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POKA -YOKE SYSTEM FOR OUTPUT SHAFT ASSEMBLY OF TWO WHEELER

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Abstract

It is not possible to eliminate all the mistakes people make. People are not mistake proofed by their nature. But organization can avoid these mistakes from reaching the customer, which is known as a defect in this case. Mistakes can be stopped as soon as they happen at least. Poka-yoke is very simple concept in nature. The basic concept of this is avoiding the problems by correcting the process. Poka-yoke is a quality assurance technique developed by Japanese manufacturing engineer Shigeo Shingo. The aim of Poka-yoke is to eliminate defects in a product by preventing or correcting mistakes as early as possible. So what is mistake proofing? The use of process or design features to prevent errors or their negative impact. Also known as Poka yoke, Japanese slang for "avoiding inadvertent errors" which was formalized by Shigeo Shingo. A method that uses sensor or other devices for catching errors that may pass by operators or assemblers. Shigeo Shingo defines Poka Yoke as: Poka – "Inadvertent Mistake That Anyone Can Make" [2] and Yoke – "To Prevent or Proof" [1]. Poka -Yoke performs two key operations of ZDQ (Zero Defect Quality) i.e. identifying the defect immediately (Point of Origin Inspection) & quick feedback for corrective action. Poka-yoke detects an error, gives a warning, and can shuts down the process.

KEYWORDS: Poka –Yoke, Output shaft assembly, PLC, ZQC.

INTRODUCTION

It is very important to avoid a mistake becoming a defect. But meanwhile it is very important to find out why there are mistakes in the system. According to my knowledge some systems lead people to do mistakes. So many data passing processes, so many contact points, unnecessary documentations and processes makes the systems complicated. Complicated systems can make mistakes easily.

Poka-yoke is a quality assurance technique developed by Shigeo Shingo. The aim of Poka-yoke is to eliminate defects in a product by preventing or correcting mistakes in the early phase. Poka-yoke has been used most frequently in manufacturing environments. Japanese industrial engineer Shigeo Shingo developed Poka - yoke [1] (to avoid (yokeru) [2] inadvertent errors (poka) along with "source inspection" as a means for achieving Zero Quality Control (ZQC). Shingo introduced these ideas in his book Zero Quality Control: Source Inspection and the Poka-yoke System.

People are human and cannot be expected to do everything like a machine, exactly the same each time. A simple distraction can lead to a part of their work being done wrong. It is also not necessarily their fault, as poorly-designed processes that require a great deal of attention can contribute severely to problems. The basic principles of Poka-yoke advocate designing or developing tools, techniques and processes such that it is impossible or very difficult for people to make mistakes. It is a simple principle that can lead to massive savings. One simple example of Poka-yoke is having an automatic stoppage of machinery when oil levels go down. So people will not operate machinery with lower oil levels. This will make sure your system is operating smoothly. Another very good example for this kind of mistake proofing process can be found in computers. Every plug has a socket exactly matched with it. No other device can be plugged into this. So even if you want to do a mistake you can't.

LITERATURE SURVEY

2.1 Historical Background of 'Poka-yoke':

'Poka-Yoke' techniques are now widely prevalent amongst manufacturers all over the world and across industry verticals. While majority of 'Poka-Yoke' systems are based on basic mechanical jigs and fixtures, there is increasing popularity for more versatile and instantly reconfigurable machine vision based 'Poka-Yoke' systems which are:

- Mistake-proofing systems
- Does not rely on operators catching mistakes
- Inexpensive

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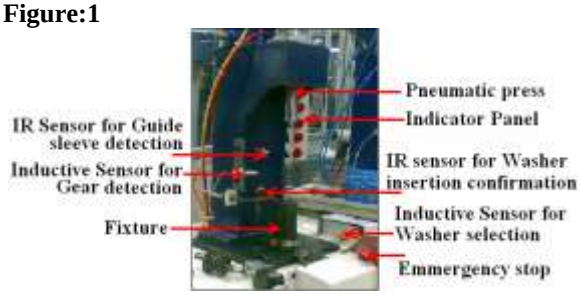
- Point of Origin inspection
- Quick feedback 100% of the time

2.2. Origin of 'Poka-yoke' technique:
In the early 1960s quality guru Shigeo Shingo combined the concepts of 'successive', 'independent' and 'source' inspections with Toyota's in-house 'fool-proofing' techniques and devised the famous production philosophy 'Poka-Yoke' (POH-kah YOH-keh) [1], a tool to achieve and sustain 'zero defects'. The term "poka-yoke" comes from the Japanese words "poka" (inadvertent mistake) and "yoke" (prevent) [2]. It implies absolute elimination of defects in the production process. Shigeo Shingo was a leading proponent of statistical process control in Japanese manufacturing in the 1950s, but became frustrated with the statistical approach as he realized that it would never reduce product defects to zero.

SYSTEM DEVELOPMENT

The research includes implementation of Poka-yoke system for output shaft assembly of two wheeler. The construction and working of system is based on programmable logic controllers (PLCs), various sensors and electro-pneumatic principles. In this system the operator has to perform several operations as per the predefined sequence. He has to insert various components such as, washers, bearings, gears, air-jets, guide sleeves, circlips etc., into the shaft as per the pre-defined sequence. If the PLC finds all the operations are performed as per the predefined sequence then and then only the next task will be performed. Otherwise if there is an error, it will be detected by the Poka – yoke system and then corrected. A prototype of Poka-yoke system with various elements is shown below in figure 1.

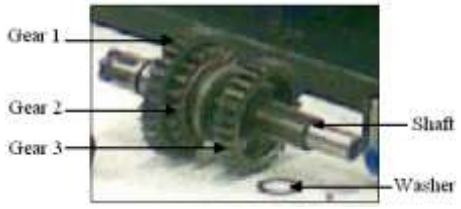
Figure:1



Poka-yoke System with Various Elements

The system can recognize the position of the gears, bearings, washers, guide sleeves etc. components and when all the sequential operations are done successfully according to predefined sequence, the signal is sent to electro-pneumatic press to operate. The heart of the system is PLC, which controls the operation of the system. Various sensors such as IR proximity sensors, inductive proximity sensors are connected to sense the parameters then to the PLC. This system is based on Messung's micro PLC having 16/12 configuration i.e. 16 inputs and 12 outputs, along with associated circuitry, i.e. (power supply, connecting wires, indicators etc). A shaft assembly with various elements is shown below in figure 2.

Figure:2



Shaft Assembly

PERFORMANCE ANALYSIS

This section comprise of experimental and mathematical analysis of a PLC based Poka -Yoke system for output shaft assembly and technical details of various associated components for the system.

4.1 Experimental analysis:
After verifying all the connections and everything found proper now verify the experimental performance of system for the desired sequence of operations, which is as listed below.

a) Operations to be performed:

- Shaft sub-assembly insertion in fixture and detection by 8mm inductive sensor.
- Washer selection by touching it to 12mm inductive sensor mounted on table.
- Confirmation of insertion of washer in to shaft by IR sensor
- Insertion of gear in to shaft
- Position detection of gear by 12mm Inductive sensor.
- Second washer selection by touching it to 12mm inductive sensor.
- Confirmation of insertion of second washer in to shaft by IR sensor
- Placement of guide sleeve on to shaft
- Detect position of guide sleeve on shaft by IR sensor
- Press will be ready for operation. (indicator shows press ready)
- Push button for press operation
- Counter, End of operation.

b) Voltages present at various sensors:
Table 1 shows the voltages present at various sensors while performing various operations.

Table 1. Voltages present at various sensors

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Sr.	Sensor	Function	Condition	
			ON	OFF
1.	8 mm Inductive	Shaft placement detection	23.9V	0.0V
2.	12 mm Inductive	Washer sensing	23.9V	0.0V
3.	12 mm Inductive	Washer missing detection	23.9V	0.0V
4.	12 mm Inductive	Gear position detection	23.9V	0.0V
5.	IR Sensor	Confirmation of Washers insertion	23.9V	0.0V
6.	IR Sensor	Guide sleeve presence detection	23.9V	0.0V

c) Status of indicators

Table 2 shows the status of indicators while performing above sequential operations.

Table 2. Status of indicatosr during sequential operations

Sr.	Indicator	Status of indicator	
		Right sequence	Wrong sequence
1.	Shaft presence	ON	OFF
2.	Washer Sense & Insertion	ON	OFF
3.	Gear presence	ON	OFF
4.	Washer Sense & Insertion	ON	OFF
5.	Guide sleeve presence	ON	OFF
6.	Ready	ON	OFF
7.	Solenoid valve	ON	OFF

4.2 Mathematical Analysis:

The mathematical analysis includes the comparative analysis of shaft assembly with the conventional method & with the present 'poka yoke'system.

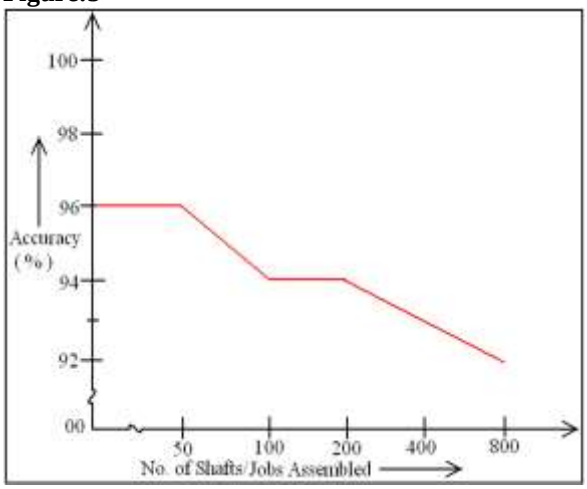
a) Shaft assembly with conventional method:

Table 3 given above shows details of shaft assembly with conventional method i.e. No. of shafts/sobs assembled, time required in hrs, error rate and accuracy. As can be seen from the graph given in figure 3, the accuracy decreases with the number of jobs. The jobs may be defective due to the human errors caused by human tendency, unknownly or may be intentionally. The solution is 'poke yoke' system, which rectifies the errors & correct it in the early phase of production.

Table 3. Shaft Assembly with Conventional Method

No. of Shafts Assembled	Time required Hrs.	No. of Faulty Shafts	Error Rate %	Efficiency %	Accuracy %
050	1.5	02	04	96	96
100	03	06	06	94	94
200	06	12	06	94	94
400	12	28	07	93	93
800	24	60	7.7	92.3	92

Figure:3



Shaft asemblly & accuracy by conventional method

b) Shaft assembly with with PLC based Poka-yoke system:

Table 4 and figure 4 given below shows details of shaft assembly with PLC based Poka-Yoke system. Figure 4, given below shows that, with the present system i.e Poka-Yoke system, the accuracy in the shaft assembly of two whller, is not affected by the number of jobs.

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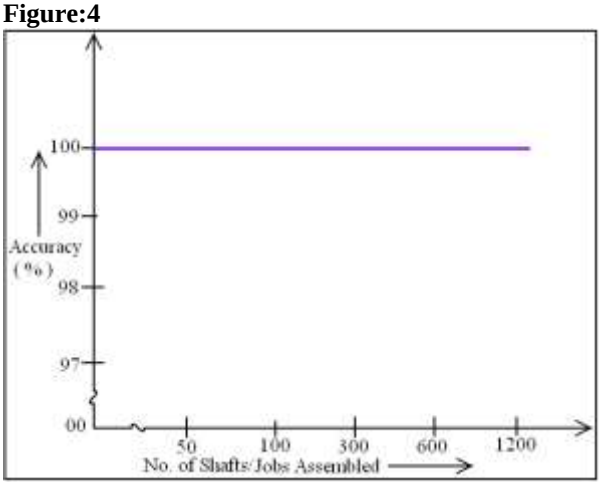
Figure:4



Shaft asemblly by PLC based poka-yoke system

Table 4. Shaft Assembly with poka-yoke system

No of Shafts assembled	Time required Hrs.	No of Faulty Shafts / Jobs	Error Rate %	Efficiency %	Accuracy %
050	01	00	00	100	100
100	02	00	00	100	100
150	03	00	00	100	100
300	06	00	00	100	100
600	12	01	0.16	99.84	100
1200	24	02	0.16	99.84	100

ADVANTAGES OF THE PRESENT SYSTEM

- Inexpensive.
- Very effective.
- Based on simplicity and ingenuity.
- Enhanced productivity
- The highest level of quality can be achieved
- Enhanced customer satisfaction

CONCLUSIONS

- "Poka - yoke system for output shaft assembly" described here can eliminate entire classes of errors. Once it is placed it can run automatically without human intervention, raising an alarm or indication only when a problem is discovered. The system which I have developed is definitely providing quick feedback early in the process, detecting localization mistakes before the application ever reached the formal testing phase.
- The Poka-yoke approach provided a simple and robust way for us to detect and correct localization mistakes that would have been difficult to detect through traditional system testing. The system has following benefits:
  - Enhanced Productivity
  - The highest level of quality can be achieved
  - Lowers Quality Cost
  - Enhanced Customer Satisfaction
  - Find errors and correct mistakes - where they occur

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