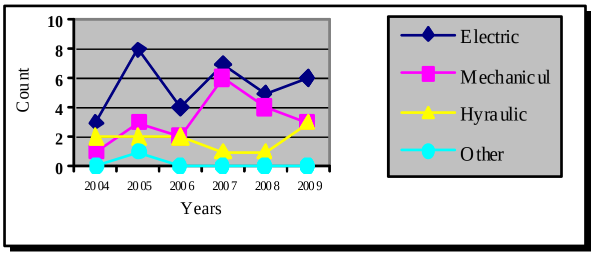

Figure 2b. Evolution of the breakdowns number of machine

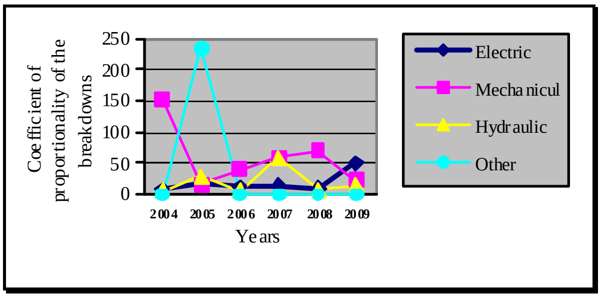

Figure 2c. Evolution of the breakdowns proportionality factor of machine

Report: By studying the breakdowns chronology and their immobilization durations, it can be noted that the mechanical breakdown is most dominant and longest to repair. Thus to prepare the spare part of first need and to determine the maintenance priority actions to carry out, a study of the reliability parameters is essential. The latter makes it possible to the persons in charge of maintenance to have, in the long run, a comprehensive view of their production process and industrial plants, even their operation parameters, namely reliability, maintainability and availability. Thus, to predict its evolution in time and implement processes for early decisions to ensure the company performance. This meets the needs for production in real-time, primary goal of the maintenance service. Thus, to apprehend the maintenance priority actions which is essential and to release a precursory plan of maintenance.

5. Study of the reliability parameters during the years 2004-2009

The industrial persons in charge must therefore have a comprehensive view, in the long run, of their production process. This results in the need for restructuring information, on the equipment operation, to predict its evolution over time and implement processes to ensure early decisions, at the desired moment, performances of the machine operation.

The reliability indicators constitute privileged representations for decision making by anticipation. The study of their evolution in time makes it possible at the same time to know the actual position of the equipment, but also to predict, to a certain extent, future situations. From these indicators one can judge the equipment state and is what it is profitable in a manufacturing process or not and that by a regular follow-up recorded in history files: a technical dossier of the machine. This latter, after a given period, allows the decision makers maintenance staff / producers to judge its effectiveness.

5.1. Calculation base

Calculate are based on the indicators of the reliability, figure 3.

$$\lambda\,(\text{failure rate}) = \frac{1}{MTBF} \quad (2)$$

$$MTTR = \frac{\sum TTR}{\text{number of breakdown}} \quad (3)$$

$$\mu\,(\text{rate of repair}) = \frac{1}{MTTR} \quad (4)$$

$$\text{Operational availability ratio} = \frac{\text{potential} - \text{downtime}}{\text{potential}} \quad (5)$$

$$\text{Intrinsic availability ratio} = \frac{MTBF}{MTTR + MTBF} \quad (6)$$

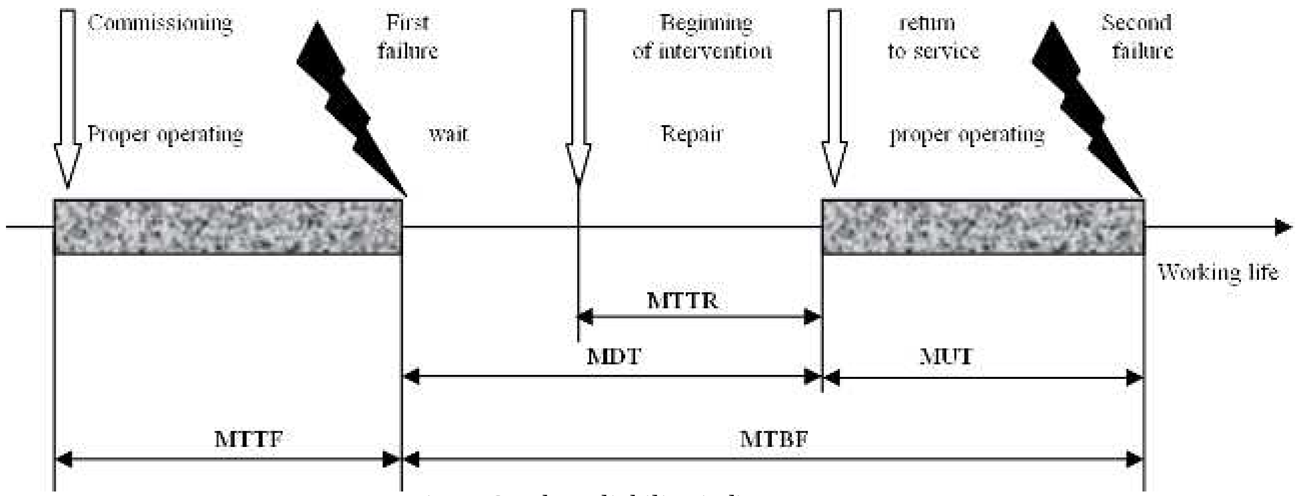

Figure 3. The reliability indicators

5.2. Evolution of the reliability parameters

Evolutions of the reliability parameters, the failure rate, the machines maintainability and availability are respectively represented on figures 4, 5 and 6.

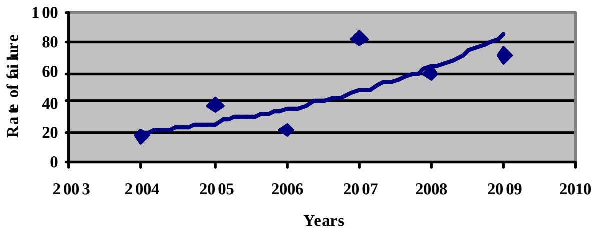

Figure 4. Evolution of failure rate of the machine

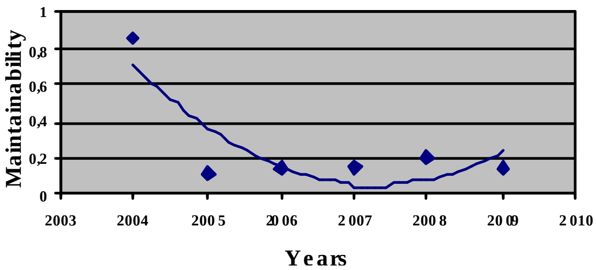

Figure 5. Evolution of the maintainability of the machine

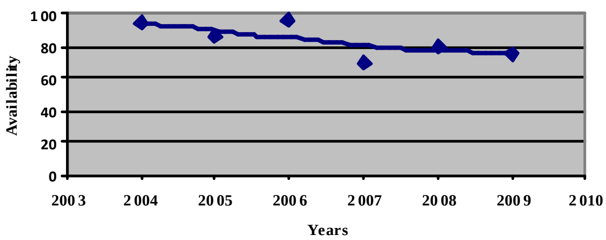

Figure 6. Evolution of the availability of the machine

Comments: By interpreting the reliability curves, of maintainability and availability, it can be noted that the machine health condition is in degradation, period of old age with a failure rate equal to 0,8, asking a special attention. Consequently, we pass to the Ishikawa diagram to release the causes of breakdowns and thus to propose solutions with the maintenance service.

6. Determination of the breakdowns causes

The maintenance in operational condition of the industrial systems with lower costs became a critical factor as for the performance of the companies and the traditional concepts of preventive and corrective maintenance are supplemented little by little by a taking into account more reactive and proactive of the failures. Since the critical failures were identified, it is a question of determining their causes. For that the Ishikawa diagram (cause-effect) is of a great utility. It consists in seeking the causes in the 5 M (Man power, Matter, Methods, Means and Medium). The 5M approach is based on the knowledge of the true state of the material credits; the investigation into the probable causes of failures and the catch of proactive actions aiming at eliminating the causes from failure. The exercise starts with an inventory of the problems by using the diagram of ISHIKAWA. The latter makes it possible nevertheless to pose the problem well and to seek the suppression of the main cause while thinking of observing the basic conditions and standardization before wanting to improve [8]. The causes of breakdowns of the machines are of two types, structural components of maintenance (Man power, machine and matter) and elements of maintenance insurance (Medium and method), respectively represented on figure 7.

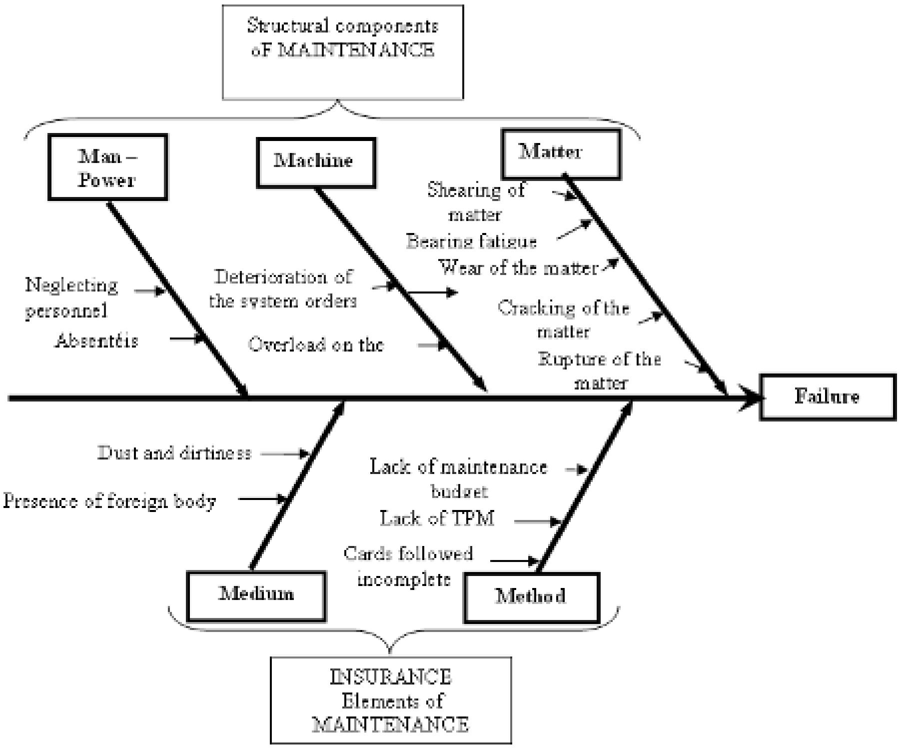

Figure 7. Diagram cause-effect machine

7. Preventive actions and corrective to be taken

After having made this study and to determine, using the Pareto diagram, by order of importance the breakdowns we recommend to the service maintenance the following actions to be undertaken, table 2.

8. Conclusion

This work has allowed to:

- To determine, by using the machines history file, the parameters of operation of the boring mill machine in the machining section. What allows the service maintenance to work out a plan of maintenance meeting the needs for the production in real-time, being given that the last years research shows that the probability of a component failure is not as related on the age or the operation life as it was believed, but much more with nature of the component and the conditions under which it operates [9].
- To highlight by the Ishikawa diagram the causes of the dysfunctions, to even determine the remedies;
- To determine the priorities of maintenance action to undertake in the emergency order and thus to engage in a process of continuous improvement.

This information enables in drawing a cartography of the experienced anomalies, and thus to direct the maintenance service with the priority actions to carry out in the company to the needs for the production in real-time.

9. Recommendations

1. The use of the organization tools for the services management of maintenance in our companies, in particular historical cards of the various anomalies which have occurred in the entity (Breakdowns, accidents, incidents, carried out actions, etc.).

2. The strict application of the 5 S, simple and concrete method, to reduce considerably problems of occupational hygiene posed within our companies. This application aims at of the economic issues and permanent progress. It is an important tool of continuous improvement imported from Japan, allowing optimizing the organization and the effectiveness of a work station.

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Table 2. Actions to be undertaken for the machine

Zone	N°	Causes of the breakdowns	Solutions
ZONE "A"	1	Deterioration of electric drive system	- To avoid overheating and vibrations - To carry out a general revision of the electric system **each week**: ▪ To check the electrical state of the contacts; ▪ To check the sets of bearings of the engines; ▪ To check the protection of the transformers; ▪ To check the state of the brushes; ▪ To check wax; ▪ To check the fuses; ▪ Thermal relays; - To make function the various safety measures - To control and change the electric elements, so in critical condition **each week**
	2	Matter cracking	- To check the degree of cracking of the flexible devices **each week** and to change the flexible device in a dangerous state
	3	Neglecting personnel	- To make sensitizing and training - To control and motivate the workmen - To control the oil level and to make draining, filling and the cleaning of the filters systematically
ZONE "B"	4	Rupture	- To check the state of the matter of the fragile parts **each month** ▪ Fingers of tightening. ▪ Wire of the pressure controllers ▪ the state of clutch ▪ Etc….. - Greasing of the clutch.
	5	Dust and dirtiness	- To announce the dirty machines - To make the **daily** cleaning of the machines - To make cleaning **after each operation** - Cleaning of the medium **systematically** **- The strict application of the 5S**
	6	Shearing of the matter	- To control the affected state of the parts shearing by the efforts **each month** ▪ Pins ▪ Etc.…. - And to change the parts which are in a dangerous state **each month**
	7	Bearing fatigue	- To control the fatigue of the bearings **each month** - To control the plays of the bearings. **each month** - To check the level of the ways of bearing **each month**
ZONE "C"	8	Overload on the machine	To observe the conditions of intrinsic reliability of its equipment, i.e. those for which they were conceived or adapted
	9	Matter wear	- To check the wear of the joints - To control the plates of wear
	10	The introduction of a strange body (water)	- To clean the medium of dirtiness and parts thrown everywhere - To clean the slides - to motivate the personnel on the presenteeism
	11	Lack of organi-zation and of monitoring	- To carry out the dimensional checks necessary - obligation of follow-up the plan of maintenance

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