

# Production Capacity Ramp Up by Increasing First Yield Pass Using DMAIC Approach

#1 Bhushan Shinde, #2 B. D. Mahadik, #3 S. Z. Ali

<sup>1</sup>bhushnde@gmail.com  
<sup>2</sup>bapusaheb211@gmail.com



#1 PG Student, Department of Mechanical Engineering, GCE, Karad, 415124,  
#2 PG Student, Department of Mechanical Engineering, TCOER, Pune.  
#3 PG Student, Department of Mechanical Engineering, TCOER, Pune.

## ABSTRACT

Production capacity is maximum output that an industry can produce in a given period with available resources. The important parameters which affect the capacity in negative way are increase in break time, downtime, repair time and many other minor factors. A case study is done in an automotive industry with the objective of evaluating production capacity of a plant to find the factors which constitute a major part of total breakdown. Efforts are made to reduce the idle time in the assembly shop. The causes for breakdown are identified and analyzed through DMAIC methodology, so that no idle time is required due to break down or for repair work. During primary investigation, rework time required to remove scratches and dents of door due to flaws in door hanger fixture constituted a major part of total breakdown. The idle time at transfer area also play an important role in restricting productivity. This research work is carried out at Volkswagen India Ltd, Pune with a view of optimizing the production to achieve set target. The results revealed a remarkable improvement in productivity and also a new door hanger fixture has been designed, developed and implemented to reduce scratches and dents on doors.

**Keywords**— Plant capacity evaluation, DMAIC, Door hanger fixture, Productivity.

## ARTICLE INFO

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## I. INTRODUCTION

In several manufacturing areas at present, real challenges are arising for the improvements such as downtime reduction, quality improvement, efficiency improvements, cycle time reduction etc. Six Sigma's most common and well-known methodology is its problem-solving DMAIC (Define-Measure-Analyze- Improve- Control) approach. Six sigma is structured methodology that focuses on reducing variation, measuring defects and improving the quality of products, processes and services. The six sigma process has a 99.99966% defect free rate. This is equivalent to 3.4 DPMO (defects per million opportunities) or single defect for every 294000 units. It has been on an incredible run over 25 years, producing significant savings to the bottom line to the bottom line of many large and small organizations.

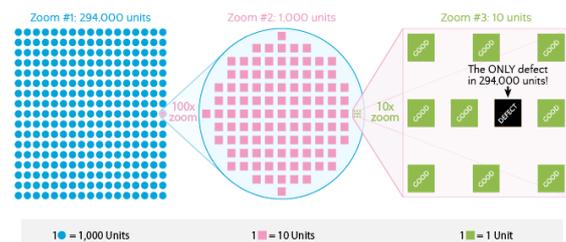


Figure 1. Six sigma: 3.4 DPMO visualized

Motorola implemented Six Sigma companywide in 1987~1997, and this practice has caused its stock price grown more 21% every year, and it also records as high as 17 billion in saving. Many more companies have also had positive results with Six Sigma. At the Schaumburg, Illinois facility, ten years after implanting Six-Sigma, great successes were seen. Though Fredrick Taylor, Walter Stewart and Henry Ford played a great role in the evolution of Six-Sigma in the early twentieth century, it is Bill Smith,

Vice President of Motorola Corporation, who is considered as the Father of Six sigma. M. Soković et al. [1] undertook projects to identify areas in the process where extra expenses did exist and introduced appropriate measurement system, which reduced expenses on production times. Gustav Nyren [2] represented the variables influencing the chosen characteristics and then optimized the process in a robust and repeatable way. John Racine focuses on what six sigma is today and its roots in both Japan and in the west and what Six-Sigma offers the world today. Philip Stephen [3] highlighted a distinct methodology for integrating lean manufacturing and Six –Sigma philosophies in manufacturing facilities.

## II. METHODOLOGY

To implement Six-Sigma, it must follow DMAIC approach step-by step. In the following sections, this approach is briefly described for the concerned organization. Lack of proper analysis may lead to the process to a wrong way, which will deviate from the main function of improvement. Every successful work goes on some specific sequence. This work also completes some specific step. After completing each successful step, it is necessary to move next step. Methodologically the total process of the work is divided into two basic stages, Measurements and Improvements. The DMAIC is a basic component of Six-Sigma methodology- a better way to improve work process by eliminating the defects rate in the final product.

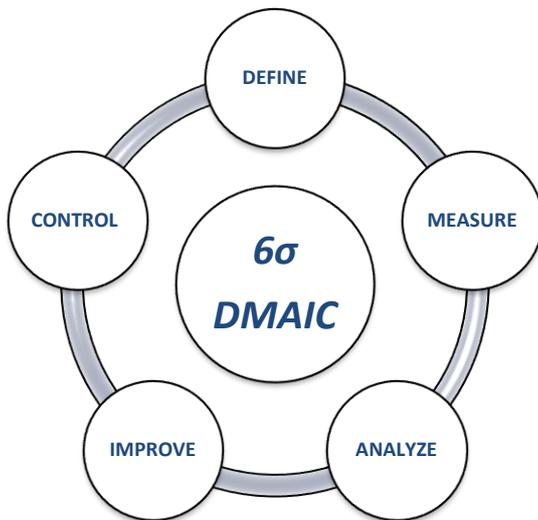


Figure 2. DMAIC methodology

The DMAIC methodology uses a process-step structure. Steps generally are sequential; however, some activities from various steps may occur concurrently or may be iterative. Deliverables for a given step must be completed prior to formal gate review approval. Step Reviews do occur sequentially. The DMAIC five steps are

**Step 1. DEFINE** the problem and scope the work effort of the project team. The appropriate types of problems have unlimited scope. Regardless of the type of problem, it should be systemic—part of an existing, steady-state process wherein the problem is not a one-time event, but has caused pain for a couple of cycles.

**Step 2. MEASURE** the current process or performance. Identify what data is available and from what source. Develop a plan to gather it. Gather the data and summarize

it, telling a story to describe the problem. This usually involves utilization of graphical tools.

**Step 3. ANALYZE** the current performance to isolate the problem. Through analysis (both statistical and qualitatively), begin to formulate and test hypotheses about the root cause of the problem.

**Step 4. IMPROVE** the problem by selecting a solution. Based on the identified root cause(s) in the prior step, directly address the cause with an improvement.

**Step 5. CONTROL** the improved process or product performance to ensure the target(s) are met. Once the solution has resolved the problem, the improvements must be standardized and sustained over time. The standard-operating-procedures may require revision, and a control plan should be put in place to monitor ongoing performance. The project team transitions the standardized improvements and sustaining control plan to the process players and closes out the project. **DMAIC builds on three fundamental principles:**

- Results-focused; driven by data, facts, and metrics.
- Work is project-based (short-term in nature, with length depending on scope and complexity) and project-structured, versus an ongoing process.
- Inherent combination of tools-tasks-deliverables linkage that varies by step in the method.

## III. CASE STUDY

Case study is performed at Volkswagen India Limited, Pune. It has Tact/Takt time of 115 seconds which indirectly means capacity of producing 31 JPH (Jobs per Hour). To check whether production is as per set target or not, a plant capacity evaluation was done in the assembly shop of the automobile pioneer, Volkswagen plant, Pune.

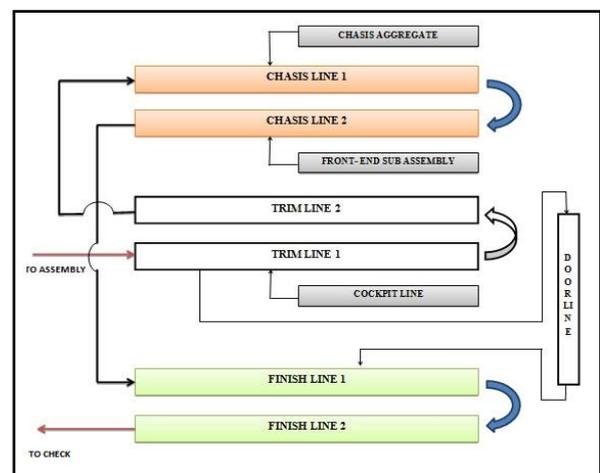


Fig 3. Schematic assembly shop layout\*

\*Not correct to scale

Capacity evaluation focused over takt times, transfer times, lifter times. This calculated time is compared with ideal timings. The comparison brought various takts, defects under light which lead to breakdowns or increase in repair time.

### 3.1 Problem definition:

Rework statistics: Number of scratches for Jan. 13- Dec 13 is shown in following chart. The chart concludes that the total number of scratches were around 1550 for the past calendar year. A company of Volkswagen's reputation are not habituated for frequent rework, also cannot compromise

with quality. What does 1 scratch mean? It means increase in cost as well as increase in repair time for an industry which produces a car every 115 sec.

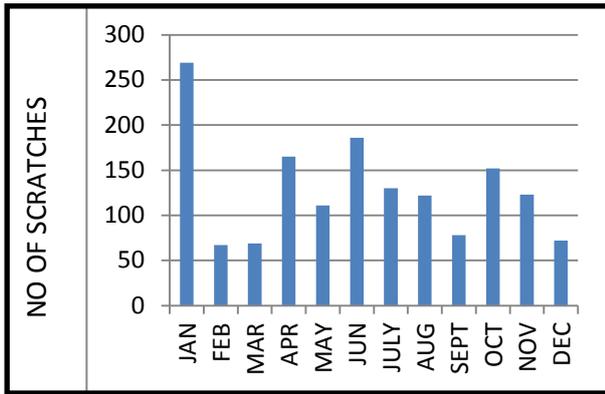


Fig 4. Month wise number of scratches in 2013

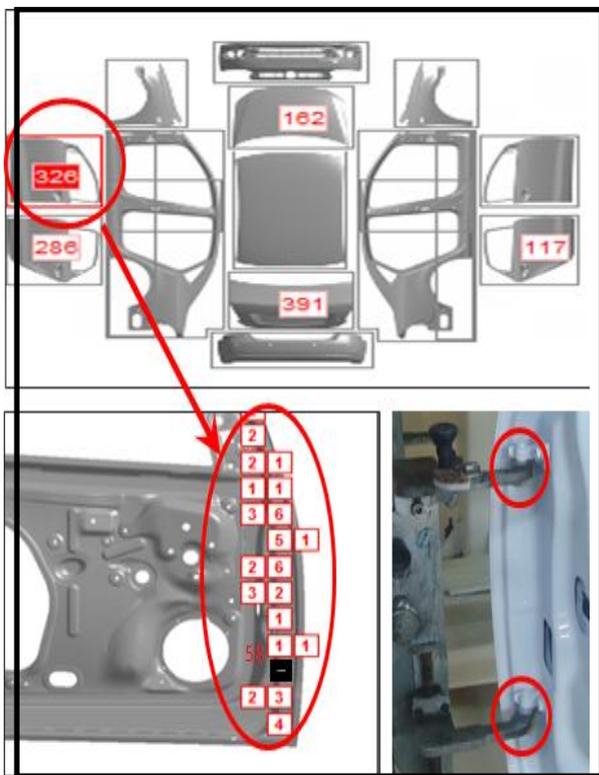


Fig 5. Door Area wise number of scratches Jan 2014 to July 2014

The results revealed that the time for rework of doors constituted a major part of total down time. The problems identified were:

1. scratches were induced in bottom half of doors.
2. frequent wearing of protective caps
3. difficulties in loading and unloading of doors

Heavy investigation was performed to root out causes of door hanger arm which led to scratches and difficulties for mounting and unmounting of doors on hangers. The root causes were as follows:

1. frequent wearing of protective caps exposed metallic nuts to bottom half of door which led to scratches on vibration.



Fig 6. Tore Protective cap and bush with metallic nut

2. the gap between door hanger's arm and door was less enough to cause an issue during locking and unlocking of doors.



Fig 7. Gap between door and locking nut

### 3.2 Proposed improvements

After thorough research through plant capacity evaluation, it was decided to redesign the fixture. The points covered were

1. Protective cap were replaced by PU coating which has excellent chemical resistance, reduced chances of wearing and hence, exposing nuts to doors



Fig 8. Increased gap between door and locking nut

2. Collar of bushes were to be reduced by 2 mm to 6 mm. this increased the gap between doors and door holding arms.



Fig 9. Nylon-6 bush and nut

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Fig

3. Metallic nuts were replaced by Nylon-6 nuts which completely eliminates possibility of scratches.

**3.3 Finalized Process sheet:**

1. Hinge bracket up and down are dissembled from door hangers.
2. Protective caps are removed and forwarded for milling.



Fig 10. Upside bracket after removal of protective caps

3. In milling thickness is reduced to 1.6 mm from 3.5 mm. and then undergoes chemical plating to get even surface and better corrosion resistance.



Fig 11. Comparison of bracket fixture before milling and plating after and

4. After plating, the brackets are forwarded to moulding where small nylon-6 balls with colour powder are heated, melted and poured in the mould, to get desired PU coating



Fig 12. Mould dies for PU coat



Fig 13. PU balls

5. Moulded brackets fixture are then assembled and checked for ease of mounting and unmounting of doors from hangers during locking and unlocking respectively.

**3.4 Cost analysis:**

The maintenance cost for temporary repair work, removal of scratches and labour was around EUR 4760 per month and rework cost for each hanger costs EUR 234.9 and has payback period of 7.4 months.

Table 1

**IMPLEMENTATION COST**

Sr. No.	Work specification	Cost (Euro)
1	Cost of 1 Door hanger fixture rework	EUR 234.9
2	Total cost for 150 hangers improvement	EUR 35,244
	SUM	EUR 35,244

Table 2

**BASE FOR REWORK**

Sr. No.	Cost	Labour (EUR)	Total (EUR)
1	Maintenance cost per month	584	4762
2	Rework cost	-----	-----
	Sum Total		4762

Table 3

**PAYBACK PERIOD**

Sr. No.	Expenditures	Euro
1	Investment	35,244
2	Expenses	0,000
3	Total	35,244
	Payback	7.4 months

**IV.RESULT**

Major benefits achieved:

1. Elimination of door scratches.

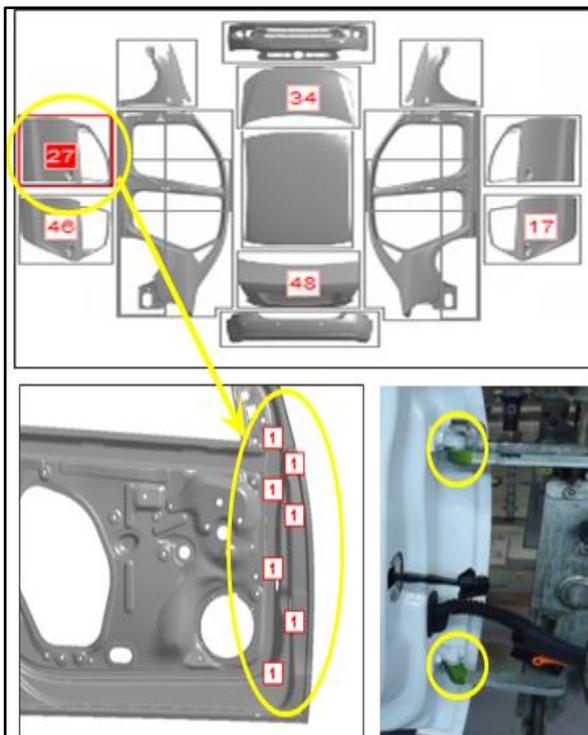


Fig 12. Door Area wise number of scratches Oct 2014 to Nov 2014

2. Elimination of continuous replacement of door hanger parts

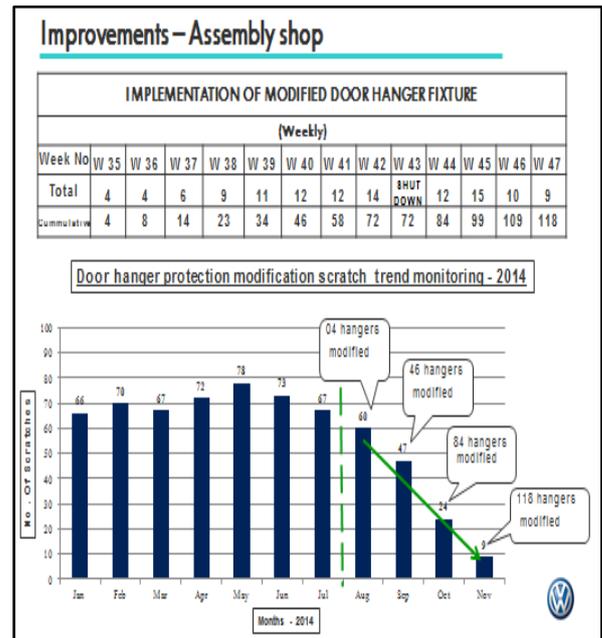


Fig 13. Implementation of modified fixture and number of scratches per month

3. Reduction in maintenance cost.

**V.CONCLUSION**

An attempt has been made to improve the productivity and profitability of the industry. The key to any successful project is to meet both budget and schedule requirements. Also, in order for project plan to be reliable, it needs to follow a control mechanism to achieve project goals. This research work demonstrated the applications of plant capacity evaluation in order to find defects, problems, itscauses and remedies for productivity enhancement. The objective of case study done at Volkswagen India limited, Pune was to eliminate rework required due to the improper design of door hanger arm.

The case study resulted in cost saving of Euro 4762 per month. Also the implementation of improved door arm fixture reduces the motion waste and monotonous efforts of the labours which further enhances the labours' job satisfaction and goodwill of the organization.

The main conclusions and recommendations from the previous analysis can be listed as follows:

1. Implementation of takt time will improve overall WIP (Work in progress) efficiency to a good value. It helps decreasing the WIP between the stages and finished goods inventory.
2. Takt time policy has no significant impact on the overall equipment effectiveness (OEE) as it is primarily depends on quality and system reliability.
3. The other thing which plant capacity evaluation reveal is there is scope for improvement in transfer time between trim lines. It has contributed second largest to the total downtime with 2316 mins of break time.
4. With objective of producing 34 JPH, industry need to focus on various TAKT's and transfer times

which are consuming unnecessary or exceeding takt time of 115 sec.

The mechanical design and material selection of the fixture is appropriate for its intended service. Failure can be attributed to improper repair/ reconditioning of the door arm fixture.

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