Implementation of Torque Wrench Poka-Yoke in Automobile Industry
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Abstract—The Inclination of the world manufacturing industries towards the Total Quality Management, Total Productive Management and the Rapid Obsolescence of Technology has driven the mind of market leaders towards an era of Zero Quality Control. The each second of changing clock has made market competitors to strive for reduction in the waste or Error to establish their leverage in the Dynamic market of competition at an Optimum cost. The whole focus has led to the usage of Lean Manufacturing techniques, Six Sigma, Flexible Manufacturing System etc. and the most easily, widely used and process specific are the development of Poka-Yoke. This paper exemplifies the application of Poka-Yoke in Automobile Engine Assembly Shop.

Key words: Obsolescence, Zero Quality Control, POKA-YOKE, Optimum cost, Lean Manufacturing, exemplifies.

I. PROJECT MOTIVATION

The development of the term Poka-Yoke as a mechanism was the result of need of intended mechanisms aimed at reduction of error in a system or process leading to waste (moda) generation which hampered the economic aspect. The Poka-Yoke are aimed at increasing the productivity of an organization with Zero Quality Control. It is a versatile tool that can be applied to any kind of process be it manufacturing or service sectors. Poka-Yoke are capable to completely eliminate the defects or identify them at the source or inline detection so that recursive actions can be implemented at the source itself to segregate the defects. The word Poka-Yoke and its development is crowned to Shigeo Shingo in 1960’s as a part of TPS (Toyota Production System) as Baka-Yoke. Poka-Yoke is the combination of two words yokeru (avoid)and poka (mistakes). The inculcation of Poka Yoke ensures the quality at output which can be deciphered as a parameter of Customer Satisfaction. The Poka-Yoke are recognized as universal approach as it aims at small improvements (Kobetsu Kaizen) at Gemba (work place) which can be inferred as transition of reactive to the pro-active quality control. Poka-Yoke are used to fine tune the improvements and process design from six-sigma. According to Murphy’s law an adage or saying that anything that can go wrong by any means would ultimately be wrong at any stage of time but with the application of Poka-Yoke mechanism it can be corrected and implemented to get desired outputs.

II. TYPES OF POKA-YOKE

The Poka-Yoke are broadly classified into 3 categories namely:

1) Contact methods: Contact type Poka-Yoke are based on detection of a parameter which may be from a sensor or a signal, after which the whole process shuts down if the suitable condition for the process is not met. It stops the process if any error in assembly or dimension occurs in the process and is usually used in assembly line to ensure the proper position of the job near the fixtures.

2) Motion set methods: Motion set type of Poka-Yoke is used when a single operator is facilitated to perform multiple operations at a workstation. It may be a case that due to monotonous work the sequence of operations is hampered and a operator may miss one operation, so to account for such error Motion set Poka-Yoke are used.

3) Fixed value methods: Fixed value Poka-Yoke are used when an operation of same nature is repeated several times at work station. This type of mechanisms uses a warning signal that the sequence of operation is not completed. It is applied to simple operations like tightening of bolts.

III. TYPES OF ERRORS OVERCOME BY POKA-YOKE

– Processing Errors are introduced in the system due to not adhering to the Standard Procedures or the operator doesn’t follow the standard process and the Poka-Yoke designed for such errors are inculcated at source only.

– Measurement Errors are introduced due to mismatch in the dimension of a component, it may be due to quality issue or machine misalignment. Like testing of Valve Seat of a two wheeler.

– Incomplete Assembly also accounts for the errors in industries as they also needs to be rectified before the testing of prototype and to ensure such Poka-Yoke are installed nearby like in case of bearing positioning at rear arm.
Wrong tooling Errors are frequently encountered at multiple operations being carried out at a workstation like using same torque wrenches for tightening to achieve different torques.[4]

IV. ELEMENTS OF POKA-YOKE MODEL

- Diagnosis of problem: The problem must be stated as in terms of Error occurring in the system and the intended functions or tasks that must be executed to overcome such issues. It involves Risk Estimation, mapping of previous Quality Issues, Brainstorming and Quality Function Deployment.
- Problem Identification: The identification of problem is then defined keeping in terms grade of problem, Why-Why analysis, alternative feasibility to ensure the main objective of error identification as main capsule.
- Blocking or Shut Down: Blocking means to block the defect or error caused due to malpractice and it involves to stop the system taking input from any algorithm.
- Alarming Mechanism: Alarming Mechanisms are designed as per the application desired in Poka-Yoke and it inculcates the sophisticated electronic circuit embedded with the PLC with a Feedback loop.
- Information Signal: Information signals are planned as suitable at shop floor like red alarms, carry catchers to indicate the prone areas of Error.

<table>
<thead>
<tr>
<th>Types</th>
<th>Contact Type</th>
<th>Warning Type</th>
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<tbody>
<tr>
<td>Contact Type</td>
<td>A Steel Pin On A Fixture Hoops Incorrectly Placed Parts From Filling Properly</td>
<td>A Device On A Drill Counts The Number Of Holes Drilled In A Work Piece; A Buzzer Sounds If The Work Piece Is Removed Before The Correct Number Of Holes Have Been Drilled</td>
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<tr>
<td>Motion Step</td>
<td>A Simple Proximity Switch Opens After All Components Are Loaded In Proper Order.</td>
<td>A Device Detects When Each Component Is Removed From Dispenser; If A Component Is Not Removed, The Device Alerts The Assembler Before He Can Move It.</td>
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Table 1: Types of Poka–Yoke[3]

V. SCOPE OF WORK AND PROCESS OUTLINE

The work emphasizes on engine assembly shop of an automobile company which manufactures two wheelers. The scope is confined to the conveyor of engine assembly shop to ensure the proper tightening of engine bolts at 10 Nm using a designed standard Poka-Yoke in form of torque wrench connected to the main unit by PLC. The engine of a two wheeler approximately consists of 350 components and so assembly of components must be carried out at immense precision to ensure that standard procedures (SOP) is adhered. If the bolts are not tightened to the standard norms then it leads to leakage in Engine testing area and thus need a rework. So to correct such issues a Poka–Yoke in form of torque wrench with ratchet mechanism inside it, is designed. One output from the torque wrench unit is connected to main server via the ladder logic which is set upon the movement of the ratchet. As the operator tighten the bolts by air guns, the conveyor is at rest to facilitate the assembly operation, it is to be ensured that it is tightened to 10Nm. The torque wrench is
located just in front of operator to examine whether the bolts are tighten to the specified value or not. The operator uses the Poka-Yoke and if it tightened at 10Nm the ratchet makes a pinking sound and an input X(0.1) is sent to the main unit of PLC with help of ladder logic and as the main unit receives the input X(0.1) it sends an output Y(0.1) which moves the conveyer ahead for centrifugal clutch loading at next station. So the conveyer moves to next station only after ensuring that tightening of bolts at 10Nm is done with help of Poka-Yoke. If required tightening is not achieved than conveyer would not move and would be at rest to completely eliminate the process error, this Poka-Yoke completely eliminates the scope of error by operator at any circumstances.

Fig. 3: Torque Wrench Poka-Yoke

VI. RESULTS AND DISCUSSIONS

The human ability to be creative and on other hand have an advantage of technology, have successfully created very simple design Poka-Yoke for error proofing. Technology are meant to make process user friendly and Poka-Yoke are the live examples of such which makes error proofing possible at various sectors of life in different form. The inculcation of Torque wrench Poka-Yoke has led to completely proofing of the error that would sure be detected at engine testing area and would lead to leakage. It has managed to reach the zero figure for rejection due to loose tightening of bolts. This rather prompts the scope of rework or May sometimes lead to rework that would directly affects the economic aspect and waste generation. The management slogan of right quality at first time is achieved with help of Poka-Yoke implementation with extremely low rejection losses. The improvement in quality and optimum utilization of production time improves the Overall Equipment Effectiveness. The usage of Poka-Yoke is sometimes exaggerated but the application of such mechanisms made us realize the importance of these simple mechanisms called Poka-Yoke.

REFERENCES