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Case Study of Cycle Time Reduction by Mechanization in Manufacturing Environment

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Abstract. Research and Innovation offer facilitation, fulfil the day to day requirements, and bring sophisticated things to the society. In industries such facilitation reduces the fatigue, employee morale and improves productivity. The research is focused on such requirement for gear box manufacturing industries. The Six sigma approach of Eliminate, Combine, Rearrange, Simplify (ECRS) method and cycle time analysis were carried out to understanding the problem and solution requirements. The newly mechanized equipment was installed and tested. The result shows that cycle time reduced significantly and reduced employee fatigue and raised morale to a great extent. The designed equipment is a general purpose to improve the productivity of similar industries.

1. Introduction

Nowadays, industrial gearboxes are vital in many industries, notably in Automobile industries, Cement industries, sugar industries, Paper industries, Steel plants, mining industries, Food processing industries, Pharmacy industries, and Pulp industries etc. This research focused on gear box manufacturing industry in particular testing section. The various kinds of gear boxes manufacture of different assembly line and arrive randomly to the Testing section. Hence the delivery schedule was probably affected by the bottleneck area (Testing Section). The facilitation in such bottleneck area will considerably increase the productivity. From the literature evident that six sigma approach can be used for improving quality in injection moulding process, in metal casting foundry industries in semiconductor foundry in a manufacturing industry [1 and 2]. A specific solution for engine overheating problem was solved by using six sigma approaches [3]. Apart from manufacturing industries, Shanmugaraja et al [11 and 12] used for various applications and proved quality with productivity achieved by using six sigma in project industries.

The lean Six Sigma is a powerful business improvement methodology for improving the efficiency and effectiveness made attempts to implement it in higher education institutions. Antony et al [4] discussed the feasibility of six sigma implications for service industries and Jiju Antony, and Darshak Desai A [5] for software industries and provided assessing the status of Six Sigma implementation in the Indian industry. Darshak A Desai [9, 10, 13 and 16] furnished the impact of Six Sigma in a developing economy analysis on benefits drawn by Indian industries. Gijo E V et.al

[14] discussed important concepts, surveys and case studies in continuous improvement methodology and highlighted future implications.

The authors noticed that the literature on this classification is limited. Kunal Ganguly [17] highlighted the role and responsibilities of academic institutions in developing six sigma by research. Jiju Antony [5] highlighted the pros and cons of six sigma concept with the academic perspectives. Neha Gupta [15] presented overview on six sigma quality improvement program. Jiju Antony [5] distinguished that even though Six Sigma and lean methodologies are focused on process and quality improvement, Lean has special features of formalization and codification of experience and judgment where as in Six Sigma has not. However Six Sigma emphasizes variation, defects and process evaluation, but Lean emphasizes speed and waste. But integration both concepts have some added advantages.

Rishi Pareek and Jaiprakash Bhamniya [18] provided a conceptual model by integrating lean principles with Six Sigma methodology as a consistent approach to providing continuous improvement. Jose Mehdiuz Zalan et.al [19] deployed compatibility of the green, lean and Six Sigma concepts and insisted that all these should be an integrated approach. In this work The Six sigma approach of Eliminate, Combine, Rearrange, Simplify (ECRS) method and cycle time analysis were carried out to understanding the problem and solution requirements.

2. Problem definition

The factory produces the gearboxes are tested under three categories like horizontally mounted gearboxes, vertically mounted gearboxes and angularly mounted gear boxes. The activities involved in the existing method of setting up for testing are as follows.

- Lifting the gear box
- Mounting the gearbox in bed
- Motor tilting
- Clamping the gear box in bed
- Clamping the motor in bed/ frame
- Oil filling
- Gearbox Testing
- Removing gear box clamping
- Oil drains.

In which the motor tilting and clamping the motor with proper alignment are not only consuming more time, but also causes for Frequent injuries to the labors and gives fatigue to workers by its frequency. Hence, these activities increase the overall cycle time of testing and lower the productivity. The research aims to study and solve this problem systematically to increase the time productivity, employee morale and their safety. It was planned to design supporting equipment instead of using standard supporting blocks, crane, and eliminate the practice of manually guessed tilt and checking of the angle of tilt, motor clamping time etc.

3. Methodology

- Recording of the customer demand, according to the production cycle time.
- Observing the corresponding customer requirement trend.
- Observing the production cycle time of the testing process and motion.
- Finding the root cause of reducing the process cycle time.
- Making the action plan to implement the root cause.
- Revising the Testing process sequence as the result of analysis in accordance with ECRS method.
- Designing the new fixture for Tilting the Motor as a result of analysis.
- Analyze the new design

- Create a part drawing & assembly drawing of the new Tilting machine as the design considered.
- Fabricate the Tilting machine as per the drawing.
- Inspecting all the parameters of Machine in manufacturers end.
- Commissioning the Tilting machine in the plant
- Take a trail of Testing process cycle time.
- Recording the cycle time continuously with minimum number of cycles.
- Monitoring the productivity result with the condition of before/after.
- Ensue the sustaining of the proposed procedure.

4. The motor tilting machine

Initially the proposed equipment was designed by using the software of solid house, version 2014. The figure 1 shows the principal part of a newly designed machine for tilting the testing motor with common clamping for all types of gearboxes. The Table 1 is Part list of MTM. The MTM consists of horizontal & vertical frame. Lead screw provided to achieve for horizontal and vertical motions to set the motor as desired location.

The lead screws are driven by electric motors. The vertical frame contains L bracket in which the face plate is attached to provide the desired angle of rotation of the motor. The motor is mounted on the shaft of face plate in the L bracket. As the faceplate is a critical part in the machine, the face plate is designed well and analyzed by FEM by using ANSYS software before it fabricated. The figure 2 shows such details.

Table 1. Part List of MTM.

Part No	Description	Qty
1	Horizontal Frame	1
2	Vertical Frame	1
3	Horizontal Lead Screw	1
4	Vertical Lead Screw	1
5	Face Plate	1
6	Face Plate Flange	1
7	Up Down Plate	1
8	LM Rail 30	2
9	LM Black 30	4
10	Gear Box	1
11	Motor 0.75 KW	1
12	Gear Box	1
13	Motor 1.1 KW	1
14	Gear Box	1
15	Plummer Block UCFL	2
16	Plummer Block UCP	4
17	Motor 22KW	1

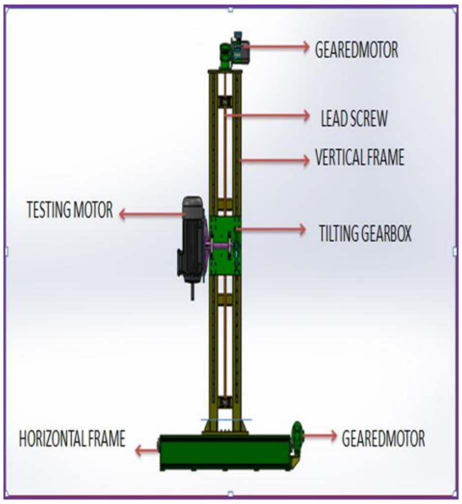

Figure 1. Tilting testing motor

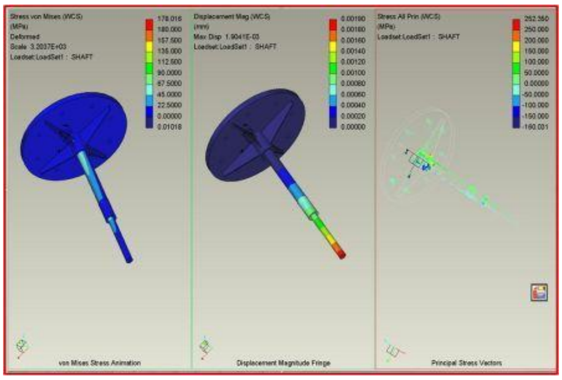

Figure 2. Design of the base

5. Performance evaluation

The Motor tilting machine fabricated commissioned and its performances were evaluated.

Figure 3. Before and after Vertical type gear box testing setup

Figure 4. Before and after Horizontal type gear box testing setup

6. Result And Discussion

The problem identified by using ECRS method the same was used here to compare performance of MTM. The time productivity can be observed from Table 2. The sustainability of the results was monitored and shown in figure 5 -8.

Table 2. ECRS observation and Before and after cycle Time Comparison

Sl. No	Activity	Before 'T' min	E	C	R	S	After 'T' min
1	Lifting the gear box	5	X	X	X	X	5
2	Mounting the gearbox in bed	5	X	X	X	X	5
3	Motor tilting	30	X	0	X	X	3
4	Clamping the gear box in bed	10	X	X	X	X	10
5	Clamping the motor in bed/ frame	30	X	0	X	X	0
6	Oil filling	10	X	X	X	X	10
7	Gearbox running time	60	X	X	X	X	60
8	Removing gear box clamping	10	X	X	X	X	10
9	Oil draining	10	X	X	X	X	10
	Total Time	170	X	0	X	X	113

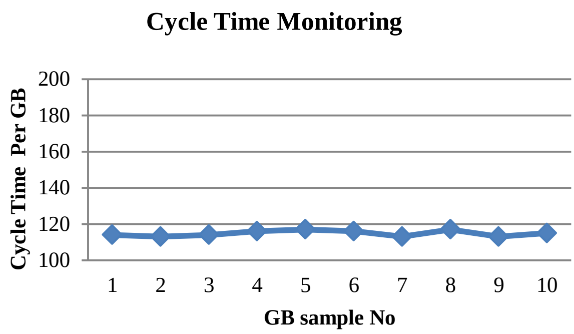

Figure 5. Cycle Time performance per week

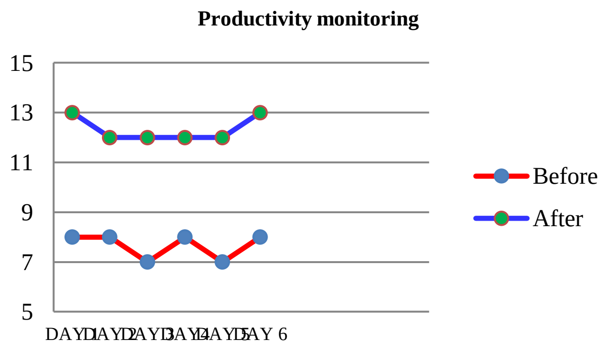

Figure 6. Productivity performance per week

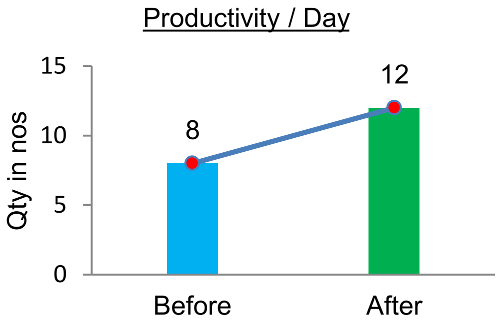

Figure 7. Average Productivity statistics for a week

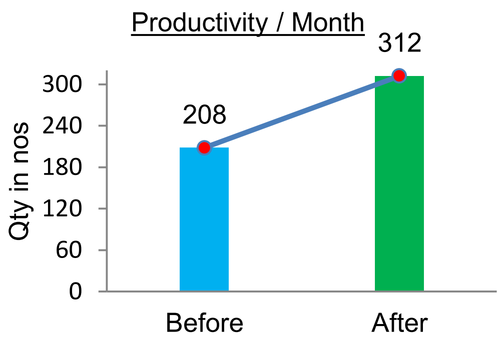

Figure 8. Average Productivity statistics for a month

7. Conclusion

The identified problem of high time and human effort consuming in gear box setting for various configurations were rectified with designing equipment. After Designing major parts like lead screws and face plate they were analyzed by ANSYIS software. The new equipment helped to reach the average testing rate from 208 gear boxes per month to 302 gear boxes per month by reducing cycle time by 57 minutes per gear box in average. The designed Machine will be useful for similar industries and increasing testing speed.

8. References

[1] VikasDwivedi Mohd and Anas Mohd Siraj 2014 Six Sigma: As applied in Quality Improvement for injection Molding Process *International Review of Applied Engineering Research* **4(4)** 317-324.

[2] Bharati P K, Khan M I and Harvinder Singh 2011 Six Sigma Approach for Quality Management in Plastic Injection Molding Process: A Case Study and Review *International Journal of Applied Engineering Research* **3(6)** 303-314.

[3] Vijayaram T R, Sulaiman S, Hamouda A M S and Ahmad M H M 2006 Foundry quality control aspects and prospects to reduce scrap rework and rejection in metal casting manufacturing industries *Journal of materials processing technology* **178** 39-43.

[4] Antony J, Kumar M, and Tiwari M K, 2005 An application of Six Sigma methodology to reduce the engine-overheating problem in an alternative company *Proceeding of the Institution of Mechanical engineers Part B Journal of Engineering Manufacture* ***219(8)*** *633-646.*

[5] Jiju Antony, and Darshak Desai A, 2009, Assessing the status of Six Sigma implementation in the Indian industry *Management Research News* **5(32)** 413-423.

[6] Vikas Tayal and Jitendra Kumar 2012 Improvement in production rate by reducing the defects of injection moulding *International Journal of computer science and comm*. Engg. IJCSCE Special Issues on Emerging Trends in Engg ICETIE.

[7] Saravanan Rathinasamy and Raju R, 2010 Sequencing and scheduling of non-uniform flow pattern in parallel hybrid flow shop *International Journal of Advanced Manufacturing Technology* **49** 213–225.

[8] Darshak A Desai and Mulchand B Patel 2009 Impact of Six Sigma in a developing economy analysis on benefits drawn by Indian industries *Journal of Industrial Engg. And Mana* **2(3).**

[9] Darshak A Desai, 2012 Increasing Bottom-line through Six Sigma quality improvement drive: case of small scale foundry Industry Udyogpragati **2** 36.

[10] Darshak A Desai 2008 Improving productivity and profitability through Six Sigma: Experience of a small scale jobbing industry *International Journal of Productivity and Quality Management* **3(3).**

[11] Shanmugaraja M, Nataraja M and Gunasekaran N 2011 Quality and Productivity improvement using Six Sigma and Taguchi method *International Journal of Business Excellence* **5(4).**

[12] Shanmugaraja M, Nataraja M and Gunasekaran N 2012 Literature snapshot on Six Sigma project selection for future research *International Journal Services and Operations Management* **3(11)**.

[13] Darshak A Desai, 2012 Quality and Productivity improvement through Six Sigma in foundary industry *International Journal of Productivity and Quality Management* **2(9)**.

[14] Gijo E V, ShreerangaBhat and Jnanesh N A 2014 Application of Six Sigma methodology in a small-scale foundary industry *International Journal of Lean Six Sigma* **2(5)**193-211.

[15] Neha Gupta, 2013 An overview on Six Sigma: Quality Improvement Program *International Journal of Technical Research and Application* **1(1)** 29-39.

[16] Darshak A Desai 2006 Improving customer delivery commitments the Six Sigma way: case study of an Indian small scale industry *International Journal of Six Sigma and Competitive Advantage* **1(2)**.

[17] Kunal Ganguly 2012 Improvement process for rolling mill through the DMAIC six sigma approach *International Journal for quality research* **3(6)** 221-231.

[18] Rishi Pareek and Jaiprakash Bhamniya, 2013 Optimization of Injection Moulding Process using TAGUCHI and ANOVA *International Journal of Scientific & Engineering Research* **1(4)**.

[19] Mehdiuz Zalan, Sujitkumar Pattanayak and Arun Chandra Paul, 2013 Study of feasibility of Six Sigma implementation in a manufacturing industry: A case study *International Journal of Mechanical and Industrial Engineering (IJMIE)* **1(3)**.