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REDUCING REJECTION RATE OF KEYWAY SYMMETRIC IN CRANK SHAFT MANUFACTURING PROCESS USING ISHIKAWA DIAGRAM AND POKA YOKE TECHNIQUE

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ABSTRACT

Organizations need to improve their processes to continually achieve customer satisfaction and, to do that in an effective and efficient way, should usetools and techniques. Thepurpose of this study is to reduce the rejection rate of keyway symmetric in crank shaft.A new modifications in woodruff keyway operation to increase its efficiency and to reduce in the line manufacturing defects by using Ishikawa diagram and Poka yoke technique. It is an effort made to carry out a detailed study on existing keyway process of crankshaft in winner XL machine and analyze their approach towards expected target.

Key words: *crank shaft, Pareto analysis, Ishikawa diagram and Poka yoke*

I. INTRODUCTION

Quality is "Fitness for use" or "customer satisfaction" or "continuous improvement". Quality Control Circles is a small group to perform voluntarily quality control activities within the same workshop. This small group carries on continuously as a part of companywide quality control activities for self-development and mutual development and improvement within the workshop, utilizing quality control techniques with all the members participating. For solving quality problems seven QC tools used are Pareto Diagram, Cause & Effect Diagram, Histogram, Control Charts, Scatter Diagrams, Graphs and Check Sheets. All this tools are important tools used widely at manufacturing field to monitor the overall operation and continuous process improvement. This tools are used to find out root causes and eliminates them, thus the manufacturing process can be improved. The modes of defects on production line are investigated through direct observation on the production line and statistical tools.

Ishikawa Diagram

A Cause-and Effect Diagram is a tool that shows systematic relationship between a result or a symptom or an effect and its possible causes. It is an effective tool to systematically generate ideas about causes for problems and to present these in a structured form. This tool was devised by Dr. Koura Ishikawa and as mentioned earlier is also known as Ishikawa Diagram

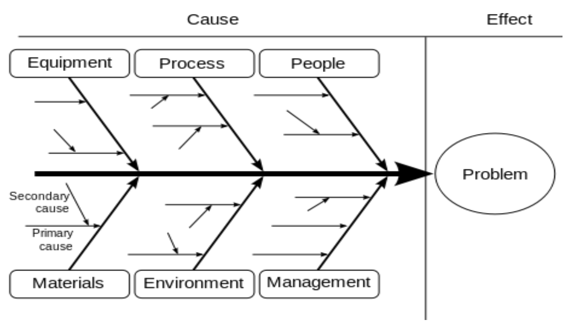

Figure 1:*Ishikawa diagram*

Poka Yoke

Poka-yoke is a Japanese term that means "mistake-proofing". A Poka-yoke is any mechanism in a lean manufacturing process that helps an equipment operator avoid (yoke)mistakes (Poka). Its purpose is toeliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The concept was formalised, and the term adopted, by Shigeo Shingo as part of the Toyota Production System

Principles Of Poka Yoke

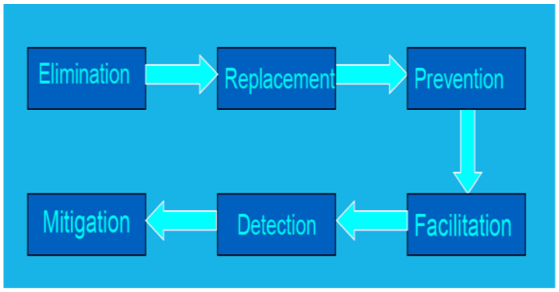

Figure2: ***Poka yoke principle***

Crankshaft

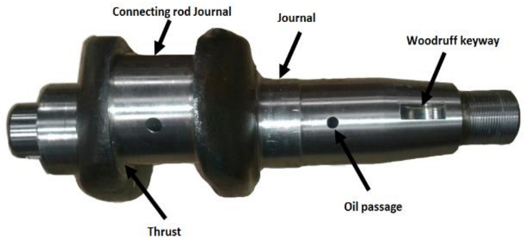

Figure 3: Crankshaft

A crankshaft is a mechanical part able to perform a conversion between reciprocating motion and rotational motion. In a reciprocating engine, it translates reciprocating motion of the piston into rotational motion; whereas in a reciprocating compressor, it converts the rotational motion into reciprocating motion. In order to do the conversion between two motions, the crankshaft has "crank throws" or "crankpins", additional bearing surfaces whose axis is offset from that of the crank, to which the "big ends" of the connecting rods from each cylinder attach.

En19 Material Specification

Table 1: ***En19 material specification***

En19 Material Specification					
Chemical properties			Mechanical properties		
Sl No	Chemical composition	Composition %	Sl No	Properties	Values
1	Carbon	0.35-0.45	1	Hardness (BHN)	201-255 BHN
2	Manganese	0.50-0.80	2	Tensile Strength	45N/mm
3	Silicon	0.10-0.35	3	yields Strength	34N/mm
4	Sulphur	0.02-0.05	4	% of Elongation	22%
5	Phosphorus	0.05	5	IZOD	40ft.lbs
6	Chromium	0.90-1.15			
7	Molybdenum	0.20-0.40			

Keyway Milling

Keyways are grooves of different shapes cut along the axis of the cylindrical surface of shafts, into which keys are fitted to provide a positive method of locating and driving members on the shafts. A keyway is also machined in the

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mounted member to receive the key. The type of key and corresponding keyway to be used depends upon the class of work for which it is intended. The most commonly used types of keys are the Woodruff key, the square-ends machine key, and the round-end machine key.

Woodruff Key

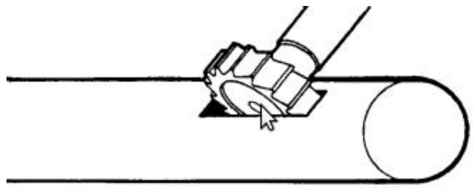
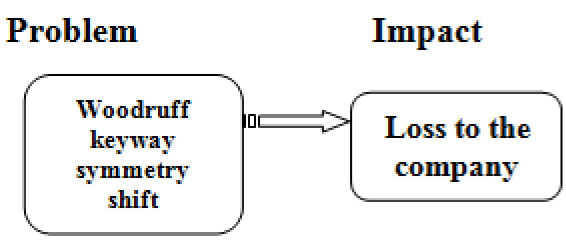


Figure 4: ***Woodruff Keyway Process***

The Woodruff keys are semi cylindrical in shape and are manufactured in various diameters and widths. The circular side of the key is seated into a keyway which is milled in the crankshaft. The upper portion fits into a slot in a mating part, such as a pulley or gear. The Woodruff key slot milling cutter must have the same diameter as that of the key. This machine makes the woodruff keyway milling operation.

Problem Definition

There was a scenario where the problem arised in the keyway milling operation,the problem in which the woodruff keyway symmetry shift in regular intervals. Due to this the rejection PPM was high.This leades to rejection of fully machined component as a scrap resulted in major loss to the company.



II. DATA COLLECTION AND ANALYSIS

Sl no	Reason for defects	Nov	Dec	Jan	Average
1	Woodruff keyway symmetry shifted	15	22	18	18.33

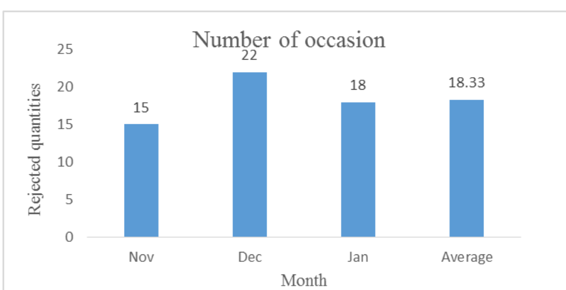


Figure 5: ***Woodruff keyway symmetry variation from Nov 15 to Jan 16***

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The total average woodruff keyway symmetry shifted per month is 18 components.

Contributing Factor For Vwh Crankshaft

Pareto analysis: It is a formal technique useful where many possible courses of actions are competing for attention. Pareto analysis is a creative way of looking at causes of problems becomes it help to stimulate thinking and organize thoughts. This technique helps to identify the top portion of causes that need to be addressed to resolve the majority of problem.

We carried out Pareto analysis and we found amongst woodruff keyway symmetry shift was one which was contributing to 31% of the component rejected.

Brainstorming Session

Brainstorming is a technique used to elicit a large number of ideas from a team using its collective power. The brainstorming procedure and rules were taught to the team members at department level as to establish the cause and effect diagram. The leader stated the topic for discussion. Brainstorming has been conducted with five people (panelists) from production, quality control and spare part (tool and die preparation) departments using the following discussion questions.

Discussed points are: • what is defect?

• How to rate the defects?

• What are the major defects in the production of cartridge (case and bullet)?

• What are the causes for the defects listed?

Causes-And-Effect/Fishbone Diagram

Ishikawa diagram also known as cause effect diagram and fish bone diagram is used to find out the possible causes for an effect or problem.

The 5M are:

- Man.
- Material.
- Machine.
- Method.
- Measuring
- Equipment

Table 3: Contributing factor for VWH crankshaft

Contributing factor for VWH Crankshaft(MM3105501)					
Sl no	**Reason for defects**	**Rej Qty**	**Total**	**Rej %**	**Cum %**
1	Woodruff keyway symmetry shifted	55	179	30.73	30.73
2	Reaming concentricity not okay	22	179	12.29	43.02
3	A side Journal damage	12	179	6.70	49.72
4	Woodruff keyway O/S	10	179	5.59	55.31
5	Reaming NOGO answering	9	179	5.03	60.34
6	Flat Keyway width O/S	6	179	3.35	63.69
7	M30 NOGO answering	6	179	3.35	67.04
8	Assembly damage due to Ø8 reamer hole U/S	6	179	3.35	70.39
9	M30 U/S	5	179	2.79	73.18
10	Ø50 U/S A side	5	179	2.79	75.98
11	Ø30 U/S	4	179	2.23	78.21

12	Ø50 U/S B side	4	179	2.23	80.45
13	U/C on journal B side	4	179	2.23	82.68
14	Ø50 damage B side	4	179	2.23	84.92
15	Ø8 O/S	3	179	1.68	86.59
16	M10 drill hole counter bore	3	179	1.68	88.27
17	Ø48 damage	3	179	1.68	89.94
18	Reaming done in turning stage	3	179	1.68	91.62
19	Ø53 pin taper	2	179	1.12	92.74
20	B side journal damage	2	179	1.12	93.85
21	Flat keyway damage	1	179	0.56	94.41
22	M30 face damage	1	179	0.56	94.97
23	Ø8 reaming NOGO	1	179	0.56	95.53
24	Pin Dia U/S	1	179	0.56	96.09
25	Ø50 collar damage B side	1	179	0.56	96.65
26	Ø8 reaming concentricity not okay	1	179	0.56	97.21
27	Pin throw U/S	1	179	0.56	97.77
28	Parallelism not okay	1	179	0.56	98.32
29	B side journal ovality	1	179	0.56	98.88
30	Ø30 step	1	179	0.56	99.44
31	Pin radius formation not okay	1	179	0.56	100.00

Gemba Investigation Of Problem Causes

GEMBA is a Japanese word which means "at the site or the real place".

This is process where we have to physically go to the place or location where there is a problem and investigate for purposes of a solution.

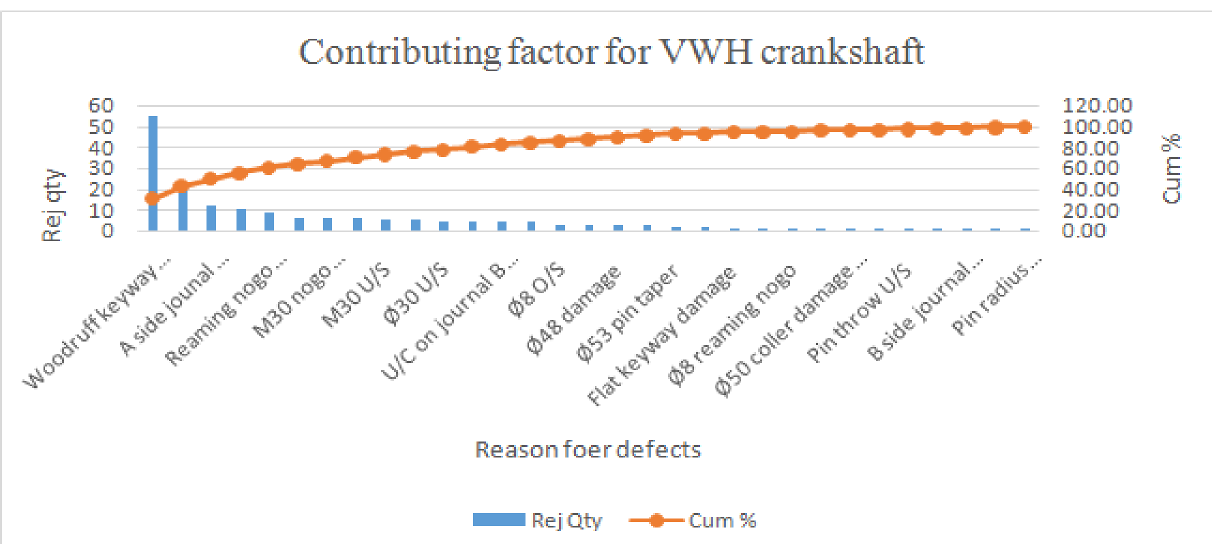

Figure 6:Pareto analysis for VWH crankshaft

FISH BONE DIAGRAM			
Part Name	VWH Crankshaft	**Customer Complaint/Inhouse Issue**	In-house Issue
Part No	K9622046	**Problem Description**	Woodruf keyway symmetry shift

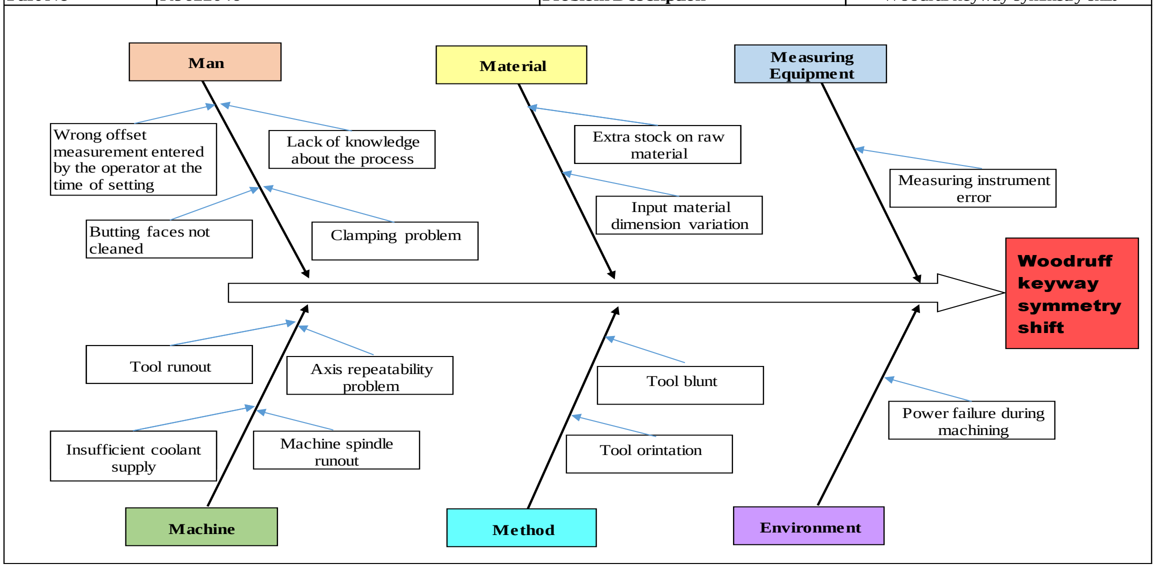

Figure 7:Cause and effect diagram

Table 4: Verification of problem causes

Verification of Probable causes				
Sl no	**Probable cause**	**Type of verification**	**Result**	**Proability weightage**
1	Wrong offset measurement entered by the operator at the time of setting	Symmetry axis tested using poppet dial guage	Found 50 microns	High
2	Tool runout	checked with prosetter	Found with in tolerance	Low
3	Lack of knowlwdge about the process	Training has been provided	Found ok	Low
4	Clamping problem	Visual	Found ok	Low
5	Butting faces not cleaned	Visual	Found ok	Low
6	Tool orientation	Checked with prosetter	Found ok	Low
7	Insufficient coolant supply	Visual	Found ok	Low
8	Machine axis repeatability problem	Checked with dial	Found ok	Low
9	Input material dimension variation	Inward inspection conducted	Found ok	Low
10	Machine spindle runout	Checked in maintance department	Found ok	Low
11	Measuring instrument error	Calibrated	Found ok	Low
12	Tool blunt	Visual	Found ok	Low
13	Extra stock on raw material	Inward inspection conducted	Found ok	Low

FISH BONE DIAGRAM			
Part Name	VWH Crankshaft	Customer Complaint/Inhouse Issue	In-house Issue
Part No	K9622046	Problem Description	Woodruf keyway symmetry shift

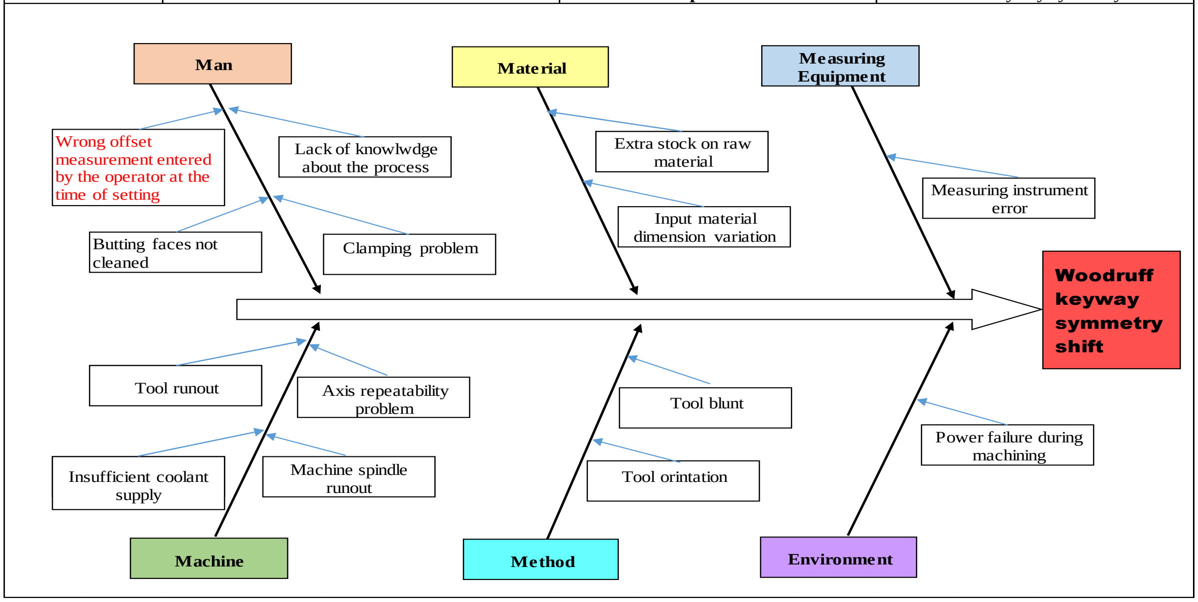

Figure 8:Cause and effect diagram

Developing Solution

Observing in the keyway operation the woodruff keyway symmetry shift is due wrong offset entered by the operator. Then team discussed and analyzed that there is no variation in keyway symmetry if POKA YOKE is introduced to the system. Also team calculated and found that POKA YOKA system is time consuming. The team decided to change to the POKA YOKE.

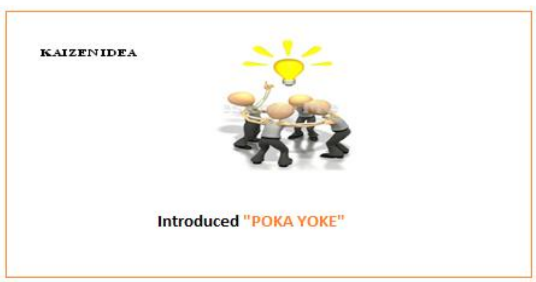

Figure 9:Kaizen idea

Poka Yoke Design

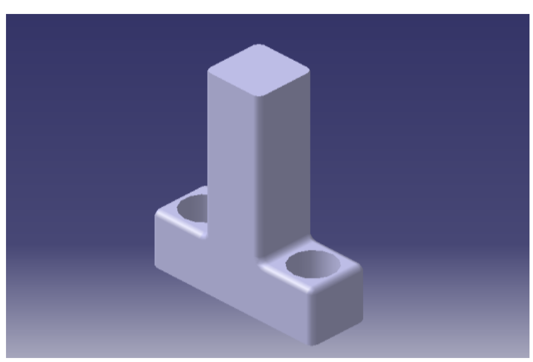

Figure 10:Poka Yoke design

Poka Yoke – Before & After

By introducing Poka yoke the rejection has reduced

Before

After POKA YOKE introduced

Figure 11: Poka Yoke – Before & After

III. REJECTION PPM ANALYSIS

Before

- Total Components produced / month = 1600
- Average components rejected/ month = 18

$$\text{PPM} = \frac{\text{Total Components produced / month}}{\text{Total Components produced / month}} \times \text{Million}$$

$$\text{PPM} = \frac{18}{1600} \times 1000000 = 11250$$

After

- Total Components produced / month = 1600
- Average components rejected/ month = 1

$$\text{PPM} = \frac{\text{Total Components produced / month}}{\text{Total Components produced / month}} \times \text{Million}$$

$$\text{PPM} = \frac{1}{1600} \times 1000000 = 625$$

Sl No	Rejection PPM	Before	After
1	Quantity rejected	11250	625

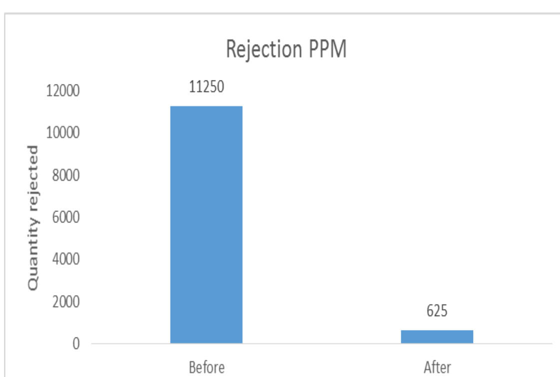

Figure 12:Rejection PPM

Expenditure

Before

- Crankshaft cost : ₹ 1,800/piece
- Average Monthly rejection : 18 No's
- Monthly Component Cost :
  18 * 1,800 = ₹ 32,400/-
- Component Cost / Year :
  54,000*12 = ₹ 3,88,800/-

After

- Reduction in Crankshaft Rejection
- Crankshaft cost : ₹ 1,800/piece
- Average Monthly rejection : 1 No's
- Monthly Component Cost :
  1 * 1,800 = ₹ 1,800/-
- Component Cost / Year:
  3,000*12 = ₹ 21,600/-

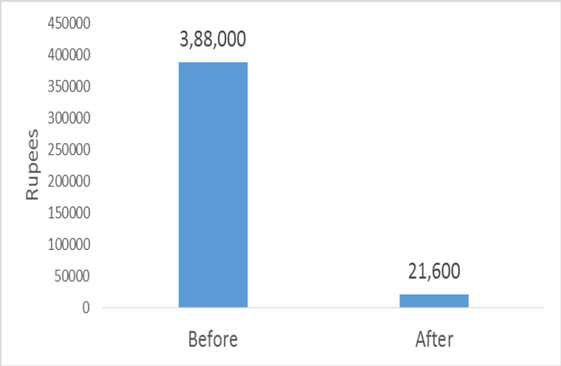

Figure 13:Expenditure

Annual Savings = Before – After
3, 88,800 – 21,600
= 3, 67,200/- ₹

IV. CONCLUSION

The main reason for the present process was due to the wrong offset measurement entered by the operator at the time of setting. The proposed method helps to meet the customer requirements because of proper method and implementation of POKA YOKE method.

- There has been decrease in the Rejection PPM by 30 %.
- This has helped dramatically in reduction cost of 3, 67,200/- ₹ per year.
- The machine also provides safety for the workers and time for preventive maintenance.

V. ACKNOWLEDGEMENTS

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