# Stock Management and performance measurement

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**ABSTRACT**

The introduction of the Just In Time (JIT) techniques for parts procurement implies a thought on the indicators capacity in place to translate the process of the management system. The identification of families of parts based on the cluster analysis of the planning statistics parameters has allowed the development of a new method for inventory management and control in IBM. The system performance and the general coherence of procurement depend on the homogeneity of the identified part families.

**KEYS WORDS :** : Inventory management, Fuzzy control, Stock control, statistics, frequency control, target tracking, decision theory, multivariable control systems, speed control.

## 1. INTRODUCTION

The inherent problem of each change remains in the lack of adapted tools able to translate its evolution and to qualify it. The currents tools based on the past logic quickly show failure in front of the introduction of the new techniques. The enterprise is then facing an unavoidable fact, either continuing to drive its system using obsolete or inadequate criteria which could result on evil effects, or to adopt a visual navigation that could end up with the lack of coherence of the decisions and the inability to justify them. The management process and more precisely the parts procurement has drastically changed. The management techniques such as Materials Requirement Planning (MRP) ensure a coherence based on the planning of the all necessary resources for execution taking into account the production capacity. The introduction of JIT techniques in some production or procurement segments and in a MRP environment, conduces to an acceleration of the requirements for the set up of new performance measurements which, is the basis of the monitoring.

The main objective of the performance measurement system is to provide *the basis for communication, coordination and control* [T.BROWN 1991]. The basic assumption introduced in this approach is that, in an industrial environment the independent stocking of a part makes sense when this part is used as stand alone only. The one item management, whose most of *the literature basics on the subject are satisfied with,* sets the problem of the objectives consolidation or explosion [J.P.BEAULIEU , A.PEGUY, 1985], creating discrepancies between local and global optimization One of the main criticism made to the inventory management models is that they have as hypothesis the independence of the products [ORLICKY]. If this hypothesis is verified for spare parts (stand alone demand ), it remains simplifier in the case where each reference is included into an upper structure when this structure is itself dependent of a complex product. If the theoretical models which focus on one item at a time can apply, they are not providing any feedback for the day-to-day management or the way to manage hundreds or thousands of items,[POPE J.A,

ARDALAN A., 1988]. The modeling *as an instrument for the knowledge accumulation and transmission is in fact a representation of the real only* , [V.GIARD, PELLEGRIN, 1992] and therefore reducing nevertheless it remains necessary for the understanding of the phenomena.

## 2. Management methodology

If the production management techniques allow an optimization by item, the assurance of the global coherence of these parameters has to be verified. The main aim of the homogeneous classes creation is the integration of the cross functionality between the products at management level as well as performances measurements. Taking inspiration from the pull system principles (kanban) or from bottleneck regulation (OPT) which focus on the « total synchronization, total quality, and total productivity » [P.M.Gallois,1989], this method allows the extension of those principles at administrative management level. Making homogeneous the supply parameters, the inventory control, the synchronization of the flow and the shortage anticipation are the basic points of this method.

### 2.1 The parts homogeneous classes

The identification of the cross functionality between component parts is based on the cluster analysis of all descriptive variables of the planned demand, integrating by themselves the parts physical specifications and the description to their management. The studies variables are the yearly and quarterly average of the statistical spread, standard deviation, maximum demand, spread characteristics such as the number of week with positive requirements, the date of maximum requirement. The identification of theses classes leads to the homogeneousness of the management parameters and inventory of parts on one side, and to a management simplification on the other side. The analysis of the component demand statistical variation has been performed on a lot of chips (1036 parts numbers) used on various assembly. The main problem of the cluster analysis was to determine the optimal number of homogeneous classes for the studied family and the adequate variable for the classification. The factor analysis has also been used to reduce the number of analyzed variables to two factor. These results have been compared to those got when the number of variables within the cluster analysis has been increased or decreased.

### 2.2 Empiric analysis and stop point determination

The stop point determination in the algorithm used for the classification has been got out of an iterative procedure. The cluster analysis may be used to simplify data by grouping observations into a set number of clusters. The algorithm employed is a non-hierarchical method. The objective of this method is to minimize the sum of squared distances of the observations from the centers of their respective cluster [CAILLIEZ, PAGES]. The empiric analysis has allowed to draw the regression between the number of classes and minimum value reached by the Reduced Sum of Squares (RSS)[1].

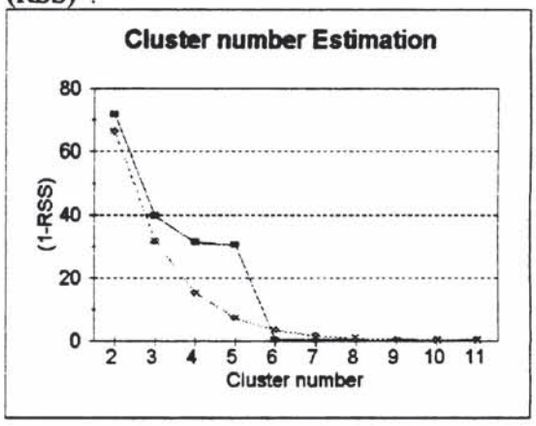


*Fig 1 .Cluster number estimation*

When the number of classes increases the value of the objective function is determined by the

[1] The reduction achieved is expressed as a percentage of the maximum or total squares. The objective function is based on the minimisation of Tj/T

$$T = \left\{ \sum_{i \in C_j} \sum_{k=1}^{m} w_i \cdot \left( L_k \cdot Y_{i,k} - M_{0,k} \right)^2 \right\}$$

where $L_K$ , the loading for variable Xk

$w_i$ the weight of the ith observation.

$Y_{i,k}$ , the normalized observations

$M_{0,k}$ the weighted average of the points in Cj.

estimation of $\alpha$ and $\beta$ parameters (the slope and the origin ordinate).

$$\hat{E} = f(\eta) = \beta \times e^{\alpha\eta} \qquad (1)$$

where $\eta$ equals the number of classes,
$E = 1 - RSS$,
Error not reduced by the grouping of cluster analysis.
The optimum spread being when $\eta$ observations match $\eta$ classes, this spread correspond to the stand alone management, this is not the objective of the study.
This analysis has been applied to some samples of the described family, thus allowing to highlight a relationship between the slope $\alpha$ and the number of parts observations. The estimated of residues by the equation (1) has allowed the simplification of the search of the optimum number of classes. The number of classes must be in such a way that the groups are homogeneous and remains stable every time. The here under measurements principles is based on the stock homogeneousness analysis for a set of items driven by the same product.

## 3. The performance measurement

The management simplification and the new concepts of performance control have been reached by the integration of the concept of parts homogeneous class Three measure types have been implemented :

- Dynamical approved expense control
- inventory homogeneity Control
- Coverage dispersion control

### 3.1 Dynamical expense control

The objective here, is to detect financial drift situations to appreciate the daily administration quality. This control is performed globally. The aim is to make the analyzer responsible for his decisions through pertinent tools. The definition by management of an expense authorization for which they are accountable materializes the analyzer responsibility. This expense is determined from the smoothed requirement rate profile and the replenishment parameters. This implemented control allows a graphic visualization of the authorized expense in quantity of parts for the analyzer, then in financial terms.

This control card allows to appreciate the parameters calibration quality, the use of inventory, and to detect external interventions. The analyzed parts (215 items) are chips used by a single product ; they are supplied by the reorder point technique. The components calls issued from the pull system are represented and allow to verify the procurement system and the product activity. The stock performance is obtained when the product inventory fluctuates around 1/2 and 2/3 of the reorder point. The fluctuation around another value indicates a bad parameters calibration or procurement problems or a consumption different from what has been estimated. However the analysis by commodity presents disadvantage. The global performance has the tendency to smooth values hiding strong or poor performances. To solve this problem, the approved level of expense is analyzed according to calls frequencies, thus the product activity. The representation is made with a spread into two frequencies class (null, positive).

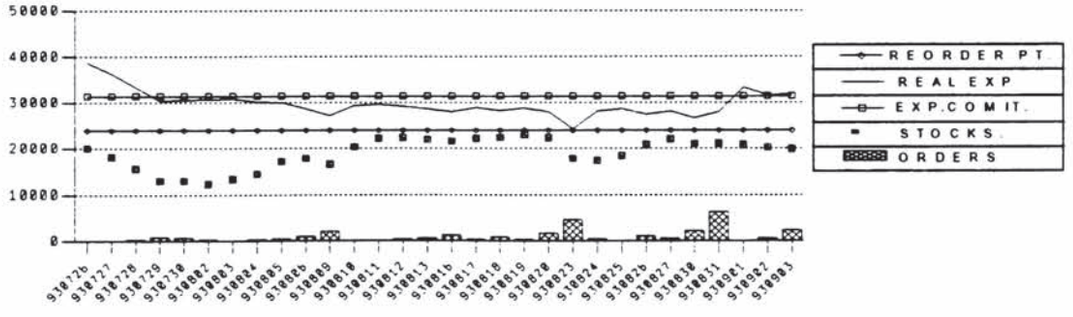


*Fig 2 Approved level expense Control for one manager (by commodity)*

## 3.2 Inventory Homogeneity control

From an inventory and financial view point, the firm orders that will be delivered on a short term and the items in stock must be under an accurate control. The system which decides the capability to order combine the available stock and the future stock (on order). A calculated level of expenses based on a theoretical speed of consumption enables to prevent a risk of shortage and a risk of over expenses.

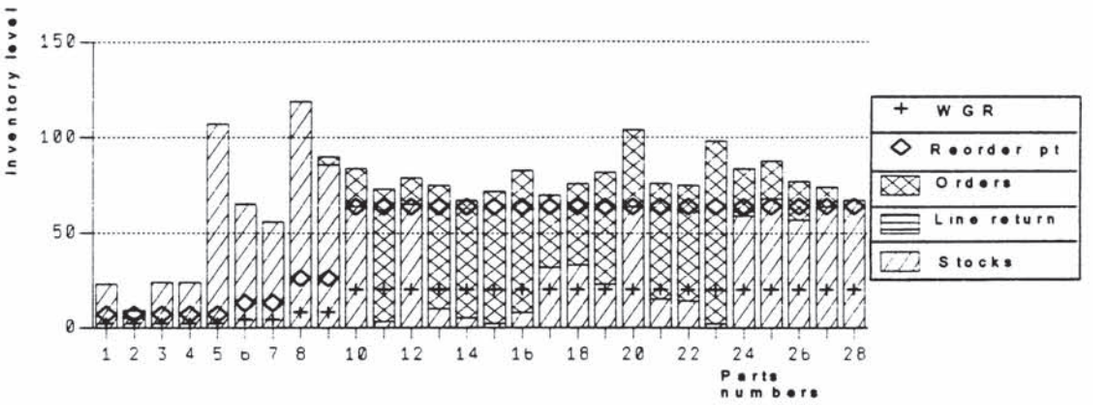


*Fig 3 Homogeneity inventory control*

The proposed analysis is static. Within the same class, all the items of this class contain a homogeneous inventory. Base on a predefined minimum stock ( for example one day consumption) the parts may be declared as critical when the stock is lower than the predefined level. However this system maintaining a homogeneous inventory, the undelivered orders needs to be expedited; On the other hand, the parts may be declared as over covered when the addition of the parts on order and in stock is greater than the approved level of expenses. This approved level is defined as the addition of the reorder point and one call. The reorder point is the minimum level of inventory for each item of the product. The control in place is similar to the bottleneck identification on the manufacturing line. On the above picture, the parts are pulled (consumed, used) in the same way but the volumes are different (homogeneous cluster). One item in shortage condition mades unusable all the other items in stock. The inventory quality cannot be a measurement of each individual item, the inventory quality is the capability to the group of items to make a manufacturable assembly. the is no added value to make sure all the stocks are maintained at a minimum level (this is not realistic from an operational view point). It is most important to control and maintain a full set of parts that may feed the manufacturing line without missing element.

## 3.3 Stock coverage and turn over

The approved inventory based on statistical volumes and statistical speed of consumption does not provide any information on the coverage linked to the real needs.

The approved inventory has been calculated to make sure all the situations of production demand (peak included) may be supplied. It is important to qualify this inventory in relation to the real profile of requirements for each item. The results of this method are usable for any technique of ordering and stock management (MRP/JIT). This method shows the homogeneity of the inventory or the possible deviations. The coverage table has been spread in detailed classes (0 to 60 days) and rough classes (above 60 days). The frequencies may be expressed in quantity of items, or in parts volume or invested francs. **More the distribution is concentrated, better is the performance.** The volumes may be concentrated around any class, this is the result of the decide inventory policy[2]. The volumes may be dispersed across all classes ; if the inventory policy is the same for all the items, this situation request a deep investigation. Value analysis allows analyzer to measure his performance compared with strategic financial goals, and to improve enterprise results. Therefore, the analyzer can instantly measure the impact of an action on the inventory turnover and quality. Management quality is

[2] *More the inventory is concentrated around a short coverage, better is the speed of consumption of the invested goods.*

given in appraisal form (excellent, bad,...) but can be expressed in numbers. Introduction of a quality label, and not a value, brings a more psychological impact to the agent, because he associates this label with his own performance, when the number is more linked to the stock management. Quality indicator shows the consumption speed of the inventory in relation with the total inventory over a variable horizon. Also coverage concentration indicator may be introduced.

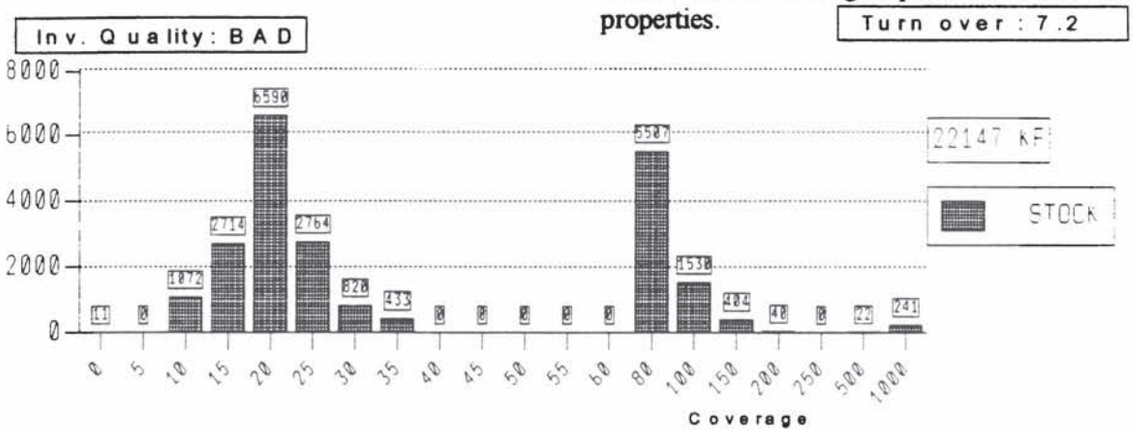


*Fig 4 Stocks homogeneity measure and analysis*

Analysis of the stock level impact on the management quality (short term distribution) and financial performance (turn-over). The advantage of such a measure is to integrate programs variations (delay or cut in the demand) and to give a vision of the management quality , as seen by the planning which remains the reference for the capacity sizing, not for the scheduling.

# 4. Conclusion

The research for a tool allowing the follow-up and the control of new management techniques is a fundamental step in the success of its implementation. The concepts which have been developed, introduce an important change in the management process. The flexibility of the tools set allows the administrator a usage facing all the situations, whatever the management techniques are MRP/JIT. The adaptability of these concepts to other systems is verified insofar as the managed parts have the same properties.

Analysis and piloting by homogeneous groups have a benefit only if the number of parts assembled into the finished product is important, that means products having several assembly levels. On the other way if the structure is too complex, monitoring is done at the semi-finished product. With the introduction of the JIT techniques we are moving to a synchronized piloting of physical parts and product flows. Performance measurement system must integrate this synchronization as a new tool for quality performance of the stock management.

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