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THE PRACTICAL LIMITS FOR J.I.T.

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Abstract

Z.I. or near Z.I…..¿are we doing the right thing?. Some years ago going along with inventory reduction beyond the more or less apparent economic optimal level has been justified in terms of getting on synergistic effects on flexibility, productivity and quality, and we all have seen the very famous diagram representing a company as a ship crashing with reefs when low tide (low inventories) comes.

That is really true, and till a certain limit, clear savings in expenses are got from this policy simply doing things right with no significative investment. Therefore you normally are forced to save in lead-times, with very much synergistics effects.

All that is a path to be walked more or less fast, but have we to stop anytime?. The paper establish the practical limits for inventory reduction using the concept of the "economic transfer lot" that is affected, among other factors, by the practical economic level of the "minimum production lot", that is calculated in terms of the "manufacturing system decision triangle"

Keywords

J.I.T, Z.I., Manufacturing Strategy

1. INTRODUCTION

Car component makers are particularly forced to continuous improvements in lead-times and costs reduction. The FIG. 1 represents a very attractive interaction in which cleverly focused lead-time reduction leads to dramatically reduce costs improving simultaneously quality and service. But is this an absolute linear non-ending model, then showing us Z.I. (Zero Inventories) as the panacea for best manufacturing practices?. The answer is no; the multiplying links of the figure works out only from an initial manufacturing system given situation to another in which the maximum limit achievable manufacturing flexibility is a function of the involved machines technology.

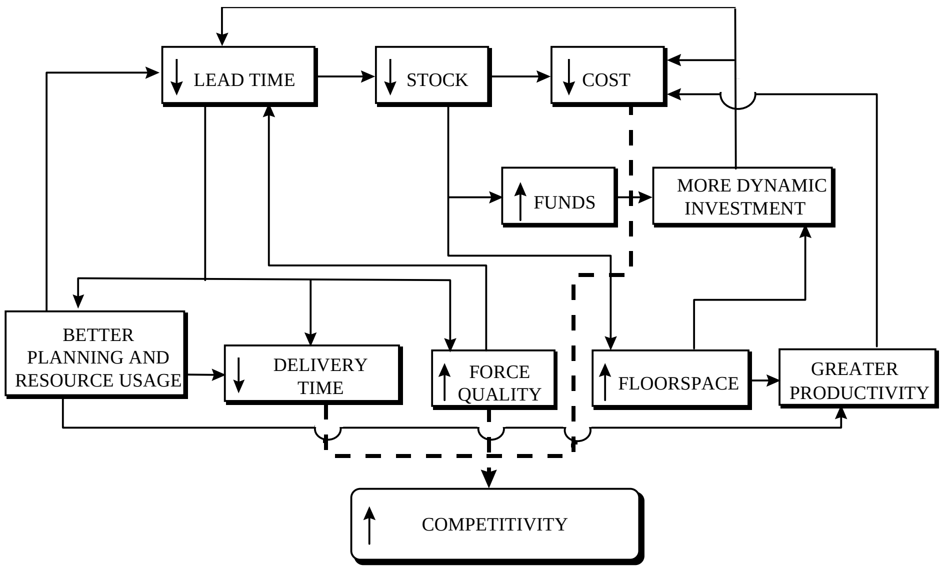

FIG. 1: LEAD TIME, ITS REDUCTION AND COMPETIVITY IMPROVEMENT
Note the "multiplying" characteristics of the links.

Going on beyond this point reducing set-up times is just a waste of precious time and money. Therefore, the minimum level of inventory you can have depends only on the Technology Strategy you are practicing. The confusion stands because the problem in real life is identification of the inventory sources. But take that into account; if you deduce the level of the inventory related to a lot-sizing practice (roughly ½ EOQ), and you compare the figure with plant obtained samples, the surprise is that theoretical inventory is only one third (or less) than the sampled. Where is the difference?. Very easy; on things that must be dramatically eradicated; machine breakdowns, inadequate and suppressive CPK´s, scrap and rework, under controlled process adjustments of setting up with loss of expensive material, or inadequate or very slow operating planning and scheduling systems. Z.I. that must be pursued most is the inventory you have because all these things more or less randomly occur. This is the limit of linear behaviour of the model showed in FIG. 1, and what we call P.Z.I. (practical zero inventories).

Proper identification and removal of these all scraps requires a previous setting of a logistics model and a coupled technology strategy for involved machines and plant physical systems.

2. THE LOGISTIC MODEL AND THE MANUFACTURING DECISION TRIANGLE

Supposed defined if you are a ATO (assemble to order), MTO (manufacturing to order) or MTS (manufacturing to stock), the identification of main and auxiliary lines is the key to issue. The FIG. 2 represents the lay-out of M&A lines.

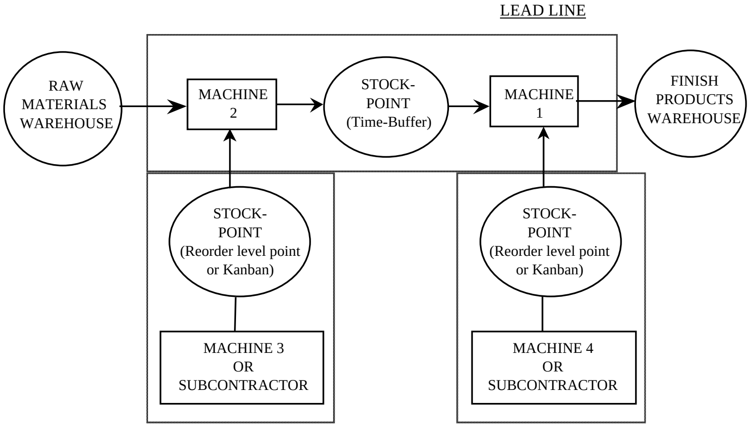

FIG. 2. LEAD AND AUXILIARY LINES. A SIMPLE MODEL

The main line is synchronized, time buffered inventory, contains the most added value product parts and process technology, and sets the manufacturing lead-times. Main lines contents the reserved capacity of differentiation on product inventory, quality, flexibility and service, and cost reduction for the future. The auxiliary lines (machines or subcontractors) are just opposite decoupled systems likely producing any of the rest of the areas represented in FIG. 3, and performing JIT or reorder-level-point operating practices.

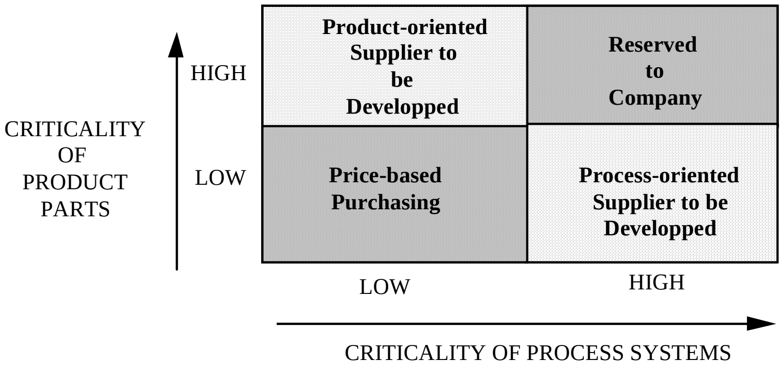

FIG. 3. THE ADDED-VALUE MATRIX

Main lines are the places to perform PZI, and doing this hierarchy through the logistic model is extremely useful, given that it channels to there product and process innovation and more intensive continuous improvement management efforts.

Which is the most convenient practical lot-size in the main-line?. If you can manufacture as small as you can rationally move you get the following:

- If the customer fix order's window is small (and in fact is decreasing continuously), there is a clear trend to order what is reasonable to move and deliver if you do transfer and manufacturing lots equal the main line remains syncronized along process stages.

- Operative integration of production and material handling personnel decreasing labour costs through polivalence and self-balancing.

- Extremely simple and straight planning, scheduling and control system, complemented by easy work in progress visual traceability.

- Everything that is on the plant must be moving (with exception of safety time-buffer-stock) and assigned to a customer order.

- Safety time-buffer stock size, convenience and lead-time added is clearly and continuously visually identified so decisions about definitive or occasional removal of safety are very easy to take.

- With the exception of some given scheduling conveniences (grouping for saving in set-up times) customer orders priorities or changes affects not very much to productivity.

So, it is clear that in the main line manufacturing technology must be coupled with the idea of doing manufacturing lot size equal to transfer lot size. The level of the transfer lot-size is selected with the criteria of minimizing handling costs, and depends on the product morphology, distances, and transport devices design (selected for minimum handling costs).

With these conditions, we have to select the manufacturing technology for the main line. Minimum theoretical set-up times have to be reasonable for producing transfer lot sizes, and are calculated reversing the well known "Wilson" or "Coverage" formula (Coverage analysis is more appropriated for a family of products produced in expensive main lines). With deduced convenient set-up times, maximum admitted direct and labour costs, and product life cycle, we move to the FIG. 4; the machine decision triangle.

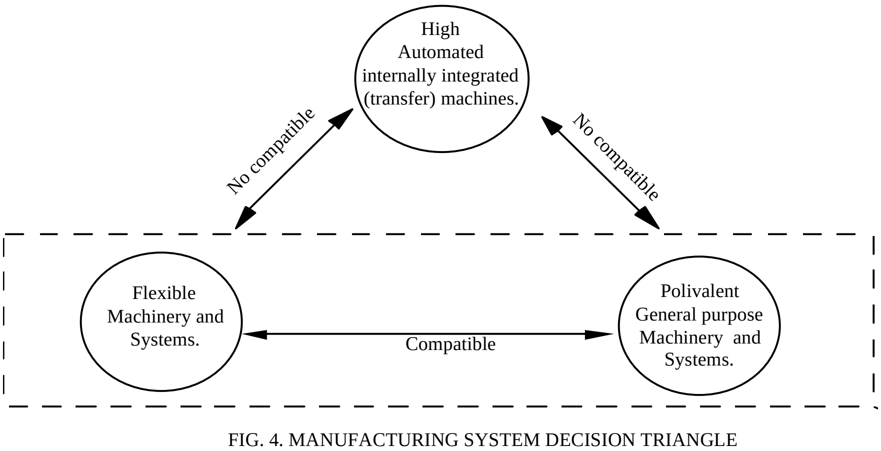

FIG. 4. MANUFACTURING SYSTEM DECISION TRIANGLE

Looking at the figure, and if needed flexibility is given by the transfer-lot, what we have to do is move as much as possible to automation but keeping the ability of necessary rapidity in changeovers. This contradictory trade-off can be alter in own favour with good integrated product and process engineering practices. The Table 1 represents how to decide on the different alternatives, and FIG. 5 situates them on an interline flow-chart.

TABLE 1

HOW TO BALANCE THE "MACHINE TRIANGLE" OR THE "DECISION´S CUBE" IN PRACTICE (for the key-machines of the lead syncronized line)

F = Flexibility H = Human
P = Polivalence C = Economic comparison
I = Investment

	① Current Alternative		② Transfer Line		③ Flexible Manufacturing system		④ Flexible Transfer-line		⑤ Flexible Manufacturing Cell	
	Value	Technical Comments	Value	Technical Comments	Value	Technical Comments	Value	Technical Comments	Value	Technical Comments
F Set-up time										
Material cost in set up times										
Optimum manufacturing batches										
Set-ups/year										
Transfer batch										
Theoretical lead-times: Tp+tu.L										
Lead-time or terms (adjusted with (6))										
Stocks's level (1)										
Set-up total cost (mat+MO)										
AI Typical optimum frequent limit (Tf)										
Material scrap/hour										
Variable operation cost/hour (without amortization)										
Variable maintenance cost and stocks/hour										
MOD cost/hour (4)										
MOI cost of supporting/hour										
MTBF										
MTTR										
Aviability.% $\frac{MTBF}{MTBF+MTTR}$ (6)										
Operation total cost/hour										
Number of hours/year										
P Target process cycle life without changes										
(2) Investment in process in period 1, 2, 3, 4, Until target										
H Differential cost/hour (4)										
Training cost (5)										
Improvement capacity (A,M,B).										
Investments according to current situation										
I Net investment (3)-(1) $\leq$ (2) + (5)										
C Comparison of alternatives: VAN/TIR in marginal target of costs										

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	⑥ Cell including general purpose		⑦ Manipulate orientated cell including general purpose		⑧ Disminish set up oriented cell including general purpose machines		⑨ Set up oriented cell including general purpose machines	
	Value	Technical Comments	Value	Technical Comments	Value	Technical Comments	Value	Technical Comments
F Set-up time								
Material cost in set up times								
Optimum manufacturing batches								
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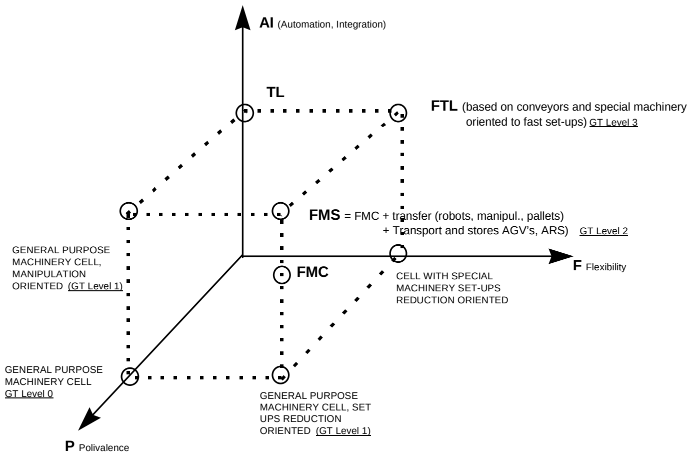

FIG. 5. THE DECISION CUBE

TL = transfer-line
FTL = flexible transfer - line
FMS = flexible manufacturing system
FMC = flexible manufacturing cell

3. DEDUCTION OF PZI AND RELATED M.I.S (management information system)

The size of PZI can be calculated in a roughly way (formula-based) or by simulation of optimal sequences in scheduling systems software that has the input of the MPS (master-plan) for the main-line (FIG. 6). The difference is that in the first, products are independently pipe-lined along the main line, and that with simulation grouping and changeover savings-and then some finish product inventory excess-arises. Depending on real cases, both are valid tactics, and their results are the ideal limits for plant management performance indicators.

The formula for deducting PZI for one part in terms of time is:

PZI = Σ (Set up time+Transfer lot*Production-time+Transport-time+Minimum Safety lead-time)

(time) (process stages)

$$PZI = PZI * \frac{\text{unit cost * Annual Demand (units)}}{365}$$

(money) (time)

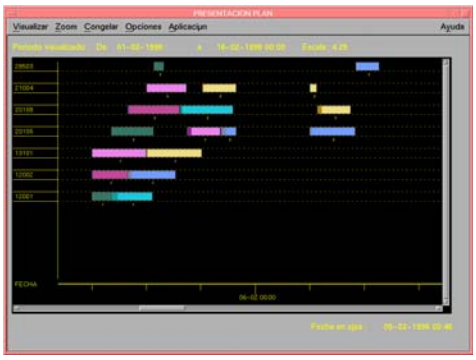

FIG. 6. Gantt chart of an scheduling system software

Finally, a convenient M.I.S. for managing ZPI could be as follows:

- PZI excess (see FIG. 7) =

+● Time EDI - Time dispatching.

+● Time breakdowns and shortages - Time scheduled for buffering.

+● Time scrap+rework - Time scheduled for buffering.

+● Non-identified .

This non-identified piece of excess must also be continuously traced for deducting not so obvious problems.

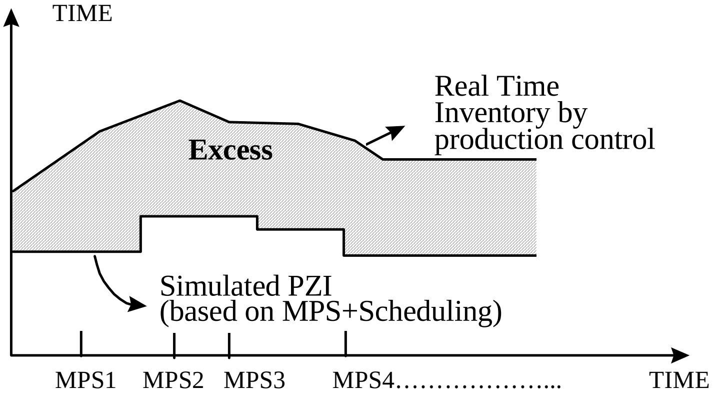

FIG. 7: INVENTORY EXCESS FROM PZI

4. CONCLUSIONS

The paper concludes saying that Z.I. is not, general speaking, a consistent strategy, but very interesting approach is arised if you fight Z.I. only for these all elements that are not part of the manufacturing system decision triangle strategy, and that push to you to have, sometimes, much more inventory than optimized correspondent set-up times EOQ would.

BIOGRAPHY

Prof. Dr. Javier Borda Elejabarrieta has been working as plant Engineer and Production Manager staff for 7 years, and from 1984 he is the managing director and C.E.O. of DATALDE, S.A., a spanish 35 people industrial engineering company, sited in the Basque Country. He read in 1989 the Doctoral Mechanical Engineering dissertation on "CIM for plastic injection workshops". He is also Professor of Production and Engineering Management in the University of Deusto, Bilbao, and the author of several international papers and a book titled: "Advanced Maintenance Techniques" (1990). He has become recently an IFIP WG 5.7 member.

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