# Inflicting Agility through Just–in–time Practices in a Truck Tyre Manufacturing Plant

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**ABSTRACT:** In the recent time the phenomenal changes have been observed in the manufacturing management front in case of the advanced organizations. Just-In- Time (JIT) is one of the indispensable tools of the manufacturing management. It not only enables a production unit to operate at the minimum possible inventory level, but also it brings substantial ease in the operations of the material handling devices with optimal batch load. In fact JIT is a revolutionary concept and the challenge is its simplicity for effective management of working capital. It introduces no advance technology or complicated principles but instead it strives to eliminate unnecessary burdens of complexity in production process leading to minimum inventory holding. This paper discusses about the implementation of JIT- practices for a Y- box rubber tread extruder in a premier Indian truck tyre manufacturing unit. Y–box extruder is an important machine in truck tyre manufacturing process as it is capable of extruding two different materials to produce ultimately a tread rubber fitted with two side wall along the two sides of it. This tread rubber and side wall rubber are of different materials because of their different applications. In this paper of a diagnostic review has been made for die changing time of this Y–box extruder and goal performance monitoring table is made for different reduced values of die changing time. The results of this review are critically analyzed to get a detailed justification of incorporating short cycle time of this critical die changing operation and the possible methodologies are suggested for implementation.
***Keywords:*** JIT, Truck Tyre Manufacturing, Manufacturing Management, Inventory

## LITERATURE SURVEY

**He et. al. [14] [2002]** emphasized on the delayed product specifications, in terms of attaining the agility in the scheduling process of the manufacturing systems. He stressed on the point that the delayed product differentiation is of immense importance in achieving short cycled manufacturing at the lowest possible cost. No doubt it is a candidate cause but it is not all. The entire effort has been focused on the scheduling instead of an integrated approach on agile engineering. **Sawik et. al. [23] [1993]** focused on flexible flow lines while **Silver et. al. [26] [1985]**, **Gupta[11] and Krishnan[1998]** stressed on decision system regarding inventory and production planning in attaining agility into the manufacturing system. But these are one of the relevant causes of agility and thus an integrated view is ignored. **Gupta et. al. [11-12] [1991],[1998]** expressed the benefits of delayed product differentiation in terms of reduced safety stock only and shorter customer response time. **He et. al.[15] [1996]** argued that since in designing the modular designers intend to replace a unique integral part with the assembly of common components that may be manufactured in the machining stage or brought directly from the suppliers. Modular designs increase the number of assembly operations and the assembly time and hence, they may require additional assembly stations in the system. This event converts the manufacturing system into a long cycled manufacturing instead of a short cycled manufacturing which is a characteristic feature of agile manufacturing. **Kausiak[18] [1989]**, proposed a system of representation of assembly sequence through a digraph G, where each node represents a part or subassembly and an arc represents a precedence relationship between two nodes. Any node with the number of edges incident to the node>1 denotes a subassembly or an assembly. The root node of a diagram always represents an assembly. **Hull C. et al.[16] [1995]**, stated about the potential of rapid prototyping technology for attaining short cycled manufacturing. He argued about the tremendous growth potential of rapid prototyping replacing many of the existing technology. **Dong[7] [1998],** has emphasized on the intelligent rapid prototyping techniques to attend rapid response manufacturing. **Hansen,D[13] [1993],** talked about the proper production strategies for plants with multiple production lines to attain proactive manufacturing. **Comb.,J.W.[6],et. al., [1994]**, discussed about layered manufacturing for attaining complex profiles in relatively short time to meet the needs of the customers. **Cho, K.Y.[5] et. al, [1996]** studied a Korean Motor factory case to find the effect of simulation in attaining manufacturing efficiency. **LU,C.J.[21], et. al, [1995]** stressed on real time operation plan optimization using accelerated simulation modeling. **Chattopadhyaya S.[3] and Varma, *A.*, [2000]** made the possible design of a

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mechatronic factory of an Indian manufacturing unit where rapid response manufacturing could be implemented with the relevant implementation of mechatronics. **Chattopadhyaya.,S[2]. and Basu, A.K., [1999]** discussed about the facility management techniques in related to the agile engineering environment to meet the customer's need at the earliest. **Kotha[19] et. al, [1998],[2000]** have discussed the use of advanced manufacturing technologies across the countries. **Swamidass[26-29] et. al, [2000],[2002],[2002a],[2002b]** stated that US manufacturers are using different Japanese innovations to impart agility into the system. **Wheelwright [31] [1981], Schonberger[24] [1982], Grewin[9][1992] and Womack et. al, [1990]** indicated that the Japanese were devoted in making their products profitable and competitive by being dedicated simultaneously to quality, variety and cost leadership to attain agility into their manufacturing system. **Gordan and Sohal[8] [2001]** compared manufacturing practices and manufacturing technology use in Canadian and Australian manufacturing industries. **Jaikumar [17][1986]** found that the innovations in manufacturing process in the form of Advanced Manufacturing Technology are used far more readily in Japan than in USA. **Vastag and Whybark[30] [1994]** have shown much interest in comparing manufacturing practices of USA and European firms. **Mansfield[22] [1993]** discussed about the difficulties in justification and assessment of different advanced manufacturing technologies. **Grewin and Kolondy[9] [1992]** analyzed different comparative strategies of adoptions of different technologies in the manufacturing sector. It has been revealed from the above survey, the majority of the articles on implementation of agile manufacturing are conceptual. Further scrutiny reveals that some of the articles discuss about the variables associated with the implementation of the agile manufacturing philosophy. Unfortunately, there is little consensus among researchers regarding the relative importance of this variable in the implementation of the agile manufacturing. Hence, there is a need to identify the critical variables associated with each of the basic tenets of the agile engineering philosophy, which may be there in specific type of industries. For the purpose of our study, the frequency of citation was used as the major element of importance of these variables. However, given the ambiguity in the surrounding the terminologies used by the different researchers it was necessary for the researchers to use their best judgment in classifying and grouping the variables discussed in the articles. Therefore, some of the variables may not be mutually exclusive and in some cases they are interacting. Due to that a mathematical model is required to determine the relative agility of different manufacturing systems at least in homologous cases.

Little research has been done in truch tyre manufacturing plants especially for one of the largest rubber product manufacturing companies who are also manufacturing the aero tyres also. when the entire manufacturing varieties with their all-possible process sequences in the manufacturing plant are considered. Here an effort has been made to develop a model of this sort to get the preliminary ideal of the agility status of the concerned manufacturing units.

## GOAL PERFORMANCE MONITERING

In the agile manufacturing system JIT practices are followed. Through this method all form of stocks and storages are reduced to minimum level through implementation of short cycled manufacturing operations. By implication of JIT practices for a y box extruder the number of treads manufactured per shift can be substantially increased.

The following tables shows a comparative study of number of treads per shift in truck tyre manufacturing unit using various tyre making machines using one Y box extruder and two Y box extruder conditions respectively.

**One Y Box Extruder Condition**

| *Serial no* | *Tyre making machine* | *Low no of treads/shift* | *Medium no of treads/shift* | *High no of treads/shift* |
|---|---|---|---|---|
| 1 | Automatic | 5 | 20 | 50 |
| 2 | Segmental | 20 | 50 | 80 |
| 3 | Zero Collapsing | 20 | 50 | 80 |
| 4 | Traditional | 15 | 40 | 60 |
| 5 | Small OTR | 2 | 5 | 10 |

The graphical representation for one Y box extruder condition for the above table

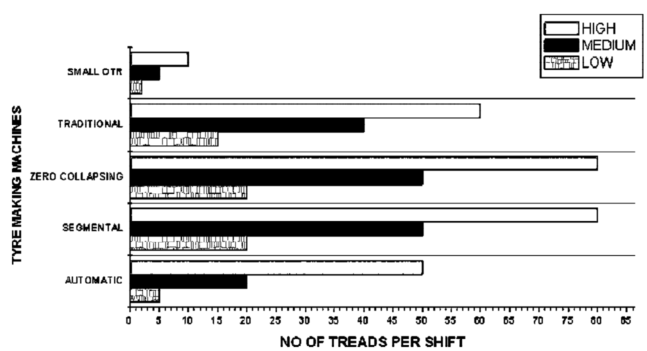
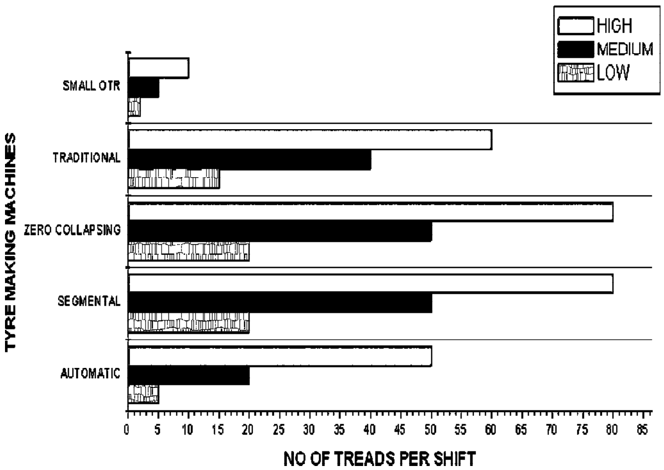



**Figure 1: The Tabular Representation for No. of Treads per Shift for Two Y Box Extruder Condition**

| *Serial No* | *Tyre making machine* | *Low no of treads/ shift* | *Medium no of treads/shift* | *High no of treads/ shift* |
|---|---|---|---|---|
| 1 | Automatic | 2 | 10 | 25 |
| 2 | Segmental | 10 | 25 | 40 |
| 3 | Zero Collapsing | 10 | 25 | 40 |
| 4 | Traditional | 7 | 20 | 30 |
| 5 | Small OTR | 1 | 2 | 5 |

**Table 1**
**The Graphical Representation for Two Y Box Extruder Condition**




The analysis of the above table and graphs shows that the no of treads per shift in each type of the tyre making machine is increased by about 4 -5 times from low no of treads /shift to high no of treads /shift and 1.5-2 times from medium no of treads /shift to high no of treads/ shift.

In the study of truck tyre manufacturing unit it has been found that for minimum operating inventory the implementation of JIT process is necessary. The areas where one should concentrate is to reduce the die changing time for attaining agility the following die changing operations add up for the work measurements.

**Work Measurement**

1. Opening the nuts and bolts;
2. Unloading the existing die;
3. Loading the new die;
4. Tightening the bolts with nuts.

The following g tabular form shows the die changing times for the different operations involved in work measurement for low, medium and high number of treads /shift.

**Table 2**
**Die Changing Time (in min)**

| *Operation* | *Low no of treads/shift* | *Medium no of treads/shift* | *High no of treads/shift* |
|---|---|---|---|
| 1 | 1.5 | 0.5 | 0.1 |
| 2 | 4 | 2 | 0.3 |
| 3 | 4 | 2 | 0.3 |
| 4 | 1.5 | 0.5 | 0.1 |
| Total time taken | 11 min | 5 min | '1 min |

The graphical representation of the above data is as follows:

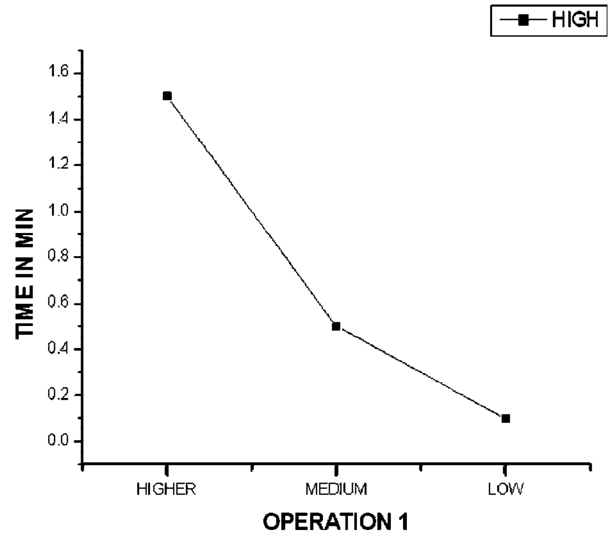



**Figure 3: Operation 1:Opening the Nuts and Bolts**

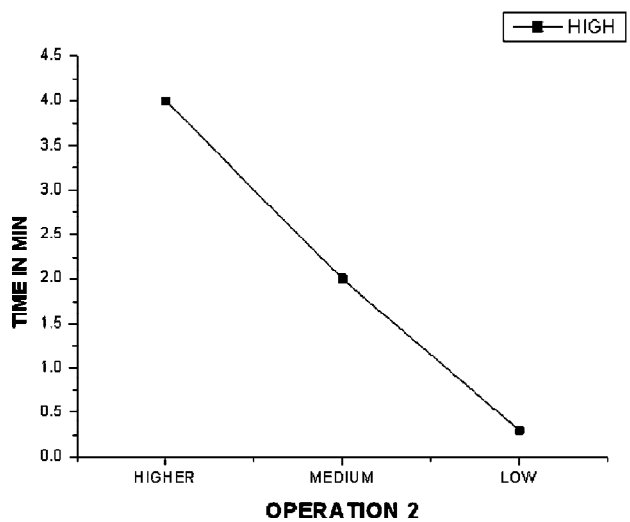



**Figure 4: Operation 2:Unloading the Existing DIE**


**Figure 5: Operation 3 : Loading the New Die**

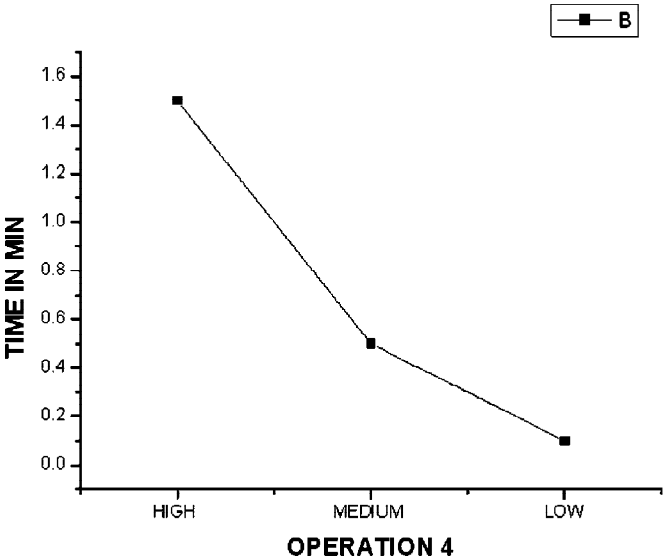



**Figure 6: Operation 4 : Tightening the Bolts and Nuts**

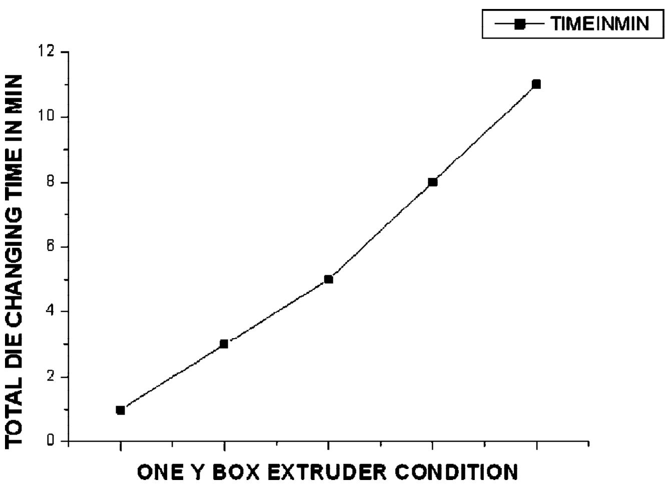



**Figure 7: Total Die Changing Time Required for One Y Box Extruder**

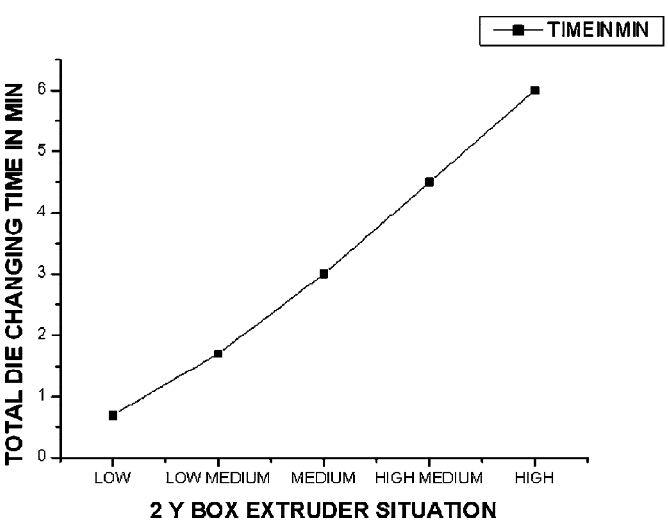



**Figure 8: Total Die Changing Time for Two Y Box Extruder Condition**

The analysis of the above tables and graphs show a comparative study of die changing time for various work measurement operations using one and two Y box extruder.

## CONCLUSION

In a truck tyre manufacturing unit where the product variety is substantially large, application of one Y box extruder considerable operation efficiency without many complexities. The sensitivity analysis for a reduction of die changing time is crucial for the augmentation of the manufacturing. The reduction of the die changing time enables manufacturing unit to become a candidate for implementation of JIT and for running a plant at the minimum possible cost with least hazards and expenditure.

Zero inventory has not yet achieved its summit. It is still in a developing stage. However manufacturing industries could achieve SMED (Single Minute Exchange of Die).It is one of the techniques which support the short cycle characteristic of technology. The possible methodologies include

- Using power spanners;
- Incorporating slider die magazines;
- Fitment with taper attachment of dies;
- Gang tree based dedicated loading and unloading of die magazines.

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