Modelisation of the maintenance-production couple by a graph of scheduling

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Abstract— The problem of scheduling, both maintenance and production, was a work of many articles. The algorithms genetics, ant, and multi-agent, gives solutions approaches with this problem. Modelled the problem in a simple and concrete way, pushed us to propose a graph connecting maintenance and the production, with weightings realities. To develop quality, and the validity of the model, a statistical tool is used for the calculation of the factors of variances, in order to improve the output of the production.

Keywords- Maintenance, Production, Scheduling, Graph

I. INTRODUCTION

Maintenance is the whole of the technical measures, administrative actions and of management during the cycle of life of a good, intended to maintain it or to restore it in a state in which it can achieve its necessary function. It decides on the level direction service maintenance, it owes of course being included/understood and accepted by the service of production. The various works carried out on the problem of scheduling united between maintenance and the production, on the various forms of this problem, proposes resolutions by exact methods or approaches , with algorithms of ant, genetics, [1], [2], sequential [3] or multi agent [4]. These resolutions are theoretical and inapplicable on the ground. Moreover it treats only one form of maintenance, with a type of production. For example the preventive maintenance and the job shop, with ideal conditions, been essential to pose the problems and its resolution in an adequate way.

This work differs much from the studies carried out before,for example the analytical representations in the form of mathematical program. The objective is modeling the problem In the form of graph with proportions of the interventions by real weightings. Collect histories machines of a platform.

To validate this model, the statistical methods are called, in order to improve the explanatory variance of the factors (type of maintenance), and made reliable the model to ensure better a production.

II. VARIOUS TYPES OF MAINTENANCE

By definition maintenance [5], [6], is the maintenance of a technical material in operating condition, it is the whole of means of maintenance and their implementation. According to AFNOR: maintenance it is the whole of the actions making it possible to maintain or restore in a specified state or able to ensure a given service. The types of maintenance are Corrective Maintenance, Preventive Maintenance, and ameliorative Maintenance.

A. Corrective maintenance:

According to the Standard X 60-010, corrective maintenance is defined as being the " Maintenance carried out after failure ", it is the type of maintenance nearest in its spirit to traditional maintenance, or one intervenes on the

system after the appearance of a failure. But with approaches more structured and obeying to quasi-universal standards. For this type of maintenance we distinguish two aspects

- Palliative maintenance MCp: relate to the operations of breakdown service, and/or the simple breakdown service, its objectifies it is to remove the effects of failure in order to take again operations.
- Curative maintenance MCc: include repairs, to bring back the system to its level of performance. It can be considered as the second phase of a breakdown service.

B. Preventive maintenance:

According to standard AFNOR X 60-010 " maintenance carried out in the intention to reduce the probability of failure of a good or the degradation of a rendered service ". Its objectives are wide-ranging, one can quote three of them: The reliability of the material, Surety of operation, and To reduce the interventions of corrective maintenance. Three types are distinguished.

- Preventive Maintenance Systematic MPs

  According to standard AFNOR X 60-010 it is " preventive Maintenance carried out according to a bill book established according to time or the number of units of use " it Concerne mainly the materials whose behavior is perfectly known and intervenes within the framework of lawful regulations.

- Conditional Preventive Maintenance MPc

  The definition of AFNOR X 60-010 it is the " preventive Maintenance subordinated to the crossing of a significant threshold predetermined of the state of degradation of the good " MPc, a priori, applicable dice at the time the evolution of a degradation is detectable. It does not require a good knowledge of the behavior of the material.

- Estimated Preventive Maintenance MPp,

  Definition AFNOR (standard X 60-010): " preventive Maintenance subordinated to the analysis of the supervised evolution of significant parameters of the degradation of the good, allowing to delay and plan the interventions "

  Contrary to MPc, and MPs, the principle of MPp is to follow the evolution of the drifts of state in order to intervene with the more meadows before the damage.

  Generally the tree structure of the various types of maintenance and the operations accompanying, this is summarized on figure 1.

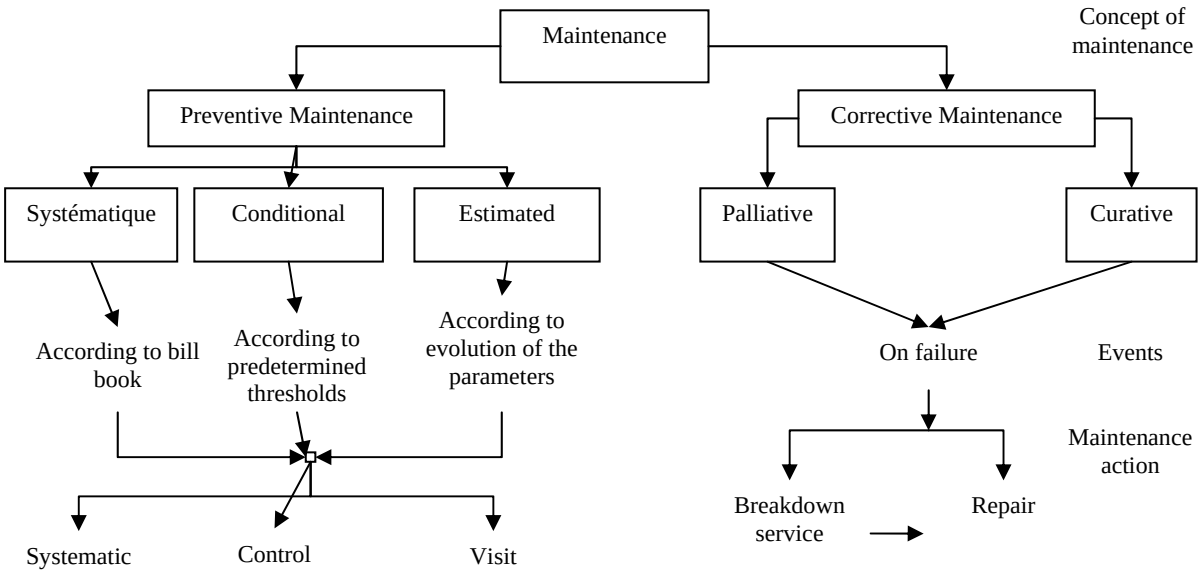

Figure 1

This figure includes all the existing relations between the various types of maintenance. It breaks up into three phases, the concept maintenances, the events, and the Maintenance actions. This decomposition between corrective and preventive maintenance is dregs by arcs enter each phase of the figure.

III. VARIOUS TYPES OF PRODUCTION

One distinguishes three great types of production, knowing that one can find many types intermediate [7], [8]:

- production continuous;
- production into discontinuous;
- production by project.

A. Production uninterrupted or discontinuous

A Production uninterrupted is retained when one treats significant quantities of a product or a family of products. The establishment is carried out in line of production, which returns the flow of the linear product in the direction, if there is stop in a stage, there will be stop of all the production they are chains continuous. It is said that one is one presence of a workshop with flow which the Anglo-Saxons name flow shop.

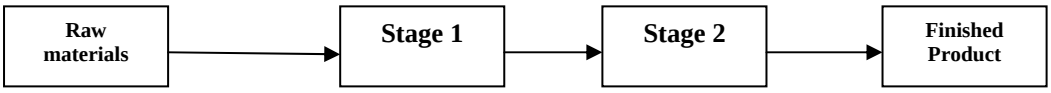

Figure 2

In this type of production, the machines or the installations are dedicated to the product to produce, which, in general, does not allow a great flexibility. Moreover, in order to avoid creating bottlenecks and to flux the flow of the products, the balancing of the production of each machine must be neat.

Petrochemical industries, and the cement factories, are of the typical examples of this type of companies. In general, this type of production is accompanied by a thorough automation of the production processs, as well as handling systems. This automation is made necessary by the need to obtain costs of low cost, a level of quality high and stable, to have only very little work-in-progress and to obtain a fast circulation of the products. It constrained to carry out a preventive maintenance of the machines under penalty of risking a total stop of the workshop.

B. Production into discontinuous

A production into discontinuous is retained when one treats relatively small quantities of many varied products, realized starting from a machine stock to general vocation. The establishment is carried out by functional workshops which gather the machines according to the spot that they carry out the flow of the products is a function of the sequence of the spots that the Anglo-Saxons name job-shop.

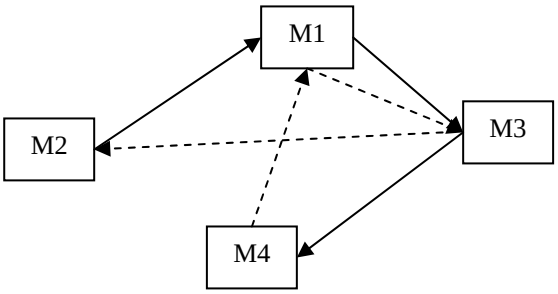

Figure 3

The positioning of the machines does not follow a sequence well defined but the chains of production can begin from different placement, for example in the workshops of the turners a part can be milled, keyed, bored, or clavète, milled and perse according to the availability of each machine i.e. in general can about it go the machine M1, m3, m2, and different M4 part can take another route for example M4, M2, M1, and M3.

In this type of production, the machines or the installations are able to carry out a great number of work; they are not specific to a product, which gives a great flexibility. But it is very difficult to balance the spots in a production into discontinuous, which generates on the other hand levels of stocks, high work-in-progress.

Maintenance for the production into discontinuous admits a good luck, for its realization. If the preventive maintenance is supposed too expensive for the industrial ones, here the corrective turn-around times are the best. The cause that the manufacturing units into discontinuous adopts much the corrective one. Because the stop of a machine does not influence the production in general contrary has the production uninterrupted.

C. Production by project

In the case of the production by project produces it 's single. Examples are the organization of the Olympic Games or the construction of a barrage. The production process is single there and does not renew itself. What requires (obligatory) a preventive maintenance vigilance, a very high monitoring . The principle of a production per project thus consists in connecting all the operations leading to the result of the project, by minimizing the idle periods, between the ways earliest, latest and the critical path. In order to deliver the product with a minimal time or at the agreed time.

IV. METHODS AND RESULTS

Maintenance, and the production are among the pillars of an industry, worked jointly request a well structured organization, in order to avoid the industrial disputes. Several work of scheduling is completed to solve this type of problems, whose majority relate to part of maintenance with a type of production. Our objective is to found the possible bonds and cases between the various types of maintenance, and production in the form of graph. The method, proposed is to take the flow chart of maintenance, figure 1, until the state of the events, the connections which follow are supplemented by one of the types of the production continuous, discontinuous or by project. Weightings suggested, are real of history machine.

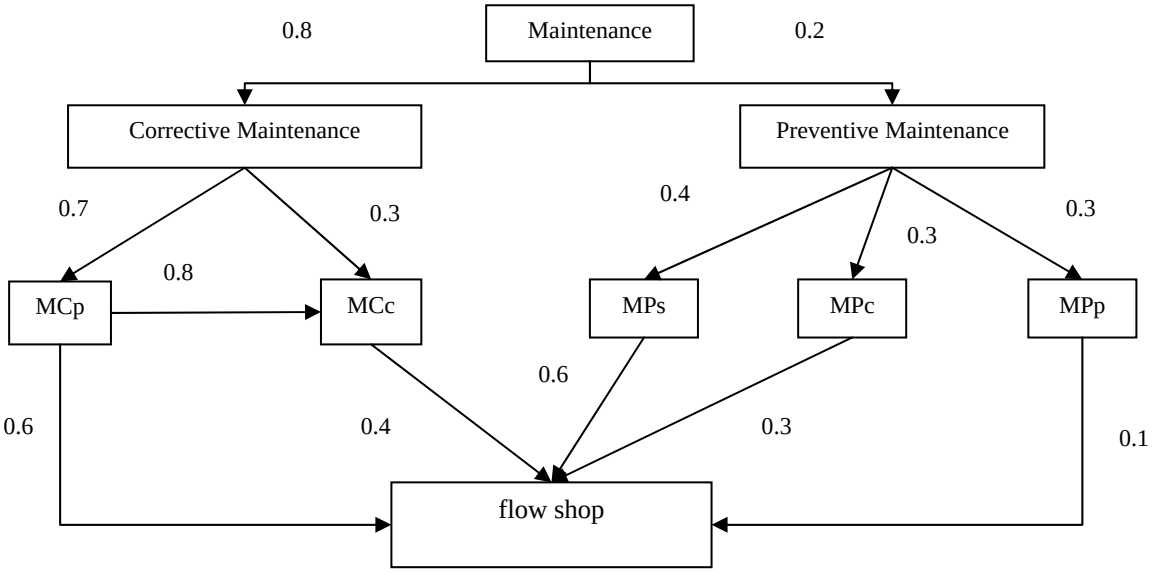

Figure 4

Data of the following study are of a line of production continuously, whose corrective maintenance is significant; it reaches the 80% of the interventions. The share of the preventive maintenance presents 20% divided on the three forms of the latter. And whose application does not exceed ßt and the 2nd level of intervention.

A. Results and discussed

The graph presented on figure 4, is our model of study. Weightings deposited present the interventions carried out on the machines according to the type of maintenances carried out the definitions of the various elements of the graphs, and the corresponding matrix are the principal stages for the evaluation of our model.

B. Definition of the graph

- graph not directed because it does not admit a loop

- the tops of the graph are the points of maintenance, and the production. S = { M, MP, MC, MPc, MPs, MPp, MCp, MCc, P }
- arcs A = { (M, MP) , (M, MC), (MC, MP), (MC,MCc), (MCp, MCc), (MP, MPs), (MP, MPc), (MP, MPp), (MCp, P), (MCc, P),(MPs, P), (MPc, P), (MPp, PC) }
- one can divide the graph into several under graph (complete, partial..)

C. Definition of the matrix

	M	MP	MC	MPs	MPc	MPp	MCp	MCc
M	0	0.2	0.8	0	0	0	0	0
MP	0.2	0	0	0.4	0.3	0.3	0	0
MC	0.8	0	0	0	0	0	0.7	0.3
MPs	0	0.4	0	0	0	0	0	0
MPc	0	0.3	0	0	0	0	0	0
MPp	0	0.3	0	0	0	0	0	0
MCp	0	0	0.7	0	0	0	0	0.8
MCc	0	0	0.3	0	0	0	0.2	0
P	0	0	0	0.6	0.3	0.1	0.6	0.4

The weightings suggested on the graph, and the matrix are divided into two types. The first presents the proportions of the interventions carried out between the various types of maintenance. The second presents the gain and the loss between maintenance and the production. In the event of gain of the production, it is a loss in preventive maintenance, is gain in corrective maintenance, is screw poured. The gain or the loss is presented, and discussed on the chart of projection.

The use of the factorial analysis as approaches " confirmatory " advances theoretical of the model suggested checks well that the two principal components in our model, are the two types of maintenance (corrective, preventive),of more can than it establish a hierarchy, between the various maintenances, based primarily on the explanatory value of each one of them, presented on table 1.

TABLE 1: EXPLAINED ORIGINAL VARIANCE

Component				**Extraction Let us be squares of the factors selected**		
	Total	***% of the variance***	***% cumulated***	***Total***	***% of the variance***	***% cumulated***
1	3 ,381	42,261	42,261	3 ,381	42,261	42,261
2	1,943	24,291	66,551	1,943	24,291	66,551
3	1,522	19,031	85,582			
4	,664	8,305	93,887			
5	,303	3,786	97,673			
6	,186	2,327	100			
7	3,852 E -16	4,815 E - 15	100			

The cumulated variance indicates that the reduction of the variables has two components allows, to preserve essential phenomenon measured by the initial variables, 66,551%. Therefore our representation is of quality.

The first factor, represents the percentage of the variance 42,261%. The second account for 24,291% after presentation of the chart, on the horizontal axis we find the first component which represents the preventive maintenance which is close to this axis. On the vertical axis second component, we find maintenance corrective (MCc, MCp).

It is noticed that maintenance is close to the second component, which is logical since 80% of the interventions are corrective. The position of corrective maintenance is opposed to different the type of preventive maintenance east screw-poured.

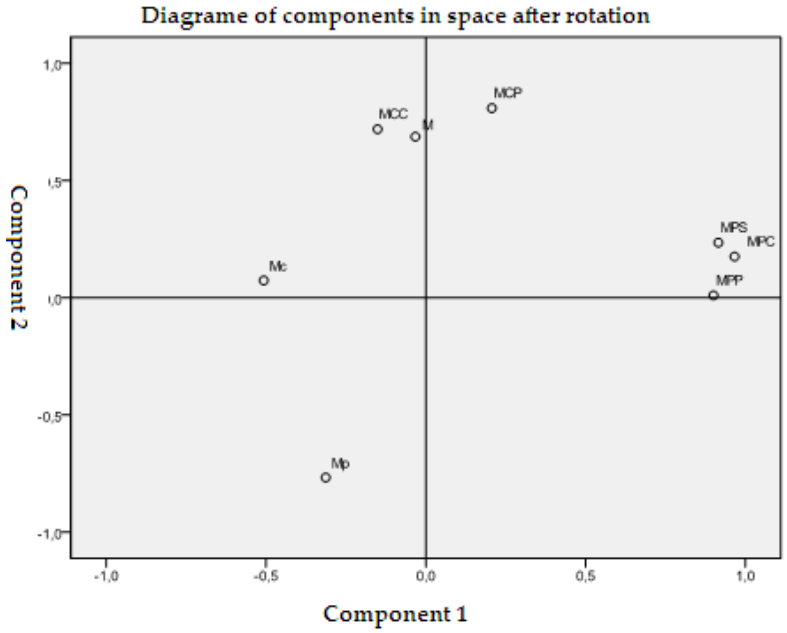

Figure 5

The diagram of components in space after rotation presents the parpport production at the two components. preventive maintenance and production one it even smell of variation, contrary within the meaning of the variation of corrective maintenance. What explains their positions on the chart (loss-gain).

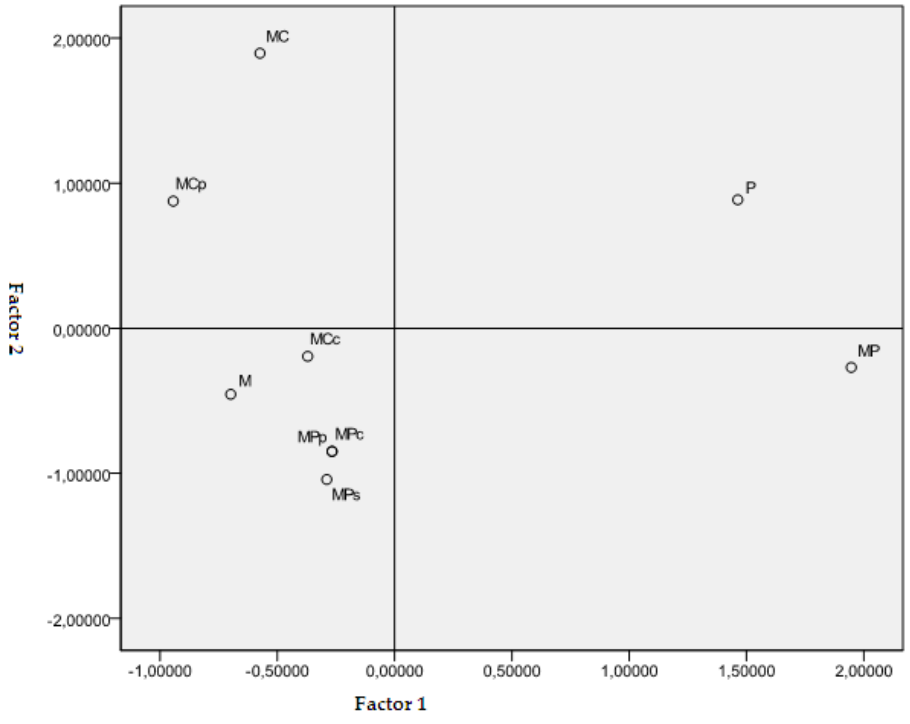

Figure 6

V. CONCLUSION

The model presented along this writing, shows its coherence with reality. The improvement of the explanatory variance of the factors (reliability of the model), gives the result of a new departure, with new studies. The insurance of better a production support on the variability of different weightings from the graph. In order to have the best combinations of coherence enters maintenance, and the production within scheduling.

REFERENCES

[1] Jean-Marie Auberville, plant Maintenance of basic maintenance to the optimization of safety, Ellipses edition, 2004.
[2] François Monchy, Maintenance and Organizations, 2nd edition, 2003.
[3] Courteous Alain, Maurice pillet, Chantal Martin bonnefous, Production control, ême edition, 2003, p19
[4] Jean Benassay, production control, edition hermes, 2nd edition, 1990.
[5] Fatima Benbouzid Sitayeb, Contribution A The Study Of The Performance And The Robustness Of Joint Schedulings Production/maintenance – Case Of The Flowshop, 2005
[6] Baez Oscar Felt, Methodology Of Assistance A Decision Multicritere For The Scheduling Of Discontinuous Workshops, 2007
[7] Fatima Benbouzid, Yassine Bessadi, Sid Ali Guebli. Christophe Varnier, Nourredine Zerhouni, Résolution of the problem of scheduling Unites Maintenance/Production by the sequential strategy 4th French-speaking Conference of Modeling and SIMulation ' ' Organization and Control of Activities in Industry and Services' ' MOSIM' 03 – from the 23 to 25 April 2003 – Toulouse (France)
[8] Thierry coudert, contribution of the systems multi-agent for the negotiation in ordonancement: application to the functions production and maintenance, 2000