

REDUCTION IN LEAD TIME OF MACHINED HOT FORGED RAILS TO BOSCH THROUGH SUPPLIER DEVELOPMENT

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Abstract

Robert Bosch GmbH holds 71.8% stake in M/s Bosch Ltd., India. M/s Bosch Ltd., is a market leader in manufacturing of automobile components and has a very diversified product range like inline fuel injection systems, starters and generators, electrical drives to name a few. Newest in the stable is the Common Rail Direct Injection system for diesel engines.

Rail is the new product in the Common rail system to India. We were earlier importing this product from one of the plants in Germany and delivering to meet the demands of the Indian car makers. As a part of the localisation program in India, the supplier M/s Karnataka Turned Components, has been selected, capacities installed and supplies started. But the supplier was not able to meet the demand, hence the project has been assigned to the Automotive Supplier Development team, through the project team which was handling the localisation of the forging machining in India. This is when, we had to pitch in to identify the reasons for failure and eliminate them systematically. The scope of the project was to reduce the lead time of machining hot forged rails and hence improve the delivery performance to Bosch Ltd., from a machining supplier. The challenge was to identify the main causes for high lead time and delivery failure and eliminate them. The major issues identified as losses during the project were performance, availability of the bottleneck process for production as well as certain quality issues. The project also deals with the improvement of internal rejections as well.

Shop floor management cycle is a tool developed by Bosch to improve the OEE in the bottleneck process and hence the productivity. The identification of the bottleneck is done through Takt chart and then hourly monitoring is used to identify the losses further this data is analysed by the use of tools like pareto and other quality tools and real root causes are listed down. Later these causes are validated and appropriate actions are taken to reduce / eliminate them. The improvement in delivery performance from 90 % to 100 % has been found with increment in OEE on bottleneck process from 73 % to 78 %. Same time this study brought the reduction in inventory from 10 days to 05 days with reduced internal rejections from 56228 ppm to 19875 ppm.

1. INTRODUCTION

As a part of the localisation program of the Common rail in India, the supplier M/s Karnataka Turned Components, has been selected and supported by colleagues from Bosch in setting up the production at the supplier. Supplier development is an approach aimed at improving the quality, cost and delivery of the products delivered to the buying organisation. More often than not, the issues related to deliveries at the supplier are due to the lack of resources to identify and eliminate the technical losses leading to the failure in deliveries. This is where the buying organisation can bring in a change by sharing the expertise from their plants with the suppliers.

Bosch Ltd., in its small way had started this initiative in the year 2007, to take care of the suppliers, more so financially, in setting up their new facilities / procuring new jigs or fixtures / buying new technologies etc. However over a period of time, it was realised that the suppliers have taken advantage of this gesture and have grown a bit too complacent. This was evidenced by the worsening of key performance indicators at these suppliers with respect to cost, quality and deliveries.

It is believed that only through maintaining close customer supplier relationships can assemblers achieve meaningful cost reductions and quality improvements that can translate into sustained competitive advantage in the global market place. The Japanese have practiced collaborative “supplier partnering” since the 1960s (Schonberger 2001:20) Rail is the component, highlighted in the Fig 1, is the product on which this project is focussed to improve the deliveries from supplier to Bosch. Rail, in the common rail system, holds and transports the fuel to the engine at a high pressure through the injector in an atomised form to facilitate complete combustion of the fuel and hence better efficiencies and better fuel economy.



Fig. 1 – Common rail system

C J Botha [1] The TOYOTA Supplier Support Center (TSSC) was born in Lexington, Kentucky in 1992 and is staffed by a few TPS experts from TOYOTA and group leaders from the TOYOTA plant in Georgetown. The TSSC approach is to set up a model line within the supplier plant according to TPS principles and then expect the supplier management to diffuse TPS throughout the rest of the plant (Liker 1998:6). The TSSC personnel follow the TPS philosophy that lean manufacturing is a manufacturing methodology that decreases the time line between the

customer order and shipment through the elimination of waste (Liker 1998:7).

Robert B Handfield et.al [2] Bavarian Motor Works (BMW), the car manufacturer, does not provide financial support to suppliers; however, it has provided the services of its employees when suppliers request assistance. BMW has sent maintenance engineers and procurement, logistics, and quality personnel to suppliers — sometimes for several weeks at a time. During its initial start-up in the United States, BMW had to focus on problem-driven projects. It still relies on a Pareto-driven approach to assisting suppliers. It identifies problems early and prevents them from worsening, which minimizes expending a supplier’s resources and the need for BMW to undertake supplier improvement efforts.

Perumal Puvanarasan et. al [3] The three main concepts that play crucial roles during lean process management are Respect for People, Skill and Knowledge and KPI. That is, all these three concepts or elements are integrated to optimize the functioning of the employees and bring out Total employee involvement.

Said Rabah Azzam et. al [4] Advocates of the lean manufacturing and just-in-time (JIT) viewpoints state that U-shaped assembly systems present more than a few benefits over conventional straight-line layouts. Especially, upgrading in labour efficiency. U Assembly Lines have turned up to admired place through offering the Key advantages of evened workload, multi-skilled workforce and other standards of the JIT way of life.

C. Anderson et.al [5] If one process in the value stream is starved of products to manufacture due to problems in a previous process step, there are different views on whether this is an unplanned or a planned downtime. If OEE is to be used as an improvement tool, our opinion is that this should be categorized as an unplanned downtime. Every equipment downtime that is categorized as planned will not rise to the surface; hence no attention will ever be paid to the problem.

James P Womack [6] At the heart of lean supply lies a different system of establishing prices and jointly analyzing costs. First the lean assembler establishes a target price for the car or truck and then, with the suppliers, works backwards, figuring how the vehicle can be made for this price while allowing a reasonable profit for both the assembler as well as the suppliers. In other words, it is a “market price minus” system rather than a “supplier cost plus” system.

John Nicholas [7] TPM aims for greater manufacturing competitiveness through improved equipment effectiveness. By tailoring equipment to better suit a particular production environment, and by making it better-than-new, TPM increases production capacity and process reliability and reduces the costs of lost production time, defects, repairs, shortened equipment life, and inventory.

Shigeo Shingo [8] Two factors greatly affect a worker’s productivity: rhythm and fatigue. Productivity increases as rhythm improves, and productivity decreases as fatigue increases. In learning a new task, a worker constantly things

about what to do next and receives instruction from his or her brain.

However, once the task has been learned and a work pattern established, a condition called mental dominance sets in. The learned behavior becomes automatic and the worker no longer consciously needs guidance from the brain. When this condition has been reached, one can perform one's job while humming or singing a tune. Because the body already knows what to do, the job can be done very rhythmically.

BTC-IN [9] Value stream mapping is a process of identification of wastes in a value stream from the customer towards the supplier, while identifying the wastes in the processes. It majorly focuses on the material flow, information flow as well as operator flow in case of assembly processes or in case of one man operating more than one machine. The wastes are identified as kaizen flashes and analyzed in detail to arrive at the value stream design, which is the future state of the present process flow, keeping in mind, clear requirements of the customer.

To conclude on the literature review to decrease the lead time between the order and shipment, the supplier has to be able to see the waste and be able to eliminate it, whether it is due to shortfall in the capacity on the bottleneck process or high internal scrap rates.

2. LEAD TIME REDUCTION

2.1 Value stream Mapping and Design

A value stream map as shown in Fig.2 is drawn to identify the wastes in the value stream and then target to reduce / eliminate these wastes systematically. High lead time was the most evident cause as an outcome of the value stream map apart from the following observations, which directly / indirectly led to high lead time:

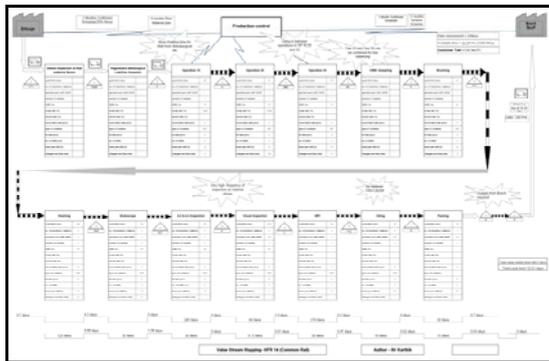


Fig 2. Value Stream Mapping

- ✓ Frequent delivery failures to the customer – data monitoring of the scheduling versus actual deliveries at Bosch incoming logistics and frequent line stoppages.
- ✓ High lead time of the components from the raw material stage to the finish goods and then to the dispatch section.

- ✓ Poor material flow – Criss cross movement of the material
- ✓ High frequency of inspection at material stores

Areas identified as weakness in VSM, have been tried to improve upon in the VSD. The parts are being transported after every operation to the stores for accounting and quality purposes. the part literally moved all around the shop floor, the inventory was high due to the fact that the operators in the rail value stream did not know what to produce and when to produce and how much to produce. Other than the issues mentioned above, there was an issue on the deliveries, which meant that the scheduling of the production orders need to be taken care of. This led to the proposal of pull system based scheduling system, which is depicted in the VSD in Fig.3 in detail.

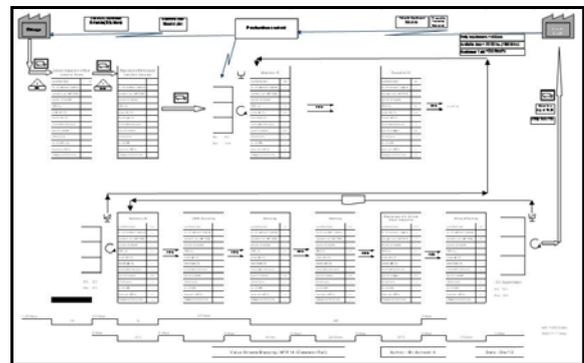


Fig 3. Value Stream Design

2.2 Data collection system

Do It Right (DIR), is a systematic that is followed at Bosch to collect the data on a daily basis in the form of a run chart with clear targets mentioned for each metric. This is a very basic tool for understanding the problems on the shop floor, which further will enable the team in effective problem solving. Quality, inventory and delivery monitoring have been started as shown in Fig.5, to identify the major losses causing these and systematically eliminate them.

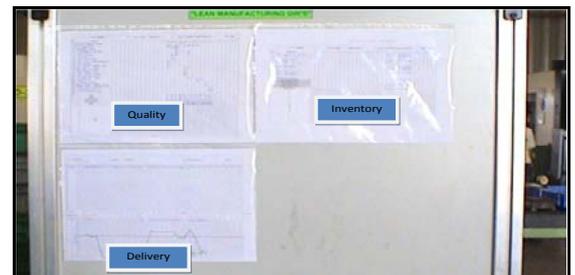


Fig 4. Do it right station

2.3 Analysis of data

The following were the main causes for the failures in delivery:

- Capacity at Operation 30 (Bottleneck)
- High inventory

- Issue with the bins for delivery to the customer

Top four losses causing high inventory have been identified as:

- Raw material at stores
- OP 20 SF (semi finished)
- OP 10 SF (semi finished)
- Quarantine stock.

Top four losses for high internal scrap rate have been identified as:

- TBT power scrap
- 4.2 diameter oversize
- RDS /DRV face lines
- M18 thread tight

Having collected the data for a month's period, the Pareto has been arrived at and this has been taken for further analysis. Analysis of the Pareto follows the following steps:

- Fishbone for all the major losses to identify the probable causes
- Validation of all the probable causes to identify significant / insignificant causes
- 5 why analysis of the significant causes
- Identification of the root cause
- Fixing the actions for the root cause identified
- PDCA for sustenance tracking and further improvement.

3. PROBLEM SOLVING

Issues with delivery were considered for problem solving and the three main causes for failure were analyzed in detail and actions taken.

3.1 Shop Floor Management Cycle (SFMC)

SFMC is a Systematic approach to improve Overall Equipment Effectiveness (OEE) on the bottleneck process.

Cycle time analysis and Takt diagram

Cycle time is defined as the time elapsed between two consecutive outputs. Cycle time is taken for twenty consecutive cycles / pieces. Based on the output and the variation in the times, either the highest repetitive cycle time is taken or the average of all the cycles is taken respectively. Takt is the time the supplier has to produce one piece of the customer demand.

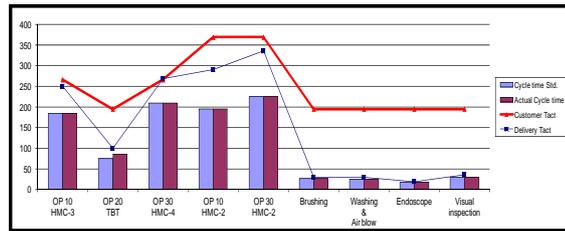


Fig 5. Takt Chart

The above chart clearly indicates that OP 30 is the bottleneck process. Otherwise, the capacity on all the other processes is sufficient to meet the requirements of the customer.

Hourly monitoring sheet (HMS)

Based on the cycle times collected from all the process across the value stream and upon identification of the bottleneck process for the demand considered, a monitoring mechanism is implemented onto the OP 30. Typically each hour the targets are fixed based on the actual cycle time, by using a formula.

$$\text{Target per hour} = \frac{\text{Available time (sec)}}{\text{cycle time (sec)}}$$

Operator on this machine is trained to enter the data onto HMS sheet as shown below.

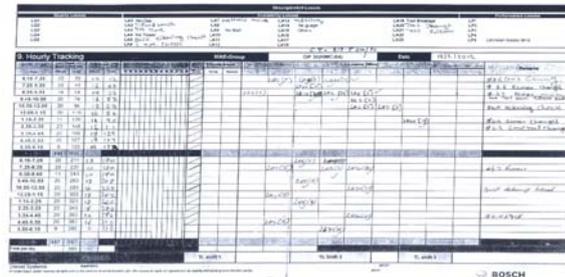


Fig 6. Hourly Monitoring Sheet

Pareto of Losses

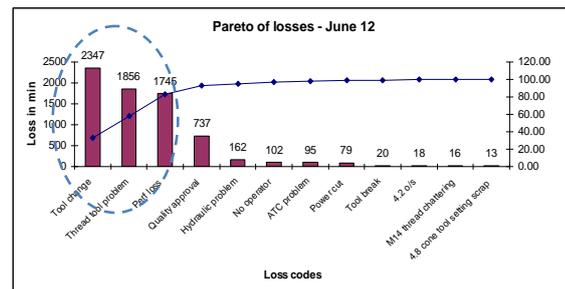


Fig 7. Pareto for quality losses

The top three losses accounting to about 80 % of the losses as highlighted in fig 7 are:

1. Tool change
2. Thread tool problem
3. Performance loss

All the above mentioned losses were analyzed in detail and specific actions were arrived at, through a detailed analysis and extensive usage of basic seven quality tools.

3.2 High Inventory

Inventory has been identified as a cause for delivery failure; this led to identification of major areas where the inventory is being blocked up. Data was collected on a daily basis and Pareto was drawn to identify the major reasons causing high inventory.

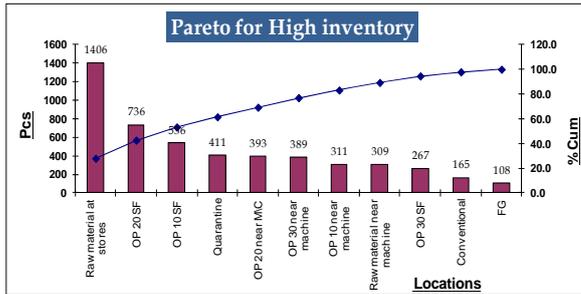


Fig 8. Pareto for inventory losses

Top four losses have been identified as:

1. Raw material at stores
2. OP 20 SF (semi finished)
3. OP 10 SF (semi finished)
4. Quarantine stock.

All the above mentioned losses were analyzed in detail and specific actions were arrived at, through a detailed analysis and extensive usage of basic seven quality tools.

3.3 Poor quality

Monitoring of defects on a daily basis has led to the identification of the major defects causing high internal rejections.

Following are the top four defects considered for analysis:

1. TBT (deep hole drilling) power scrap
2. 4.21 dimension oversize
3. RDS (inlet – pump side) / DRV (outlet –engine side) face lines
4. M14 thread tight

Each of the above mentioned significant causes have been further analyzed by 5-why analysis to arrive at the root cause of the problem.

Detailed 5- why analysis, identification of root cause and action of each of them is as mentioned below. All the above mentioned losses were analyzed in detail and specific actions were arrived at, through a detailed analysis and extensive usage of basic seven quality tools.

4. RESULTS AND DISCUSSIONS

The outcome of the actions taken for the significant causes are discussed and validated by monitoring of the key metrics for successive months. As we had started on the reduction in the lead time of the delivery of the machined hot forged rails to Bosch from the supplier, the following graph in Fig 9, shows a month on month development of the lead times for this product.

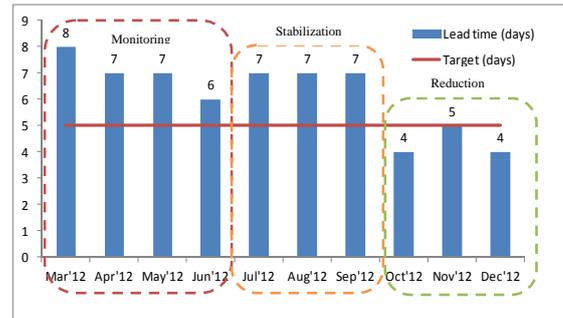


Fig 9. Lead time development month on month

The lead time has been reduced due to the following reasons:

- ✓ Reduction in semi finished goods inventory
- ✓ Reduction in quarantined stocks in the value stream

4.1 Delivery related actions

As a result of the actions taken to improve the delivery performance, the following is the development of the delivery month on month.

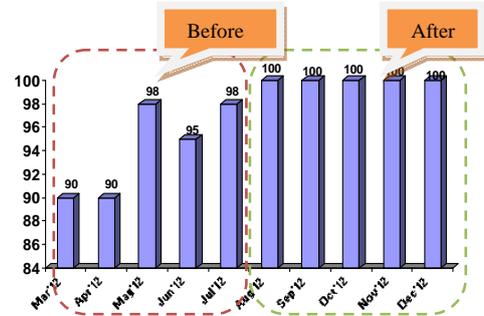


Fig 10. Delivery performance

The above data in fig 10, clearly reveals that the delivery issues were sorted. This was possible since there have been improvements in the following metric.

- ✓ Improvement in OEE on the bottleneck process (OP 30)
- ✓ Reduction in inventory in the value stream
- ✓ Reduction in the internal rejections in Rail value stream

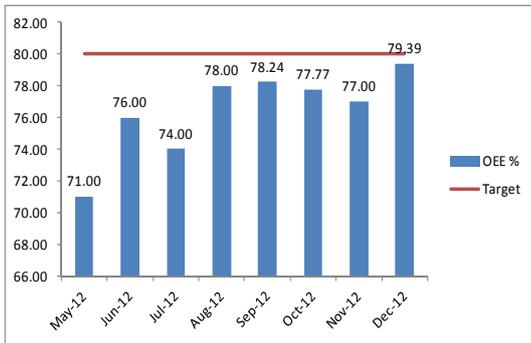


Fig 11. OEE on bottleneck month on month

Improvement in OEE has been due to the reasons like:

- ✓ Improved measurement system
- ✓ Spare tools provision near the machine
- ✓ Tool life and resharpening frequency establishment and
- ✓ Improved skill of the operators

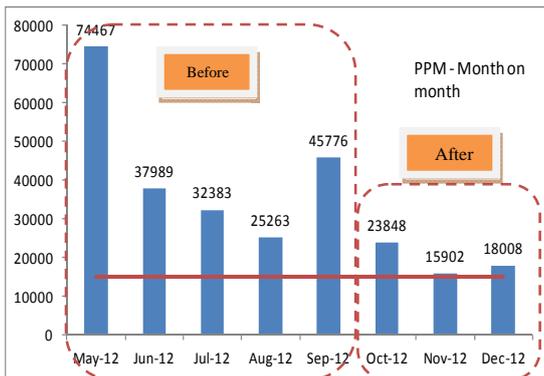


Fig 12. Internal rejections (ppm) month on month

Improvement in internal rejections has happened from the following actions:

- ✓ Reduction in TBT power scrap
- ✓ Improvement in tool design of 4.21 reamer
- ✓ Establishment of tool life and fixing the frequency of resharps

5. CONCLUSIONS

The project was taken up with an aim to reduce the lead times of the machined hot forged rails to Bosch.

- A detailed analysis of the initial data collected revealed that high lead time was due to:
 1. High inventories
 2. Low capacity on the bottleneck and
 3. High rejections

Time tested tools and techniques like Cause and Effect Diagram, Brainstorming, problem solving techniques etc were used find out the root causes of the machine stoppages. Improvements plans are made and implemented after analyzing the root causes.

All the three causes mentioned above, have been further broken down in detail to the most possible root causes, actions taken and these actions are reviewed using PDCA for each of them.

The results achieved from the project in terms of KPI have been tabulated below:

Table 1. Improvement in key metrics

Metrics	Q2'12	Q3'12	Q4'12	Yield
Lead time (days)	6.63	7	4.33	35%
Internal rejections (PPM)	56228	34474	19253	66%
Productivity (pcs / man -hr)	10.96	11.99	15.85	45%
OEE on bottleneck (%)	73	76.67	77.6	6%

With the improvement in the above metrics, the following table indicates the benefits from this project.

Table 2. Cost benefits from the project

Heading	INR /Pc
Production	7.80
Logistics (Inventory)	0.87
Quality	18.30

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