Design of Pokayoke Systems to Increase the Efficiency of Function Check Oxygen Sensor Machine using Programmable Logic Controller in Manufacturing Industry

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***Abstract* -- This research was conducted at the industrial manufacturing company in the manufacture of automotive components. The company made cost savings by replacing pre-heating machine and characteristic check on line oxygen sensor machine. The machine that will be used to replace the pre-heating machine and check the characteristic is the function check machine. But the function check machine is not approved because the company cannot reach the determined target MOR (Machine Operation Ratio) at the time of trial, namely 90%. This is due to some problem in the machine. However, we focus on the problems with the highest frequency of down time misjudgement. The problems of down time misjudgement are caused from several factors, namely the human factor, the method factor, and machine factors. Problems stemming from human factors that determine the operator one part the result of checking, then the problem comes from the method that is the risk factor part OK (Good) and NG (Not Good) mixed, and the last issue of the factors that occur misjudgement machine when the checking part machine is OK. We design the pokayoke systems to increase the efficiency of function check oxygen sensor machine using Programmable Logic Controller (PLC). We use the pokayoke shutter systems and a photo electric sensor Omron E3T-ST12 as pokayoke sensors. We also add the text alarms on the HMI, so that the operator can easily determine the part is OK or NG. In addition, we also added spring in jig station checks each part so that the probe can touch the part, so there is no misjudgement. Finally, the misjudgement problem can be reduced to 0.14% and MOR on the machine can achieve the targets that have been set, i.e. 90%.**

Keywords--function check machine; MOR (Machine Operation Ratio); misjudgement, pokayoke systems

I. INTRODUCTION

This research was conducted at the industrial manufacturing company in the manufacture of automotive components. The company is an industrial manufacturing company in the manufacture of automotive components, namely the manufacture of cu radiator, stick coil, spark plugs, oxygen sensors, aluminium radiator, bus air conditioner, car air conditioner, and magneto.

Production activities covers cu radiators, spark plug, stick coil, oxygen sensor, and oil cooler. In a plant production activities include bus air conditioner, aluminium radiator, magneto, air cleaner, and car air conditioner. At Plant production includes Engine Electronic Control Units (ECUs), Variable Cam Timing (VCT) Control System, starters, alternators, and spark plug.

Because of the increased production capacity and production development planning, The Company led to the production process should go well, but it takes effective use of production time for each machine. This additional capacity makes the Company to replace one of the methods that can be used to measure the effectiveness of production time is the operation ratio. Operation effectiveness ratio is the ratio of actual production with the result that production should be achieved within a certain time machine. In the operation that there is loss-time ratio, that time is wasted due to activities outside production. Loss time is divided into two, namely the down time and except time. Down time is wasted production time due to a problem with the machine.

For exception production time is the time that is allowed to conduct meetings in the morning and cleanliness. The goal of this method is to measure the effectiveness of the machine, determine the calculation of the capacity of the machine, knowing waste that exist on the machine, and can be used as material for improvement.

Body Assembling Oxygen Sensor 2WV has new machines procured by Production Department, it is Function Check machine. This machine is used to measure the resistance element of the oxygen sensor body. Elicitation of this machine aims to replace the existing machines on line 2 oxygen sensor assembling body. But there is a problem at the time of trial. This machine cannot reach the target MOR (Machine Operation Ratio) that has been determined. This is caused by the misjudgement.

Misjudgement is a difference of opinion in determining part OK and NG or vice versa. This misjudgement problem has a fair high frequency, resulting in lower MOR in the machine function check. Therefore, we conducted an analysis of this misjudgement problem in order to increase the productivity of the machine function check. We design the pokayoke systems to increase the efficiency of function check oxygen sensor machine using Programmable Logic Controller (PLC) [2, 3, 4, 5, 6, 7, 8, and 9].

II. METHODOLOGY

Initial conditions Machine Function Check

Fig. 1 shows the condition of function check machine before the modification.

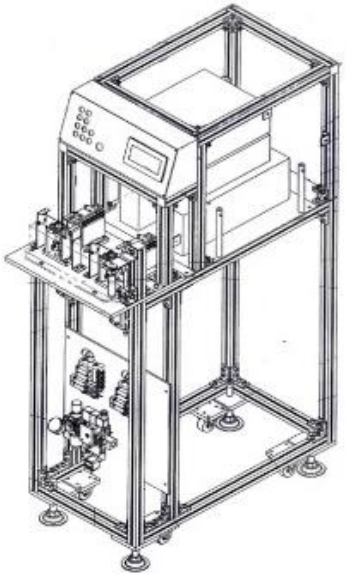

Fig. 1. Function check Machine

The machine is operated semi-automatic function check by the operator, that is by contacting nagara switches then the machine will operate automatically. Dimensions of the machine are small enough to make this machine cannot put the part into the machine and out of the machine automatically, so this machine is still need the operator is help. Fig. 2 shoes process flow operation of the machine function check.

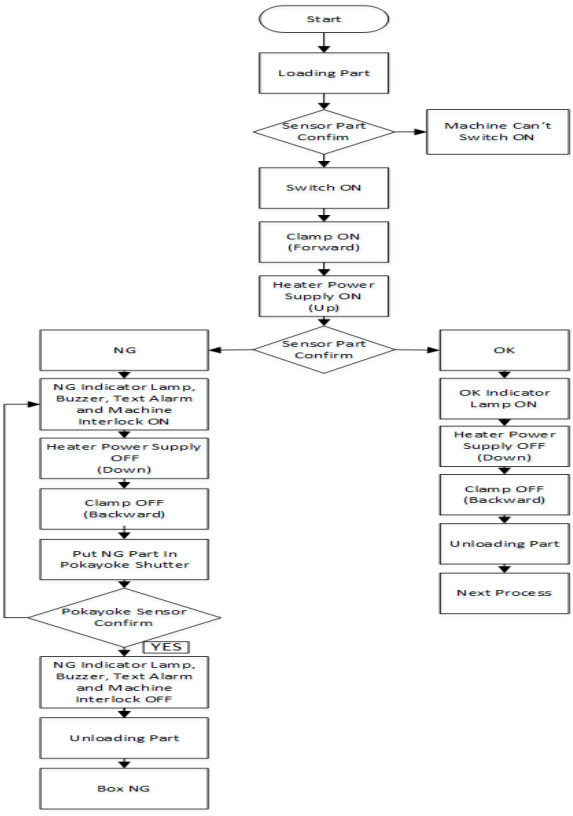

Fig. 2. Process flow operation of the function check machine

III. DESIGN, TESTING, AND ANALYSIS

A. Design of the additional spring in Jig

Based on an improvement plan, then we designs an additional spring in jig. Fig. 3 shows the additional spring in jig.

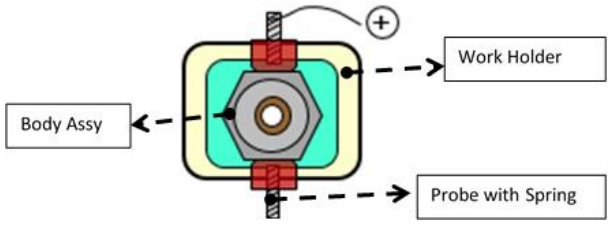

Fig. 3. The additional spring in jig

This spring functions to make the probe can move flexible so it can adapt to the shape of the body of oxygen sensors and touching part of the body the oxygen sensor [1, 10, 11, 12, 13, 14, 15, 16, and 17].

Design of Pokayoke Program

In addition, pokayoke program is to check the machine in first function performed which is to know the working order then design the program. After working, then be made to determine the sequence of the flow chart is used to simplify the manufacturing of PLC programs. Fig. 4 shows the sequence of the flow chart.

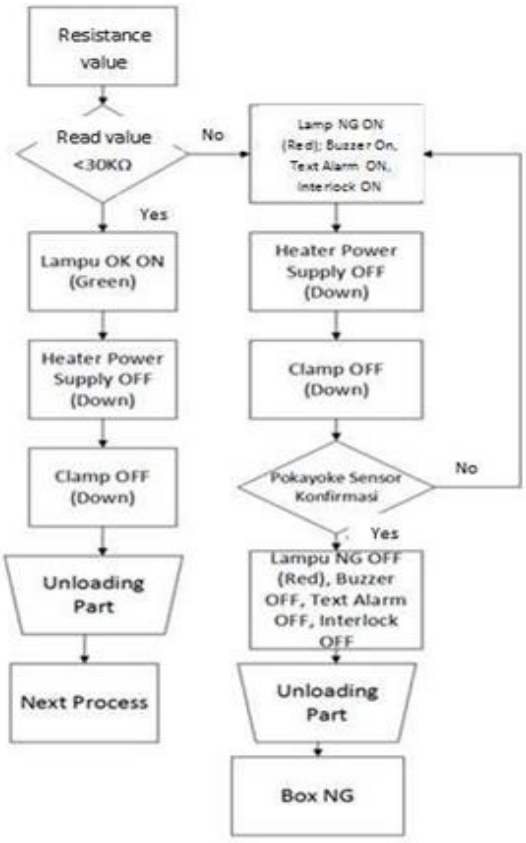

Fig. 4. The sequence of the flow chart

The machine will detect NG part while the part has a resistance < 30KΩ. When the machine detects part NG, NG indicator lights will illuminate as well as the buzzer and alarm text, then the machine will lock or unworkable. Then the heater power supply and cylinder clamp will be off, and then the next step is the operator to be put on the NG part pokayoke shutter. If the operator put part OK on the shutter, pokayoke indicator light, buzzer, and alarm text will not off, and the machine cannot be started, a step must be done and the operator must put the right part in pokayoke shutter.

Design of Text Alerts

Fig. 5 shows the design of text alarm.

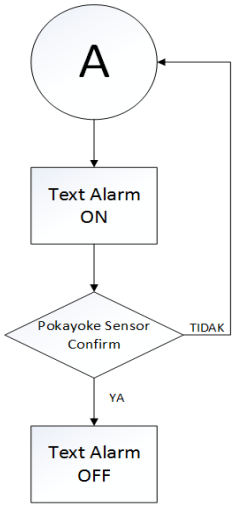

Fig. 5. The design of text alarm

The machine will detect a part NG, and then the text alarm will be ON. After that, the operator will put part on pokayoke shutter with photo-electric sensors. If pokayoke sensor detects part OK on pokayoke shutter, the text alarm will remain ON, but otherwise if pokayoke sensor detects NG part in pokayoke shutter the alarm text will remain OFF.

Design of Pokayoke Shutter

Fig. 6 shows pokayoke shutter. Pokayoke shutter will be equipped with photo electric sensor (pokayoke sensor) for detecting the parts that will be placed by the operator.

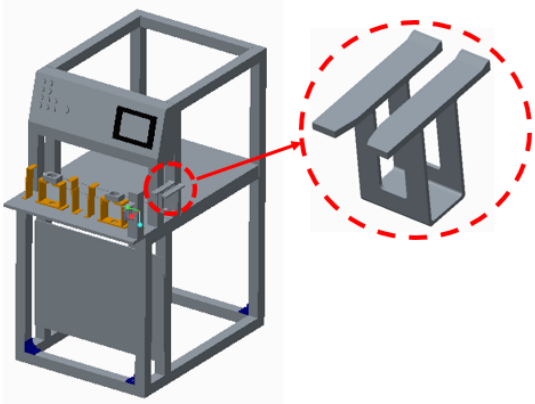

Fig. 6. Pokayoke shutter

The addition of the Jig Station Spring Testing

The purpose of the spring addition on the jig is so that the probe that serves to deliver electrical current to be able to touch the part of the part. Fig. 7 shows the position spring in the jig.

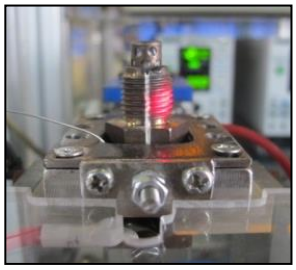

Fig. 7. Position spring in the jig

Design for Pokayoke Program

Design for the program on a machine pokayoke function check using hardware and software. Laptops are used as the hardware has been installed therein KV-Studio software. KV-Studio is used by ladder diagram language (ladder diagram). The design of this program refers to the work processes that have been made previously on the design of the program pokayoke.

Design of the Text Alerts

The internal relay inspection judge NG which is located MR1201 will be active when the machine detects a part NG, then activates the internal relay inspection error at station 1 which is located LR11005, here in after internal relay LR18004 be active simultaneously activates address LR18004 the HMI contained in the image.

Figure 10 shows the address on the HMI, LR18004 an address to activate an alarm text on station 1 while LR18005 is an address to activate an alarm text on station 2. Fig. 8 shows an alarm text display that appears when the machine detects a part NG.

Fig. 8. The address on the HMI (Human Machine Interface)

The Addition Shutter Pokayoke With Photo Electric Sensor

The purpose of the pokayoke shutter addition is equipped with a photo electric sensor that the operator put NG part and function of photo electric sensors to detect laid part by the operator in pokayoke shutter, whether part NG or part OK placed, so that the operator will not be one of the determining parts and put the part. Photo electric sensor position is located at the bottom of the pokayoke shutter. Fig. 9 shows the position of the photo electric sensor.

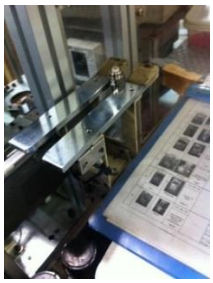

Fig. 9. The position of the photo electric sensor.

When the photo electric sensor detects the presence of NG part that passes through the shutter pokayoke NG indicator light, buzzer, and alarm on the touch panel will be off.

Installation of Electrical Photo Electric Sensor

Installation of electrical wiring of photo electric sensor is photo electric wiring to the sensor input module KVN16EX. Fig. 10 shows electrical wiring of photo electric sensor.

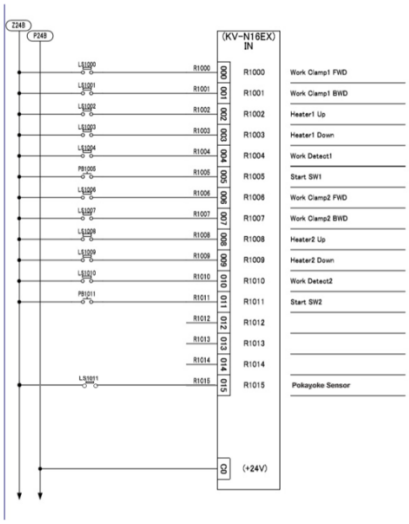

Fig. 10. Electrical wiring of photo electric sensor

In the picture above shows a program for detecting parts on pokayoke shutter. If the part is placed on pokayoke NG shutter, the machine can be operated again. If the part is OK, the machine cannot be started before the operator puts the correct part.

IV. CONCLUSION

In this paper, we have discussed about the improvement effectiveness and the problem misjudgement on the function check machine. We design the pokayoke shutter systems and use a photo electric sensor Omron E3T-ST12 as pokayoke sensors. We also add the text alarms on the HMI, so that the operator can easily determine the part is OK or NG. In addition, we also added spring in jig station checks each part so that the probe can touch the part; accordingly there is no misjudgement. Finally, the misjudgement problem can be reduced to 0.14% and MOR on the machine can achieve the targets that have been set, i.e. 90%.

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