

Lean Manufacturing In Chassis Assembly Through Poka-Yoke

K.Velmanirajan¹, G. Rajaraman², S.K.Karthikeyan³, D.Dinesh⁴

¹Department of Mechanical Engineering, Kongunadu College of Engineering and Technology, Trichy, India.; ²Ashok Leyland Ltd, Ennore, Chennai, India.; ³Department of Mechanical Engineering, Kongunadu College of Engineering and Technology, Trichy, India.; ⁴Department of Mechanical Engineering, Kongunadu College of Engineering and Technology, Trichy, India.
Email: velmanirajan@gmail.com, konguskarthi@gmail.com, duraidinesh90@gmail.com

ABSTRACT: Some mistakes accruing between the assembly and manufacturing shops in Ashok Leyland Ltd. Actually Ashok Leyland, one of the biggest and leading heavy vehicle manufacturers in India and also exporting some specified model vehicles. Every month they come across some customer complaints and sometime face those problems before dispatching in the pre delivery inspection. Even though, some mistakes go up to consumers. So, we received some frequently coming problems, about 12 from the PDI shops. Out of these problems, we took two important Customer affecting problems. Then we were analyzed and provided solutions through the "POKA-YOKE" techniques, it means that mistake proofing solutions for a particular problems.

Keywords: Lean manufacturing, steering box, Template, silencer, sub assembly.

1 INTRODUCTION

Lean manufacturing is a manufacturing system and philosophy that was originally developed by Toyota and is now used by many manufacturers throughout the world. At Toyota the system is referred to as the Toyota Production System. Other manufacturers have adapted the system to meet their own needs and assigned a proprietary name to it, such as Delphi Automotive Delphi Manufacturing System. Therefore the term Lean Manufacturing is a more generic term and refers to the general principals and further developments of Lean. The term Lean is very apt because in Lean Manufacturing the emphasis is to cut out the "fat" or waste in the manufacturing process. Waste is defined as anything that does not add value to the customer. It could also be defined as anything the customer is unwilling to pay for. Though they may not call it Lean, the "Eyeglasses in About an Hour" companies have applied many Lean principles to their operation. What used to take weeks is now done in about an hour, adding value to the customer. It is no surprise that these operations have opened up all over the country. What was once thought of as impossible speed of delivery is now commonplace. Applying Lean Manufacturing principles gives manufacturers these types of results on a routine basis.

2 SOME OF LEAN MANUFACTURING TACTICS

- MISTAKE PROOFING - "POKA-YOKE"
- VALUE STREAM MAPPING
- WORK PLACE ORGANISATION
- LOW COST AUTOMATION
- MULTI MACHINE MANNING
- SEQUENCING
- JUST IN TIME - JIT
- STANDARD OPERATING PROCEDURE

- SELF CERTIFICATION / STATISTICAL PROCESS CONTROL
- VISUAL CONTROLS
- KANBAN SYSTEM - PULLING SYSTEM
- SINGLE PIECE FLOW
- CELL LAYOUT OF INDUSTRY
- LINE BALANCING
- TOTAL PRODUCTIVE MAINTENANCE SAFETY

2.1 MISTAKE PROOFING IN LEAN MANUFACTURING ("POKA YOKE")

Poka-Yoke: Also called Error Proofing, Mistake Proofing or Zero Quality Control (ZQC). Poka-Yoke is a system and/or a device that prevents errors before they become defects. With Poka-Yoke operators are not blamed for the errors, but instead find ways to keep errors from becoming defects. When used with other Lean Principles Poka-Yoke can be a very valuable tool in the overall Lean Manufacturing process. Basically, solving the customer complaints and mistakes by unknowingly is called mistake proofing. Otherwise it also called as "POKA YOKE". This word came from Japanese Language. While the production going on in a company that emphasizes traditional quality control methods. The main objective of the title is "MAKE NO MISTAKE". This reveals about why such traditional methods fail and shows how to create and competitor with word class quality standards through some fool proof methods. In practice, we can control in every source of potential errors and human errors by through these step by step methodologies and also we can eliminate complexity, variations, confusion of assembling and other root causes of defects. Mistake proofing it focus on preventing rather than detecting the defects. As the scientist Mr. Walimbe states that "the great value of mistake proofing is that, independent of the causes, psychological factors, and potential consequences. It blocks about an undesired

outcome when the consequences can be minimized". Due to involving their principles output become minimizes the omitted parts and also parts cannot be placed in wrong way. By implementing of these techniques we can achieve the time management during the process going on. By some new classification system is the key to rapidly finding outstanding problems in any shop floors.

2.2 PROBLEM IDENTIFICATION IN CHASSIS ASSEMBLY

In the chassis assembly shop at Ashok Leyland we were given about twenty problems. Among them two particular problems we took for analysis. The Complaints were silencer inlet and outlet wrong fitting and steering box drop arm setting wrong when analyzing these problems, some important factors might affected such as design aspects, improper identifications, some human errors. In some situations problems may create by the speed of the conveyor because, they unknowingly fitted as very quickly. So it may accursed .these kind of mistakes directly affect the production and also spoil the product ranges. Indirectly it consumes more time, human effort for rectifications of mistakes. So we were taken these problems to found a proper solution through locators or templates. Main aim of project should be not allow for wrong fittings on shops. So these can be done by using "fool proof methods".

2.3 WHAT IS FOOL PROOF METHOD?

In any location system should positively prevent wrong fitments of the work piece in a fixture or locators. It is called Fool proof method. These principles are mainly used for similar or identical components like our problems. We can make locators by using any varying drills, projection and also grooves of the work piece .Finally, this is impossible to load the work piece wrongly due to the fool proofing. As the result finding a mistake proofing solutions should prevent occurrence of such problems.

3 CASESTUDIES

3.1 COMPLAINT - SILENCER INLET AND OUTLET POSITION WRONG FITTING

3.1.1WHAT IS SILENCER AND ITS FUNCTION?

If the high pressure exhaust gases were allowed to enter atmosphere directly from the engine. A load unpleasant noise would be heard like firing of the gun. This noise is due to the large difference in pressure between the exhaust gases and atmosphere. This reduction of noise is done by a device called Silencer. Function of silencer is to reduce the pressure of gases sufficiently to permit able to be recharged to the atmosphere silently. Basically fitting positions are depending upon the types of silencer.

3.1.2 HOW THE SILENCERS FITTING GOES WRONGLY?

This is also internal customer complaints, there wrong fitments may occur while during the fastest sub assembling of O'Clamps and frame clamps. Basically there are more than four types of silencers and clamps. They are separating the required model by using visual guides in the work place. But what was the problem that inlet and outlet position fitting as inversely or wrongly, because inlet and

outlet mouth are similar or identical. This will not affect some models. But in some particular models like 1613, goods, tipper, 2516 tipper, AL Viking, this kind of silencers do not fit wrong inlet and outlet positions. If we fit as inversely following effects may occur.

3.1.3 HIGHLIGHTS OF PROBLEMS

- The exhaust gases are not able to flow easily because changing in flow line.
- In another way the exhaust gases may return to the engine exhaust manifold by the process of back pressure.
- Due to this back pressure, exhaust gases may reach up to engine exhaust valve, by this effect it disturb the engine operation, this leads to engine shut off.
- Could not adapt the silencer function because inside of silencer, the pressure should be reduced, that way only the air may silenced if we fit as wrongly process will be changed, silencer will not fulfill its work of silencing the noise. It leads to break the silencer pipe. When high acceleration.

3.1.4 FACTORS AFFECTING FITTING OF SILENCERS

As per the previous fish bone diagram, it illustrates the affecting factors as clearly. Main factors of wrong fitments due to the design, methods of operations, Human involvements and materials are discussed in below.

DESIGN: Design is one of the factors, which affects the wrong fitting, because of the improper identification marks and also it is an identical design of silencers.

WORKERS: Workers, while sub assembling the silencer parts in the sub assembling units, unknowingly they fitting due to improper work bench and guide. In some cases this mistake done by new stand-by workers and also trainees.

METHODS: Actually, there is no proper work bench like fixtures and also there is no proper visual diagrams for positioning at near of sub assembly areas, so there may chance for occurring the wrong fitments.

3.1.5 ANALYSIS

To solve these kinds of problems in silencer sub assembling, when we analyzed these problems, we should consider two factors. One is to create a proper work bench with fixture and another one is to maintain "fool proof method "for improper fitments. We were analyzed in those places. What are the sequences of process and how much time they are spending for this work? In some cases, we thought about layout, our fixtures or work bench should not affect their layout of process planning departments. So we designed and fabricated the fixture by considering the above criteria. For this, we gave work instructions based on POKA-YOKE techniques.

3.1.6 RESULTS OF MISTAKE STUDY

WORKS INVOLVED IN THIS PROBLEM THROUGH MISTAKE PROOFING

- Application of "POKA-YOKE" techniques in order to achieve, zero defect level of working shops.
- The selected customer's complaint engine shut off occurred by the mistake at assembly of silencers.
- The requirement criteria for mistake proofing are satisfied by the identified mistake proofing at sub assembly of silencer. the technique should adopt following criteria's

I) INEXPENSIVE: Since the template with work bench made by the fabricated design should have inexpensive and durability

II) BASED ON COMMON SENSE: Then the design should be based on common sense to identify. There difference between correct fittings and wrong fittings

III) DETECTION OF PROBLEM: Our design of fabricated work holder should be eliminate the occurrence of mistakes and also slightly reduce the time of assembling.

3.1.7 CAUSE AND EFFECT DIAGRAM FOR SILNCER WRONG FITTING COMPLAINT

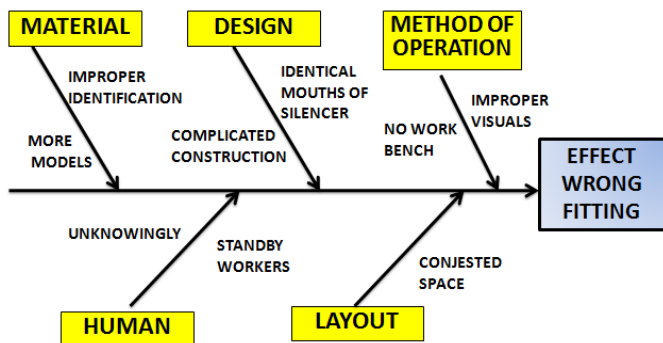


Fig 1. CAUSE AND EFFECT DIAGRAMFOR SILNCER WRONG FITTING

3.1.8 PROCEDURE APPLIED TO PREVENT THISOCCURRENCE

- Implement of 100% mistake prevent device is to be design and fabricated
- By newly designed work holder insures that, silencers could not able to fit as inversely.
- The work holder is also used as a wok bench and time minimizing instrument. Thus in act as integral part to the process

When using this device, work piece is placed on work bench at the correct position, where maximum assembling pieces are utilized.

3.1.9 RECTIFICATION AND SOLUTION FOR MISTAKE

When fabricating the fixture design, we measured all the dimensions of the silencer thoroughly. Then we made one design using fixture design parameters. When we analyzing this type of silencers, there is no varied section, instead of it silencer having an identical portion at the both side mouth of the silencer. The mouths of silencer are connected with tail pipe and exhaust pipe at both ends. When we analyzing we found one projected portion on the silencer's cylinder section. It was not a similar on both sides so we made one fixture by using stopper plates for that corresponding projection by using the principle of "fool proof method" And also we fabricated the design. It used as a proper work bench in order to reduce the operator's fault.

3.1.10 DETAILS ABOUT OUR DESIGN

In this fabricated design, we made two half circle 'C' clamp guide at vertical position. Reason of arranging the two separate clamps is to reduce material cost and also to adopt the proper balance. So that we locate two 'C' clamp guide on both sides from the center position of silencers. When designing we concentrated in its projection of silencer cylinder processing then we arranged one stopper plate for the corresponding projection portion of silencers. Actually the projected area located nearer from the inlet mouth. We found some axis variation between inlet mouth and projected portion where as it slightly varied in outlet pipe with projected portion. Then fabricate the locator by using these varied concepts by put one stopper plate between two clamp guides to seat projected portion so there is no chance for mistake if they fit as inversely it will not seat. Instead of show some difference from previous position. then we make one half circle 'C' clamp guide for inlet mouth, on one end of the work bench this guide shows clearly when we fitting as a wrongly. So there will be no chance for wrong fitting of sub assembly. Since clamp also welded with one keel on bottom side, this helps fold when we sub assembling the 'O' clamps in the silencers. actually this is simple in design so this arrangement is mounted on the 3.5feet height table with stabled legs when we mount the silencer on this work bench projected portion correctly seats on the stopper plate and also the inlet mouth locates on 'C' clamps. So it is impossible for mistakes to happen in working shops.

3.1.11PHOTOGRAPHIC VIEW OF FIXTURE WITH SILNCER



3.1.12 MERITS OF FIXTURE

- Nobody can assemble the silencer inlet and outlet position incorrectly
- It can be used as a work bench, so it can reduce the human effects and also reduce the working time.
- This fabricated design did not affect the regular processes and lay out of industry
- It occupy minimum space in the working area
- Simple in design so fabrication cost is inexpensive
- No need to inspect the inlet and outlet position in pre delivery inspection shops
- It adopts customer's complaints and also fulfills customer satisfaction.

3.2 COMPLAINT - STEERING BOX DROP ARM SETTING WRONG

3.2.1 WHAT IS STEERING BOX AND ITS FUNCTION?

Steering boxes includes with many parts such as sector and worm wheel. The sector wheel connected with steering input shaft. Sector moves over on the worm wheels. By these operations we can get the longitudinal movement of output shaft by means of worm wheels. Main function of steering boxes is converting the rotational input to the longitudinal movement of drop arms. By their variation we can rotate the wheels via track rod and drag links. These steering box constructions might be varied depends up on the model of vehicle. Now all the vehicles are using power steering concepts.

3.2.2 INTRODUCTION OF PROBLEM

Here, steering boxes are not manufacturing inside of company and also its relevant parts, instead of it, they buying from some suppliers, so their work only sub assembling of parts and then fit in vehicle chassis. Here, every month the qualities control departments analyzing the mistakes in various shops and also takes action to reduce the mistakes in shops. Our other stated problem also look like as same as previous problem.

3.2.3 HOW DROP ARM IS SUBASSEMBLING IN STEERING BOX?

Since the company buying the steering box assembly and drop arms from the outside of company. This part goes to inspection area after inspection of products it comes to working area via stores. There are two types of steering boxes such as ZF, and RANE models. It depends up on the vehicle models. Those boxes kept on the fixture tables. First they fitting the knuckle joint in the steering box input shaft and tightened. Then they are checking the number of rotations in steering input wheel by using hand and levers. After finding the rotations, they find the mid position of steering input wheel by manually. After that, fit the drop arm on the output shaft at corresponding mark position at middle of input shaft.

3.2.4 PROBLEM IDENTIFICATION AND ANALYSIS HOW THIS PROBLEM OCCURED?

While fitting the drop arm in the steering gear box output shaft, there may incorrect setting of drop arm taking place. Problem occurred by the following ways,

- Actually, drop arm and steering boxes are coming with two identification punch marks. For it's we can fit the drop arm on the correct position in middle. Sometimes it makes confusion to operators.
- In another way, mistakes are happening by improper centering of input shaft by manually. So that it will not be correct middle position, due to this improper setting, it affects turning radius of vehicle.
- After this sub assembling its goes to frame in main assembling section by using crane. While fitting, operators may change the drop arm position, for their work convenient.
- After mounting the steering box on frame brackets, they align the wheels to the straight position (parallel to leaf spring) from the leaf springs by using one long rod type scale manually. It is not an accurate position of center. Already drop arms were settled for middle position some time. This also not a correct position.
- They make connection between axle arm and drop arm by the drag link rod this drag link rod being adjustable length. So it having some threads and nuts with ball joint on both ends.
- They adjusting the length of drag link rod for its current improper position of wheel and drop arm. It makes incorrect steering angle. By these, wheel turning radius may also vary and it affects the steering geometry.

3.2.5 EFFECTS OF WRONG FITTING

- ❖ By these incorrect fitting, it may affect the max cut alignment position of wheels
- ❖ It may create improper balance to vehicle while taking turning.
- ❖ It may directly affect the turning radius of the wheels and also steering ratio.
- ❖ Mainly it may disturb the steering geometry parameters while wheel alignment setting.
- ❖ Also it makes hard steering to drivers.

3.2.6 CAUSE AND EFFECT DIAGRAM FOR DROP ARM FITTING

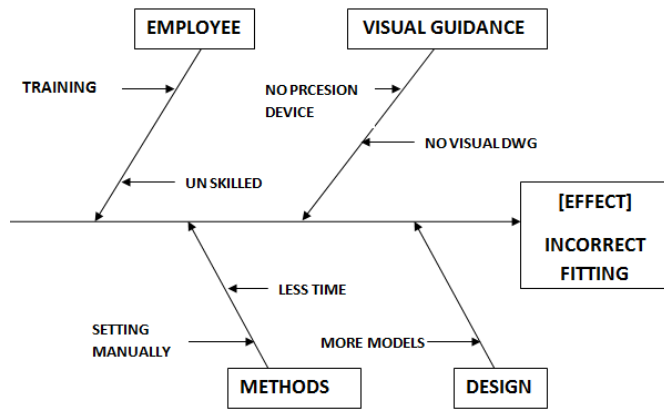


Fig 1. CAUSE AND EFFECT DIAGRAM FOR DROP ARM FITTING

3.2.7 RESULTS OF DROP ARM MISTAKE STUDY PROCEDURE FOR OCCURANCE ORIENTED POKA-YOKE

- A. Source of occurrence at the wrong assembly of steering box drop arm is classified as follows
- i. The visual information to avoid such error is not clear.
 - ii. Mistake occurs due to improper work instructions given by superior
 - iii. Error happening by setting the center position manually without accurate.

3.2.8 RESULT SHOULD BE ADOPT FOLLOWING FACTORS

- Technique should be very minimum expensive.
- It should not affecting cell lay out.
- It must remove total error during process going on.

3.2.9 PROCEDURE APPLIED AFTER MISTAKE STUDY

- ❖ To prevent this occurrence one template model is designed and also fabricated.
- ❖ This fabricated device ensures that if the drop arm is fitted as wrongly, our designed template will not allow for error occurring.
- ❖ This device is also used as a work and time minimization Instrument. Thus assembly of correct position is ensured.

3.2.10 SOLUTION

The problem of steering box drop arm fitting can be avoided by our fabricated templates. Actually those problems were analyzed with the use of mistake proofing techniques. These templates will help the operator to fix the drop arm with correct position of steering gear box. The misaligned fitting can be avoided in such a way that, when placing our fabricated templates. And also no need to rotate the steering input wheel manually. Instead of manual setting we insert the template on the steering gear box. It will seats on the bolts. After that, we rotate the input shaft and it will

go up to centre position. The template will be stopping the drop arm when reaching centre position. So who ever find the exact middle position easily?

3.2.11 ADVANTAGES OF FABRICATED TEMPLATE

- ❖ Template is to prevent improper alignment of drop arm fixing.
- ❖ It makes work easy to assemblers in assembling unit.
- ❖ Mainly it reduces time taken for fitting of drop arm on the steering box.
- ❖ It fulfilling basic needs of mistake proofing and also makes zero complaints

3.2.12 PHOTOGRAPHIC VIEW OF TEMPLATE WITH STEERING GEAR BOX



4 CONCLUSIONS

Two internal mistakes, namely steering box drop arm wrong fitting in sub assembly and silencer inlet and outlet position wrong fitting. This mistakes were studied and solved through mistake proofing (“poka -yoke”) techniques.

The Finalized Solutions are:

- (1) Solving the problem of silencer input and output position wrong fitting by the design of our fabricated work bench with fixtures, to avoid the wrong fitment.
- (2) Steering box drop arm wrong fitting problem were solved by providing our templates. It locates and gives guidance for correct fitting.

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