Reduction of Cycle Time by application of Kaizen : A Case Study

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***Abstract* – Every industry wants to enhance profit or reduce cost by applying different modern available techniques. One of the most familiar techniques for continuous improvement is "Kaizen". This paper aimed to explain the application of Kaizen in Worm Shaft manufacturing industry. The objective of this case industry was to reduce cycle time. After implementation of Kaizen the cycle time reduced from 412 seconds to 404 seconds.**

***Index Terms* – Concept of Kaizen, Continuous Improvement, Kaizen Methodology.**

I. INTRODUCTION

Kaizen was generated in Japan following World War II. Kaizen was originated by Quality Guru Dr. W. Edwards Deming, but popularized by Masaki Imai.

Kaizen is an amalgam of two Japanese words [kai(change) + zen(for the better)], that means "Change for the better" (George Alukal and Anthony Manos,2006 and Palmer V S, 2001). It is interpreted as "Continuous Improvement" in English. The word Kaizen be a sign of the standard approach of work (Chen J C, Dugger J and Hammer B, 2000).

Kaizen is an approach that (G. Wittenberg, 1994),

- Starts with people
- Focus its attention on people's efforts
- Processes are continually improved
- Improved processes will improve results
- Improved results will satisfy the customers

II. LITERATURE REVIEW

The Kaizen philosophy has made good impact on researchers as it improves the productivity of an organization and also helps to produce high quality products with minimum efforts. The concept of Kaizen has been discussed by various authors as following:

Kaizen is a process of Continuous Improvement which involves everyone (Imai, 1986). CI is extensively carried out in manufacturing and quality circles (Suzaki, 1987). Kaizen is a systematic approach to reduce wastes (Womack and Jones, 1996). Kaizen was applied to Jet Engine manufacturing industry and resulted into 89% improvement in WIP and 88.5% productivity enhancement (Sheridan, 1997). An application of CI may turn into various benefits like waste reduction, reduced setup time, minimization of breakdowns and reduced lead time etc. (Hyland et al., 2004).

III. METHODOLOGY OF KAIZEN

Kaizen methodology can be used in different fields like engineering, manufacturing, management and other supporting processes in organization. The methodology of Kaizen is also identified as Deming's PDCA Cycle or Shewhart Cycle. The methodology of Kaizen is illustrated in Fig 1(www.satistar.com).

Fig. 1 - Methodology of Kaizen

Step 1: Select Target Process

The targeted process was Key Way Cutting process carried out on a CNC machine (VMC-9) where two Worm shafts were clamped with the help of vice and the cutting operation was carried out simultaneously on both the shafts such that in single cycle time two shafts being performed key way cut.

Step 2: Create Team

Based on experience related with Key way milling process operation the team was organized.

Step 3: Set Project Goals & Plans

After creation of Team, set project goals and plans. The Primary Project Goal was to reduce cycle time and the Secondary Project Goal was to identify wastes.

Step 4: Observe the process

For observation we have carried out following kind of Time Study on VMC-9 as shown in following table 1:

Table 1 – Time Study Analysis (Before Implementation of Kaizen)

Sr. No.	Elements	1	2	3	4	5	Avg.
1	Rough cut on 1st Job on 1st Vice	72.32	72.30	72.31	72.35	72.29	72.314
2	Tool Movement from 1st Vice to 2nd Vice	5.94	5.95	5.94	5.96	5.98	5.954
3	Rough Cut on 2nd Job on 2nd Vice	72.30	72.32	72.31	72.28	72.33	72.308
4	Tool Changing and Tool Approach	10.12	10.15	10.13	10.09	10.08	10.114
5	Finish Cut on 1st Job on 1st Vice	59.03	58.98	59.01	58.95	58.94	58.982
6	Tool Movement from 1st Vice to 2nd Vice	5.98	5.96	5.95	5.98	5.98	5.97
7	Finish Cut on 2nd Job on 2nd Vice	58.98	58.96	58.99	58.97	59.01	85.982
8	Tool Changing and Tool Approach	**16.20**	**16.22**	**16.19**	**16.21**	**16.20**	**16.204**
9	Chamfer on 1st Job on 1st Vice	44.55	44.56	44.54	44.57	44.56	44.556
10	Tool Movement from 1st Vice to 2nd Vice	5.98	5.99	5.98	5.94	5.95	5.968
11	Chamfer on 2nd Job on 2nd Vice	44.57	44.56	44.57	44.54	44.55	44.558
Actual Cycle Time (sec)		**412**	**412**	**412**	**412**	**412**	**412**
Machining Time (sec)		**351.75**	**351.68**	**351.66**	**351.66**	**351.68**	**351.70**
Idle Time (sec)		**60.25**	**60.32**	**60.27**	**60.34**	**60.32**	**60.30**
Chip Making Efficiency = (MT*100)/Actual Cycle Time		**85.37%**	**85.36%**	**85.37%**	**85.34%**	**85.36%**	**85.36%**

Step 5: Analyze the process

By systematically analyzing the Time Study we conclude that the Tool Changing and Tool Approach Time is more for Chamfer Tool.

We had used the 5Why Technique to determine the root cause of a problem. The 5Why Technique is shown below.

Why-Why Analysis		
Why	**Question**	**Root Cause**
1	**Why there is more Cycle Time?**	**Tool Changing and Tool Approaching Time is more.**
2	**Why the Tool Changing Time is more?**	**The Tool for next operation is not ready for change.**
3	**Why the Tool for next operation is not ready?**	**The operator is lack of information.**

Step 6: Create Improvement

After identification of root cause, with the help of Expert advice, Brainstorming or Novel Idea we had suggested following recommendations:

1. Modify a program such that the next tool is being positioned during the previous operation carried out on 2nd Job.
2. Increase the rapid movement of tools from 50% to 100%.

Step 7: Implementation

The Cycle Time for Key Way Milling Operation was 412 seconds. Hence our reading value X = 7 or 6. For required observations we had calculated sample size for Primary Observations N = 5 as shown in following table 2:

Table 2 – Calculation for Observation Values

Observation Values	
X	**X^2**
7	49
6	36
7	49
7	49
6	36
$\sum X = 33$	$\sum X^2 = 219$

Calculation for Sample Size

$$N' = \left(\frac{20\sqrt{[N\sum X^2 - (\sum X)^2]}}{\sum X}\right)^2$$

$$\therefore N' = \left(\frac{20\sqrt{[(5 \times 219) - (33)^2]}}{33}\right)^2$$

$$\therefore N' = 2.20$$

This indicates 3 readings are required for analysis.

Following table 3 shows the Time Study Analysis after Kaizen Implementation:

Table 3 – Time Study Analysis (After Implementation of Kaizen)

Sr. No.	Elements	1	2	3	Avg.
1	Rough cut on 1st Job on 1st Vice	72.29	72.32	72.31	72.307
2	Tool Movement from 1st Vice to 2nd Vice	5.48	5.49	5.46	5.476
3	Rough Cut on 2nd Job on 2nd Vice	72.33	72.30	72.31	72.313
4	Tool Changing and Tool Approach	9.48	9.46	9.51	9.483
5	Finish Cut on 1st Job on 1st Vice	59.63	59.26	59.84	59.577
6	Tool Movement from 1st Vice to 2nd Vice	5.47	5.45	5.49	5.47
7	Finish Cut on 2nd Job on 2nd Vice	58.90	59.49	59.40	59.263
8	Tool Changing and Tool Approach	12.18	12.19	12.15	12.173
9	Chamfer on 1st Job on 1st Vice	44.89	44.81	44.96	44.887
10	Tool Movement from 1st Vice to 2nd Vice	5.48	5.45	5.48	5.47
11	Chamfer on 2nd Job on 2nd Vice	44.55	44.78	44.96	44.763
Actual Cycle Time (sec)		404	404	404	404
Machining Time (sec)		353.41	354.32	354.85	354.19
Idle Time (sec)		50.59	49.68	49.15	49.807
Chip Making Efficiency = (MT*100)/Actual Cycle Time		87.47%	87.70%	87.23%	87.44%

This analysis indicated that after successfully implementation of Kaizen the Cycle Time was reduced from 412 seconds to 404 seconds.

Step 8: Presentation

Make a record of these data and present to upper level management.

IV. Result and Conclusion

If there is a batch of 120 pieces per day then the industry will be save at least 480 sec (8minutes) per day. Hence we can save 40 hours for 300 working days.

By successfully implementation of Kaizen Methodology we have enhanced Productivity by 2.08%. The reduction of Cycle Time is shown in figure 2:

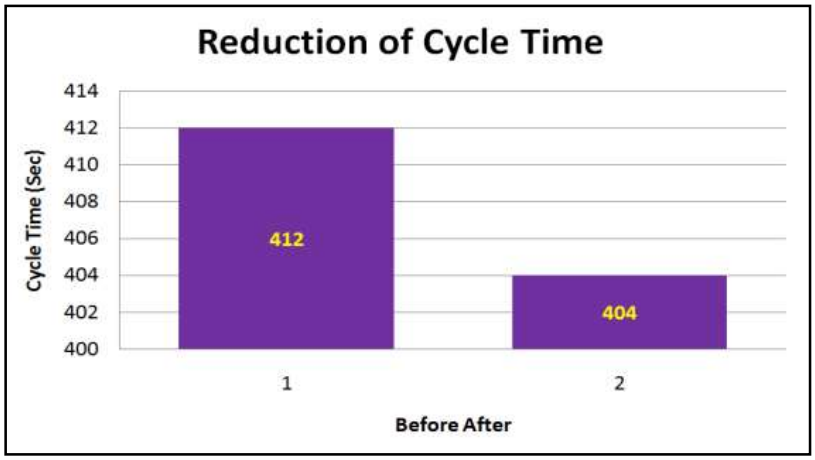


Fig. 2 – Reduction of Cycle Time

V. KAIZEN IDEA SHEET

Kaizen Idea Sheet is shown in fig. 3:

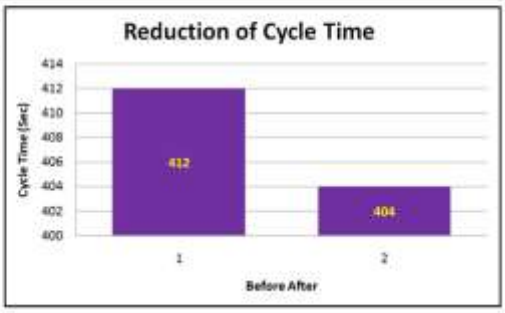
XYZ Pvt. Ltd	Kaizen Idea Sheet - Reduction of Cycle Time			
	Div. - Worm Cell	Machine - Keyway Milling Machine (VMC-9)	Operation - Keyway Inspection & Rework	Team Members - Jignesh Bhoi, R. M. Patel, Sagar Patel, Bharat Prajapati
Kaizen Theme			Kaizen Idea	
To Reduce Cycle Time			Changing Chamfer Tool before Finish Milling of 2nd Job	
Problem/Present Status		Technique (Why-Why Analysis)	Root Cause	Suggestions
The Keyway is generated on this m/c and 2 jobs are completed simultaneously. But the Tool Changing & Tool Approaching Time is more for Chamfering of jobs.		Why 1 - More Cycle Time Why 2 - Tool Changing & Approaching Time is more for Chamfer Tool Why 3 - Improper Programming Why 4 - Lack of Skill of an Operator	Lack of Skill of an Operator	Modify a program such that the next Tool is being positioned during the previous operation carried out on 2nd Job. Increase the rapid movement of Tools from 50% to 100%.
Action to be taken		Kaizen Sustainance		Result
Modify the Programme such that the Chamfer Tool will be changed before the opreation (Finish Milling of Keyway on 2nd Job). Change Rapid Movement of Chamfer Tool from 50% to 100%.		What to do? Modify the Programme How to do? Train operator		
Benefits through Kaizen		Cost of Kaizen		
Reducing Cycle Time of 8 sec for 2 jobs. If there is a batch of 120 pieces per day then PBL will save at least 480 sec (8 min.) per day. Hence PBL will save 40 hours for 300 working days.		0		

Fig. 3 – Kaizen Idea Sheet

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REFERENCES

[1] Chen J C, Dugger J and Hammer B (2000), ―A Kaizen Based Approach for Cellular Manufacturing Design: A Case Study‖, The Journal of Technology Studies, Vol. 27, No. 2, pp. 19-27.
[2] G. Wittenberg (1994), ―Kaizen – The many Ways of Getting Better‖, Assembly Automation, Vol. 14 No.4, 1994, pp. 12-17.
[3] George Alukal and Anthony Manos (2006), Lean Kaizen – a simplified approach to process improvements, ASQ Quality Press.
[4] Hyland P W, Milia L D and Terry R S (2004), "CI Tools and Technique: Are There any Difference Between Firms?" Proceedings 5th CINet Conference, Sydney, Australia.
[5] Imai M (1986), Kaizen: The Key to Japan's Competitive Success, McGraw Hill, New York, USA.
[6] Palmer V S (2001), ―Inventory Management Kaizen‖, Proceedings of 2nd International Workshop on Engineering Management for Applied Technology, pp. 55-56, Austin, USA
[7] Suzaki K (1987), The New Manufacturing Challenge-Techniques of Manufacturing Systems, John Wiley and Sons, Inc., New York.
[8] Womack J P and Jones D T (1996), Lean Thinking, Simon & Schuster, New York.
[9] Sheridan J H (1997), "Kaizen Blitz", Industry Week, Vol. 246, No. 16, pp. 18-27.
[10] www.satistar.com