

Failure Mode Effect Analysis of Cutting Operation of Needle for Roller Bearing

S. B. Chikalthankar¹, G. S. Sawadadkar²

Assistant Professor, Department of Mechanical Engineering, Government College of Engineering, Aurangabad, India

²ME Student, Department of Mechanical Engineering, Government College of Engineering, Aurangabad, India

Abstract: FMEA is generally a methodology used for product and process design, by identifying the potential failure and prioritizing them subsequently reduces the error in the process. In this work it is also used as a process development and implement tool which is implemented in precision bearing manufacturing company. FMEA technique is systematic tool based on team working which usually can be used for identify, prevent, eliminate, or control of potential error causes in process.

Keywords: FMEA-Failure mode effect analysis

1. Introduction

Bearing needles set up needs to be both efficient and accurate in order to eliminate waste in time and materials (Dale B.G. 1999). The most expensive part of any operation is in the setup as from a production point of view, no parts are being made. To achieve both accuracy and speed, proper training and operating procedures for repetitive jobs through a standard setup process can help deliver superior results (Melan E.H.1995).

The needle cutting machine can be one of the most difficult machines to run in a precision needle manufacturing shop these machine are known as LE machine. Despite all the technology improvements, the operator needs the knowhow and skills to think through the steps to create the part and anticipate problems ahead of time (Pande S.2000).

LE machines have many features to take the guess work and art out of short needles with bending, stopper assembly adjustment, anvil assembly adjustment, feed roller adjustment and so forth. While these features are invaluable, the feature richness just adds to the knowledge needed by the operator to understand the setup possibilities. Needle manufacturing shops today face the demands of many small runs and tighter tolerance demands by their customers. FMEA is a step by step approach for identifying all possible failures during process. "Failure modes" means the ways or modes, in which something might fails. Failures are any defects or errors, especially ones that affect the customer and can be potential or actual."Effect Analysis" refers to studying the consequences of those failures (Pyzdek T.2003). Failures are prioritized according to how serious their consequences are, how frequently they occur, and how easily they can be detected. The purpose of FMEA is to take actions to eliminate or reduce failures, starting with the highest priority number (Florina C.F.2002). Implementing standard operating procedures and proper training in process execution go a long way towards achieving consistency in producing high quality parts with minimal waste. This is especially true when comparing part variations produced by multiple operators with different skill levels(Gowen 2002).

2. Brief About Company

The company is a large scaled multinational company and is involved in manufacturing of precision needle as well as ball bearing manufacturer as per the orders of the customers. More than 2000 different sizes needles are produced per annum. Machinery like CNC Laser Cutting, CNC Punching and CNC Press Brakes are used for production. Needle cutting workstation contributes with 23 customer complaints in the year 2013. The customer complaints for these components were as short in needle length and end bending needles with these data, decision is taken to concentrate the efforts on the part families contributing maximum number of customer complaints. The primary goal of the project is to eliminate the actual and potential causes for customer complaints in short needles (Barney M.2002). If this succeeds it would mean 40% reduction in customer complaints and subsequent reduction in downtime of needle cutting workstation.

2.1 Formation of Improvement Group

To be able to measure, analyze and improve the current situation there is a need of process knowledge. Thus, it is decided to form an improvement group containing a variety of competences (Sanders D.2000). The group consists of case company's production engineer, two LE machine operators, Quality Manager, Quality engineer, PPC In charge, besides two authors.

3. Process Flow Diagram

The process flow diagram is plotted for the components undergoing needle cutting operation by visually studying the process and then mapping the sub-activities in the bending operation. The process map is then viewed and reviewed by the improvement group assembled for the project work. The process mapping is represented in the steps as shown in figure1.

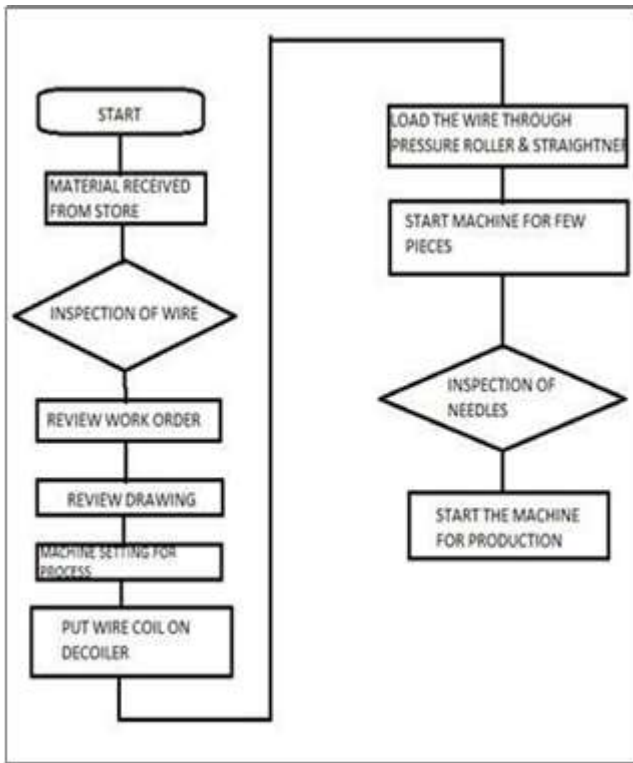


Figure 1: Flow chart for wire cutting

3.1 Ishikawa Diagram for Needle Roller Bearing

The cause and effect diagram also known as Ishikawa diagram is used to find problems in the wire cutting process. The improvement group developed a diagram with brainstorming session conducted. The starting point of the cause and effect diagram was the question [Klefsjo B.1999], "What causes customer complaints in wire cutting process?" The improvement group was able to find the important root cause to the problem. For example-

1. Lack of motivation
2. Incorrect setting
3. Poor maintenance
4. Raw material variation.

These causes were chosen, since they were detected frequently and will work as input to the process FMEA.

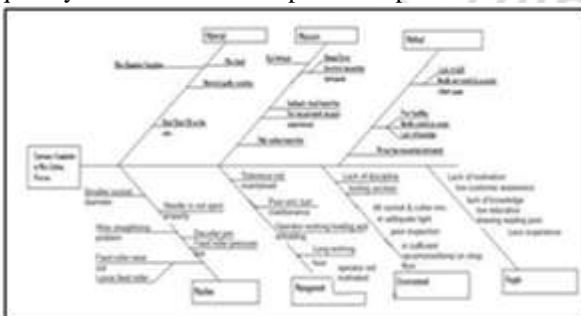


Figure 2: Ishikawa Diagram for wire cutting

Process FMEA

The process FMEA was carried out to detect the possible failure modes related to the bending operation and prioritize among them. When working with FMEA the starting point was the process map. The improvement group carried out the tool by looking at each box and to each sub activity and discussing possible failure modes and gives them the Risk

Priority Number (RPN). The causes with the RPN number can be viewed in Table1.

The potential failure cause and their effects shown in table - 1 are explained here in brief. Seven main causes were present from the beginning, Method, Machine, Material, People, Environment, Measure and Management.

- 1) Decoiler jam:- the wire coil is placed on the decoiler for to feed the wire to LE machine through straightner . when the pressure of the wire acted on the decoiler then the decoiler rotate and open the coil but if decoiler arm is jam then it cannot feed the required length of wire to the LE machine.
- 2) Roller pressure low:- the sufficient amount pressure is not apply on the wire through the feed roller then slippage is increase and short needles are cut on the LE machine.
- 3) Feed roller wear out:- due to the positive feeding continuous slippage is occur between roller and wire so that the feed roller are wear out and due to that slippage is increase that means gripping is arises.
- 4) Feed roller loose:- continuous rotation of feed roller and machine vibration due to that feed rollers are loose and slippage increase.
- 5) Poor needle ejection:- machine speed is very high that is 1040RPM and it cut the 1040 needles per minute. So if any needle delay in ejection then next needles comes short needle.
- 6) Rusting of wire:- when rusting the wire coil then the size of wire is slightly increase due to rust so the wire is does not pass through the socket because the clearance between socket and wire is very low. The positive feeding is done in cutting the total rust is collect at back side of socket.
- 7) Distance between socket and stopper:- to maintain the gap between socket and stopper atb the time of setting is not easy. If the distance between these two is low then short needle is comes out.
- 8) Oil and dust stick on wire:- if the dust and oil stick on the wire coil then it loose the grip between roller and wire so that wire feeding problem is arises.
- 9) Wire diameter is not uniform:- if low diameter wire is feed two the feed roller the proper grip is not done. Due to low grip wire will slip.
- 10) Wire bend:- at the time of loading and unloading of wire coil there is damage to the wire and bend it so that it cannot pass through straightner.

4. Selection of Ranking

Severity: PFMEA Custom Ranking, Customer Satisfaction Examples

Ranking	Example
10	In-service failure that threatens safety.
9	Extensive product recall.
8	Unscheduled engine removal.
7	Premature (unscheduled) component replacement.
6	Oil leak but system still operational.
5	Air-conditioning system not operating properly.
4	Interior panel rattles.
3	Variation in seat colors.
2	Door plugs missing.

1	Scratch on interior of housing.
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Occurrence: PFMEA Custom Ranking, Piece-Based example

Ranking	Example
10	Cpk < 0.33
9	Cpk ≈ 0.33
8	Cpk ≈ 0.67

Detection (Control): PFMEA Custom Ranking, Manual Detection Examples

Ranking	Example
10	No monitoring, measurement, or sampling.
9	Acceptable Quality Level (AQL) sampling plan used for Final Inspection.
8	100% visual inspection.

7	Cpk ≈ 0.83
6	Cpk ≈ 1.00
5	Cpk ≈ 1.17
4	Cpk ≈ 1.33
3	Cpk ≈ 1.67
2	Cpk ≈ 2.00
1	Cpk > 2.00

7	100% visual inspection with visual standards.
6	100% manually inspected using GO/NOGO
5	Statistical Process Control (SPC) used in-process with Cpk 1.33 or higher.
4	SPC used in-process with Cpk 1.67 or higher.
3	Does not apply.
2	Does not apply.
1	Does not apply.

Process Failure Mode Effect Analysis

Class	Potential Failure Mode	Potential Effects of Failure	Severity	Pot. Cause (s)/ Mechanism (s) of Failure	Current Process Control Prevention	Occ	Current Process Control Detection	Det	RPN	SOD
SC	Length U/S 0.5 mm	NP: No effect A : No Effect C : No Effect	2			7	5 Ndls / setting (4) 5 Ndls / Hr (4) 20 Ndl / Coil (3)	3	42	273
			2	Stopper setting	Setup instructions	3	5 Ndls / setting	4	60	234
			2	Anvil holder setting	Setup instructions	3	5 Ndls / setting	4	60	234
	Short Ndl. U/S by more than 0.5 mm	NP : Feeding problem A : Ndl. fallen C : Ndl. fallen	6			4	5 Ndls / setting (4) 5 Ndls / Hr (4) 20 Ndl / Coil (3) 1 plate / 20 Kg (4)	3	72	643
			5	Stopper setting	Setup instructions	3	5 Ndls / setting	4	72	534
			6	Anvil holder setting	Setup instructions	3	5 Ndls / setting	4	72	634
	Length O / S 0.05 mm	NP: No effect A : No Effect C : No Effect	2			3	5 Ndls / setting (4) 5 Ndls / Hr (4) 20 Ndl / Coil (3)	3	18	233
			2	Stopper setting	Setup instructions	3	5 Ndls / setting	4	24	234
	Length O / S >0.05 mm	NP: No effect A : Fitment C : Fitment prob	5			3	5 Ndls / setting (4) 5 Ndls / Hr (4) 20 Ndl / Coil (3)	3	45	533
			5	Stopper setting	Setup instructions	3	5 Ndls / setting	4	60	534
	Upto 0.1 mm	NP : Unclean in Grinding A : No Effect C : No Effect	3			2	5 Ndls / setting (4) 10 Ndl / Coil (3)	3	18	323
			2	Straightner Jaws setting	Setup instructions	2	5 Ndls / setting 5 Ndls / setting (4) 5 Ndl / Coil (4)	4	24	224
Squareness more upto 0.16	C : No Effect NP : Unequal A : No Effect C : No Effect	3			2	5 Ndls / setting (4) 5 Ndl / Coil (4)	4	24	324	
		2	Cutter & Socket	Setup instructions	2	5 Ndls/setting (4)	4	24	224	

5. Conclusions

Cause and Effect Diagram helped to think through causes of a problem thoroughly by pushing us to consider all possible causes of the problem, rather than just the ones that are most obvious. Ishikawa Diagram and FMEA is a team-oriented development tool used to analyze and evaluate potential failure modes and their causes in wire cutting process. It prioritizes potential failures according to their risk and drives actions to eliminate or reduce their likelihood of

occurrence. FMEA provides a discipline/methodology for documenting this analysis for future use and continuous process improvement. It is a structured approach to the analysis, definition, estimation, and evaluation of risks.

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