Improve Assembly Checking Method With Programmable "B" Pillar Fixture Using Concept of Poka-Yoke

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Abstract- *in manufacturing industries has to manufacture high quality, defect free products at optimum time and cost. In early years during inspection of product was checked and rejection is done conventionally, it takes lot of time and there is chances of human error so to over-come of this problem and to achieve demand of today's competitive world we adopt automation in inspection process. Due to automation technique of occurrence of error reduced and appropriate product is select.Poka-Yoke is one of the quality assurance tools which are mostly used in automation. The aim of the study to investigate of method. Poka-Yoke is to eliminate or minimizes human error in manufacturing process and managing as a result of mental and physical human imperfections. In to analyse effectiveness of programmable automatic Poka-Yoke Fixture over conventional method for inspection of B-Pillars. Poka-Yoke tool is connected with monitoring and Improvement of operations in the process*

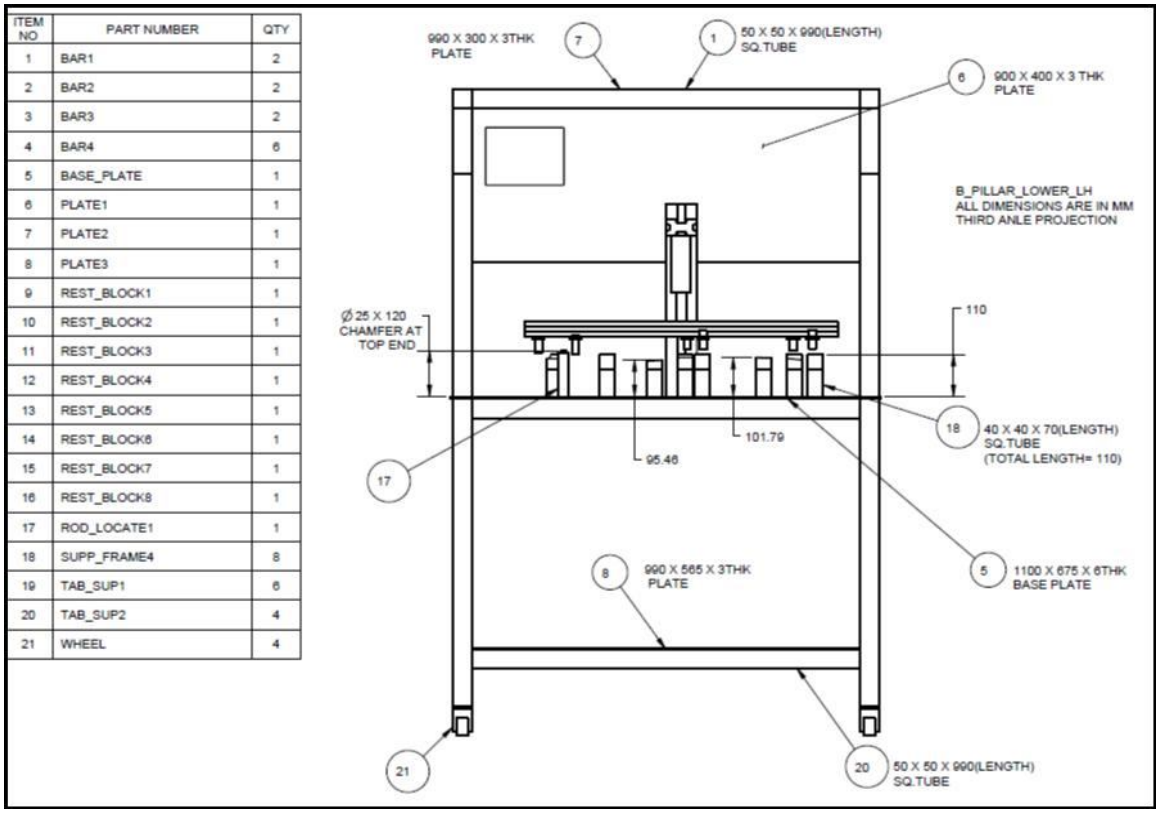
Keywords- Poka-Yoke'; 'Automation'; 'B-Pillar'; 'Human error'; 'Inspection method'; 'PLC'.

I. INTRODUCTION

Mechatronics is a branch of science where mechanical, electrical, electronics, and IT should be considered together in the design stage itself to obtain a compact, efficient and economic product rather than designing the components separately, which has proven many advantages in today life [1].Similarly the industrial automation provides many sophistications & good quality productivity with electronics. E.g. filling the bottles in the pharmaceuticals industry, printing on bottle or on tablet boxes is being done automatically with very high speed. The robotics assembly of a car in automobile industry & material handling in industry with conveyor belts, for transposition of a job, the inspection of jobs assembly also very important In today's competitive world any organization has to manufacture high quality, defect free products at optimum cost. The new culture of total quality management, total productive management in the manufacturing as well as service sector gave birth to new ways to improve quality of products. By using various tools of TQM like KAIZEN, 6 sigma, IT, JIDCO, POKAYOKE, FMS etc. organization is intended to develop quality culture. In early years during inspection of the assembly product was checked and selection and rejection is done conventionally. Due to automation the chances of occurrence of error reduces and appropriate product get selected .Thus product quality increases and expenses can also be lessen. The result is that product quality increases and decreases the overheads on the product thus the cost of product decreases. Automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery of services. The correct incentive for applying automation is to increase productivity, and/or quality, beyond that possible with current human labor levels so as to realize economies of scale, and/or realize predictable quality levels.

Poka-Yoke: [2] Poka-Yoke is a Japanese improvement strategy for mistake-proofing to prevent defects (or nonconformities) from arising during production processes. Poka-yoke is a preventive action that focuses on identifying and eliminating the special causes of variation in production processes, which inevitably lead to product nonconformities or defects. This concept was initially called Idiot Proofing but it was understood that this name may heart workers so term Mistake Proofing was coined by Shigeo Shingo. Poka-yoke gives a strategy and policy for preventing defects at the source. These solutions are not only cost-effective but also easy to understand and apply. It is one of the important tools to add to any organization's Continuous improvement. In short Poka-Yoke is a continual improvement strategy that offers a way to move the QMS (quality management system) towards a higher level of performance

Fig 1: Schematic Representation of Poka-Yoke



ITEM NO	PART NUMBER	QTY
1	BAR1	2
2	BAR2	2
3	BAR3	2
4	BAR4	6
5	BASE_PLATE	1
6	PLATE1	1
7	PLATE2	1
8	PLATE3	1
9	REST_BLOCK1	1
10	REST_BLOCK2	1
11	REST_BLOCK3	1
12	REST_BLOCK4	1
13	REST_BLOCK5	1
14	REST_BLOCK6	1
15	REST_BLOCK7	1
16	REST_BLOCK8	1
17	ROD_LOCATE1	1
18	SUPP_FRAME4	8
19	TAB_SUP1	6
20	TAB_SUP2	4
21	WHEEL	4

B-Pillar part: Pillars are the vertical or near vertical supports of a car's window area or Greenhouse designated respectively as the A, B, C or D-pillar, moving from the front to rear, in profile view. In the case of the B (or center) pillar on four-door sedans, the pillar is typically a closed structure welded at the bottom to the car's rocker panel and floor pan, as well as on the top to the roof rail or panel. This pillar provides structural support the vehicle's roof panel, as well as designed for latching the front door and mounting the hinges for the rear doors. Below fig (2) shows that the actual B-pillar part used in a analysis as inspection object, this-pillar part is upcoming four wheeler Mahindra model and developed by the Shriram machining Company. Sanaswadi, Pune .As shown in fig the white Clips are called as snap clips and Black clips are called Rib lock clips. The white clips are placed in the houses of B-Pillar part and four Rib lock clips are placed in the ribs present on the B-pillar part. Our problem statement is to carry a fast inspection of this six Assembly component with the help of Poka-Yoke fixture by using PLC.

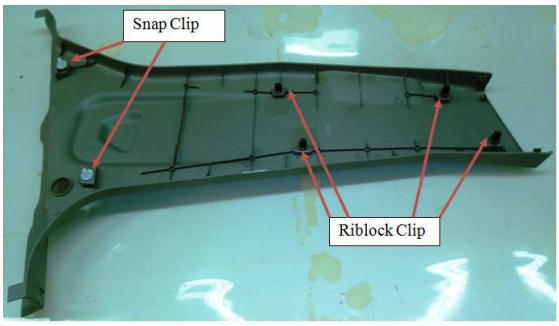


Fig 2: B-Pillar Part

Programming Language [4].A programming language is a formal language designed to communicate instructions to a machine, particularly a computer. Programming languages can be used to create programs that control the behavior of a machine and/or to express algorithms precisely. Programming Languages for Poka-Yoke Fixture are given below

1. Ladder Logic in Logo Soft! Comfort from Siemens
2. Ladder Logic form Virtual Lab

II. PROBLEM STATEMENT

Inspection of system object and to make necessary programmable decision is absence in B-Pillar assembly process which is most important function of any assembly

line. This paper work addresses the Poka-Yoke concept to eliminate and improve the process.

III. LITERATURE REVIEW

P.R. Senthil Murugan is to design a Mechatronics system to monitor the dimensions of the product (clevis) using the pneumatics system with the help of PLC [4].The clevis is placed in the clevis holder, which is used to hold the work piece tightly. Then the pneumatic cylinders which are controlled by PLC XE 102 extend and retracts based on the ladder logic diagram. The calibrated gauges are attached in the pneumatic cylinders, if the GO/no GO gauge travels smoothly inside the hole, it can be concluded that the dimensions of the hole is in accordance to the specified standard dimensions. This system eliminates the human errors and can be done at lower cost. The product is placed in the fixture. The fixture holds the product in position during the inspection .The Gauges fitted in the pneumatic cylinders extend to check the dimension of the product. Based on the dimension product is either selected (or) rejected. A device for determining whether or not one or more dimensions of a manufactured part are within specified limits a plug gage is a cylinder designed to check the component tolerance of a hole in a product. The plug gage has been found to be highly accurate, economical and convenient for small whole inspection where a determination is made of compliance with designed limits.

Fig 3: Clevis Experimental Set-Up

Ganesh B.Shinde,Vishal P.Ghadage [5] present hoe to describe the initial steps in the implementation of PLC based auto weighing control system for automation industry. They developed automation technique using PLC and increase the speed and accuracy of the process of production. Here used one load cell for measuring the weight and PIC 18F Microcontroller for displayed the weight of Job using LCD. And according to the weight of the job PLC will accept or reject the job as per the weight. Here make PCB for PIC 18 microcontroller and interfacing for load cell and LCD. This is the initial step of the hardware and then pneumatic cylinder and indicator is connected to the PLC

IV. EXPERIMENTAL DESIGN AND METHOD

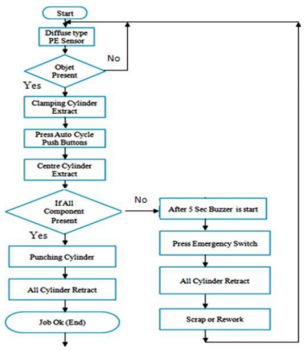


Fig 4: Experimental Set-Up Poka -Yoka

Fig 5: Methodology of Poka-Yoka

4.1 Methodology

1. Clean the Poka-yoke assembly fixture before starting the operation and fill in initial check list.
2. Take the B-Pillar Lower LH and mount the part on the Poka-Yoke assembly Fixture.
3. Assembly of two Snap Clip of Diameter 8.5 with part in end dog houses.
4. Assembly of four no rib locks
5. Plastic 6.5 mm clip with ribs present on part.
6. Then put the B-Pillar part on the resting pad.
7. After that is sensed by the diffuse type photoelectric sensor and after 2 sec part will be clamped by the two pneumatic cylinders.
8. Press the two auto cycle push button (Green) simultaneously with both hands.
9. Sensor holder will came forward by pneumatic center cylinder.
10. If there are all assembled component are present then all respective green indicator will glow. Then punching cylinder will came forward and punch component, then circle the punched mark.
11. End of the cycle.
12. If there is any assembly objects are absent then after 5 sec buzzer will start and red indicator bulb wills glow
13. The absent object indicator will not glow and de-clamped is not possible and sensor holding bracket as it is unless and until operator will pressed emergency button.
14. After reset, de-clamped and sensor holder bracket retract to its original position, then twist the emergency button.
15. Then remove the B-Pillar, reinsert the part on the system and check it by the next cycle.

4.2 **Pneumatic Circuit Connection**:

The following pneumatic circuit diagram shows the details connection between the sources to the pneumatic component. As the shown in the fig for clamping the B-pillar

part there are two pneumatic double acting cylinder is used and both are actuated by one double sided 5/2 solenoid valve. Both clamping cylinders forward and backward movement achieved by actuation of solenoid S1 and S2 respectively. Another cylinder is center cylinder and used for forward and backward movement sensor holder bracket, and its actuation is controlled by one double sided 5/2 solenoid valve. Its forward and backward movement will achieve by actuation of solenoid S3 and S4 respectively. The last cylinder is punching cylinder and it is used for punching or creating final mark on the object. It is actuated by the single sided spring return solenoid valve. [6].

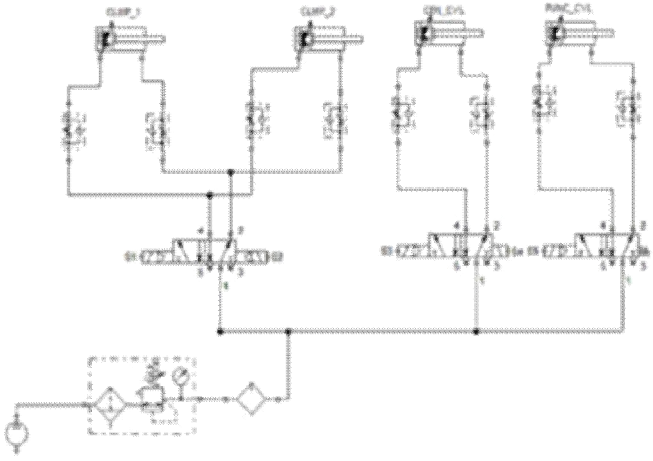


Fig 6: Pneumatic Circuit Connection Diagram.

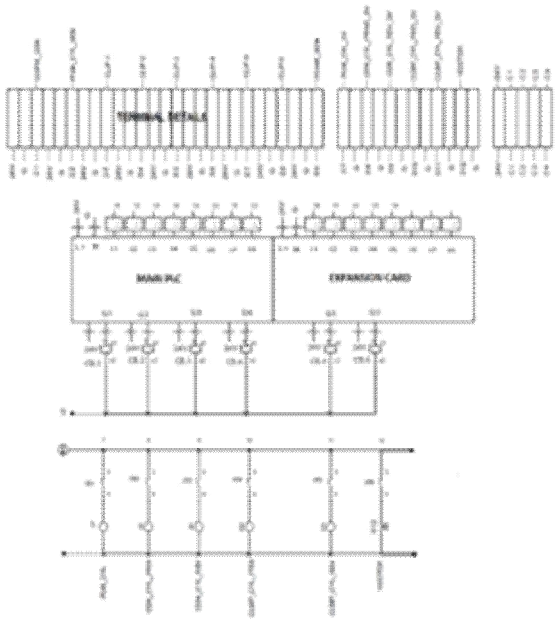


Fig 7: Control panel circuit diagram.

4.3 Control panel circuit:

The control panel circuit diagram shows that the various component of control panel and connection among them. The control panel consists of PLC, PLC expansion Module, control relay, terminal box, SMPS, MCB etc. [7].

V. RESULT AND ANALYSIS

Experimental analysis of Assembly checking is done on the assembly line of the industry by manually as well as of Poka- Yoke atomized fixture.

Table 1 Manual Inspection for B -Pillar Assembly Checking

Model NO	Time Duration in sec	Check all B Pillars	Manual Operator	Assembly Line Result
A	242 sec	OK	OK	OK
B	242 sec	OK	OK	Rejected
C	215sec	OK	OK	OK
D	230 sec	Rejected	Rejected	
E	255 sec	OK	OK	Rejected
F	205 sec	OK	OK	OK
G	220 sec	Rejected	Rejected	
H	243 sec	OK	OK	OK
I	232 sec	OK	OK	Rejected
J	210 sec	OK	OK	OK

Table 2 Manual Inspection for B -Pillar Assembly Checking

Model NO	Green lights	Red lights	Buzzer	Time Duration in sec	Remark	Assembly Line Result
A	ON	OFF	OFF	85 sec	OK	OK
B	ON	OFF	OFF	83 sec	OK	OK
C	ON	OFF	OFF	86 sec	OK	OK
D	OFF	ON	ON	85 sec	Rejected	Rejected
E	ON	OFF	OFF	87 sec	OK	OK
F	ON	OFF	OFF	84 sec	OK	OK
G	OFF	ON	ON	85 sec	Rejected	Rejected
H	ON	OFF	OFF	84 sec	OK	OK
I	ON	OFF	OFF	87 sec	OK	OK
J	ON	OFF	OFF	88 sec	OK	OK

In manual checking require almost 4 min and chances of error is more because it is human oriented activity. Poka-Yoke fixture checking process reduces assembly checking time; improve functional effectiveness and inspection quality. Operating cost also minimize by checking no of components in record time.

As per the manual trial and experimental analysis, following results are cleared

For assembly checking

1. Poka-Yoke Fixture is fully functional for assembly checking B-Pillar part. All Sensors working by checking indicators and buzzers with given sequence.
2. By the conventional method of Assembly checking require almost 255 sec duration for checking single unit. It is reduce up to 88 sec (reduce by 65.5%) by Poka-Yoke Fixture. By this method improve cost and function effectiveness. Also improve end product quality.
3. In conventional method, if operators missing to check any B-Pillar part then error found at assembly stag and its hamper on assembly cost also. But by this automatic Poka -Yoke fixture checking no such chances of error

VI. CONCLUSION

In industry the production rate should be high because the demand of the product is more. But when we inspect the object manually then it will take more time for inspecting the component and also more chances of error. So overall speed of the production will decrease, which will result in increase in cost, delay in delivery to market loss in material and increase rejection rate. By using this POKA-YOKE auto checking system we totally overcome this problem. Indicating nearly 40% increase in production. With this monitoring system error will be detected while processing which results in zero rejection.

The following conclusions can be drawn from the study of POKA-YOKE auto checking system;

1. Poka-Yoke concept is cost effectiveness
2. Poka-Yoka Fixture improves function effectiveness.
3. Zero Rejection is possible as error is detected in process.
4. This system consists of monitoring and alarm system hence highly skilled operators are not required.
5. Improve product delivery time and production rate.