

ABSTRACT

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, Six Sigma, JIT, JIDCO, POKA YOKE, FMS etc. organization is intended to develop quality culture.

During actual manufacturing of any product there are too many simple and monotonous steps which are carried out by operators. These monotonous work operations result in to mental fatigue and lack of interest in work which ultimately causes silly mistakes of operators and we know that human is prone to errors even though he doesn't want it. To avoid these simple mistakes, poka yoke concept play important role. By implementing some simple solutions we can avoid mistakes. The long term success of poka yoke gives output of saving time and we release the work pressure on mind of worker. We can use creativity and special skills of workers for more creative operations instead of increasing pressure for monotonous activities.

KEYWORDS: optimum, productive, monotonous, errors, creativity.

INTRODUCTION

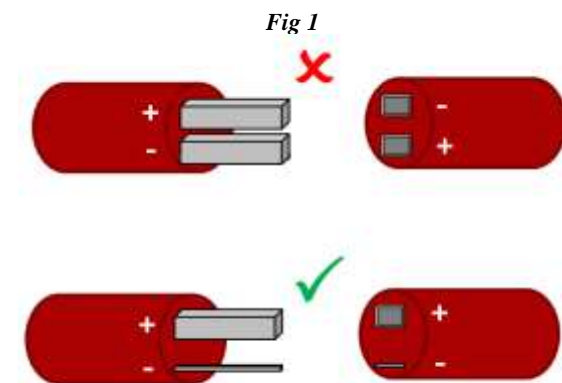
Nowadays, each and every company wants profit, high productivity, value in market. There are slogans in most factories stating defect reduction targets, but the ultimate aim should always be zero defects. "POKA-YOKE" is a vital factor in eliminating defects. Poka-yoke is a concept in total quality management which is related to restricting errors at source itself. It deals with "fool-proofing" or "mistake-proofing". A poka-yoke is any idea generation or mechanism development in a total productive management process that helps operator to avoid (yokeru) mistakes (poka). Main aim of Poka Yoke concept is to make whole system error proof that means no one can make mistake although some one wants to make mistakes intentionally. It eliminates the defects or faults. This term was coined by Shigeo Shingo in 1960s for the part of Toyota Production System. The aim of Poka-yoke is to design the process so that mistakes can be detected and corrected immediately, eliminating defects at the source. A methodical approach to build up Poka-Yoke countermeasures which consists in a three step analysis of the risks to be managed:

1. Identification of the need
2. Identification of possible mistakes
3. Management of mistakes before satisfying the need.

These steps are taken into consideration while thinking about implementation of Poka Yoke

system in any field because this methodology remains same at all the situations and conditions.

Figure:



Above figure 1 shows the concept of the Poka Yoke system. In upper diagram, size of both holes are same, therefore there may be mistake of putting positive terminal into negative hole but on the other hand, in lower figure, the sizes of both the holes are different which results in avoiding the misplacement of the terminal into wrong hole. [1, 6]

HISTORY

Poka-Yoke method was introduced by Shigeo Shingo in 1961, when he was one of engineers at Toyota Motor Corporation. This method, in other words, is to prevent defects and errors originating in the mistake. [7]

Shigeo Shingo, Born in Saga City, Japan, the Japanese industrial engineer who distinguished himself as one of the world's leading experts on manufacturing practices and the Toyota Production System. It is therefore started in Japanese organizations to implement a Zero Quality Control (ZQC). One of its elements implementing the principle ZQC is Poka-Yoke method. The name Poka-Yoke was established by Shigeo Shingo in 1963, it is translated as "resistance to errors" (avoid (yoker) errors resulting from absence of mind (Poka)). The initial term was 'baka-yoke', which means 'fool-proofing'. This term 'baka-yoke' was dishonorable connotation. Hence, the term was changed to poka-yoke, which means 'mistake-proofing'.

In the course of repetitive operations which depend on vigilance or memory, Poka-yoke may save time and release the mind of worker from stress. At each stage of the product life cycle, in each process and its operations there is a possibility of errors. In the consequence of errors the final product has defects and customer is discontented and disappointed. The method Poka-Yoke is based on convenience that it is not acceptable to produce even very small quantity of defective products. For the companies, production of products 100% without any defects is not only a challenge, but necessity. Poka-Yoke method is a simple technique which allows you to reach just such a production. [8, 9, 10,]

NEED

Manufacturing defects or errors are always the key concerns of any manufacturing industry. The success of any organization depends on the quality of product especially right product produced. Poka-yoke refers to techniques that make it impossible to make mistakes. When any organization decides to implement the lean manufacturing then one of the objective is to reduce scrap because no one is interested to compensate extra inventory on account of scrap. To increase profit percentage the cost pressures always become headache for top management so they never accept continued mistakes like scrap, rework, out of tolerance, etc. instead they are aiming to achieve value of zero in this segment. When customers of any company buys product they rightfully expect defect free products and conventional 100% inspection or statistical process control do not insure 100% defect-free products. Hence there is a necessity to

reach the root cause of any problem and avoiding it, which gives us defect free product. [5]

Poka-yoke is one of the presentations of "good kaizen", or superior continual improvement because of its preventive nature. A poka-yoke device or solution is any mechanism or idea that either avoids the mistake from being made or makes the mistake easily detected at a glance. The ability to find mistakes at a glance is important because, as Shingo states, "The causes of defects lie in worker errors, and defects are the results of neglecting those errors". It follows that mistakes will not turn into defects if worker errors are discovered and eliminated beforehand". He also adds to this that "Defects arise because errors are made; the two have a cause-and-effect relationship. Yet errors will not turn into defects if feedback and action take place at the error stage". It is therefore an effective approach to apply mechanisms to prevent errors formation precisely at the moment they occur. [2]

TECHNICAL ASPECT

Poka-Yoke technique can be applied both to prevent causes, which will result in subsequent occurrences of errors and to carry out inexpensive control, determining whether to adopt or reject the product. It is not always 100% probability elimination of all errors, in such cases the task of Poka-Yoke methods is detection as soon as possible.

Analyze the process of product defects formation and its correction. It is therefore the proposed method for reducing defective products by planning conditions with requisite solutions in which error may not happen, or will be immediately visible and captured.

Shigeo Shingo has analysed in detail the process formation of defects and errors from the source to effect. He said that mistake from the producer becomes defect for the user. It should be therefore a maximum reduced and speed up action coupling back, and so on:

- As earliest as possible signal error before it becomes the defect.
- Eliminate possibility of the occurrence error (inspection at source, verify the conditions under which runs the operation in order to eliminate the possibility of formation of error).

The Poka-Yoke is a technique for avoiding human error at work. A defect exists in either of two states; the defect either has already occurred, calling for defect detection, or is about to occur, calling for defect prediction. Poka-yoke has three basic approaches to prevent or reduce defects: shutdown, control, and warning. The technique starts by analyzing the process for potential

problems, identifying parts by the characteristics of dimension, shape, and weight, detecting process deviation from nominal procedures and norms. [7].

WHEN TO USE IT

- It is a technique, a tool that can be applied to any type of process be it in manufacturing or the service industry.
- Poka-yoke can be used wherever something can go wrong or an error can be made.
- Errors can be of any type-
 - i. Processing Error: Process operation missed or not performed per the SOP.
 - ii. Setup Error: Using the wrong tooling or setting machine adjustments incorrectly.
 - iii. Missing Part: Not all parts included in the assembly, welding, or other processes.
 - iv. Improper part/item: Wrong part used in the process.
 - v. Operations Error: Carrying out an operation incorrectly; having the incorrect version of the specification.
 - vi. Measurement Error: Errors in machine adjustment, test measurement or dimensions of a part coming in from a supplier. [10]

HOW TO USE IT

Step by step process in applying poka-yoke:

1. Identify the operation or process
2. Analyze and understand the ways in which a process can fail.
3. Decide the right Poka-yoke approach, such as using a,
 - ❑ Shut out Type: Preventing an error being made, or an
 - ❑ Attention Type: Highlighting that an error has been made.
4. Determine whether a
 - ❑ Contact Method
 - ❑ Constant Number or Counting Method
 - ❑ Motion-Sequence Method
5. Trial the method and see if it works.
6. Train the operator, review performance and measure success. [10]

METHODOLOGY OF POKA YOKE

Identify problem
Observation at work stations
Brainstorming for idea
Select best ideas
Implementation plan and implementation

Monitoring and sign off

Step 1: Identify problem

In this stage the complaints coming from the customers are collected. The principle of standard is determined by considering various criteria's like number of complaints from the customer, the quantity of defects detected by quality control, materiality defects (their impact on the customer, costs, implemented process) and then data is collected broadly. As per analysis of result of the collected data, company plans for developing poka yoke system for the selected problem. In this way in first stage the problem carried out.

Step 2: Observation at work stations

In this step the actual on site study of the problem is carried out. The causes behind the problem are evaluated. The causes may be related to man, machine, material or method accordingly the complete sorting is carried out.

Step 3: Brainstorming for idea

This is a technique to capture creativity and skills of employee's .In brainstorming session the problem under study is put forward to committee. Then all members study problem and give various solutions to avoid that defect. As each person may come up with unique ideas this step concludes with various alternative solutions for same problem.

Step 4: Select best ideas

After getting various alternative solutions it is time to select best one out of all collected solutions. Criteria for selection may be cost, time required, changes in existing system, simplicity in operation etc. By referring all selection criteria's committee concludes with one best solution.

Step 5: Implementation plan and implementation

This step is concerned with implementation planning. It deals with material requirement, processing the material and finally manufactured mechanism is implemented at actual working site.

Step 6: Monitoring and sign off

The manufactured products are checked for defects. Also the performance of poka yoke system is monitored. [2]

POKA YOKE IDEAS

Poka yoke ideas are simple but creative in operation and generation. According to Shingo, "Defects will never be reduced if the workers involved do not modify operating methods when defects occur." [4]

Following are some of the simple ideas (hints) to avoid mistakes: -

- 1) Using Shapes and Colours
- 2) Software Warnings and Reminders
- 3) Using Dialogue Boxes and Software Checks
- 4) Using Switches and Automatic Braking
- 5) Using Checklists

- 6) Visual Prevention Methods
- 7) Using Lights, Sounds, Signs and Barriers Etc. [11]

VISUAL EXAMPLES

A)



Fig 2

The floppy disc (Fig 2) is only able to be inserted in one orientation.

B)



Fig 3

Figure 3 shows new lawn mower that has a safety bar on the handle that must be pulled back in order to start the engine. If you let go of the safety bar, the mower blade stops in 3 seconds or less.

C)



Fig 4

Fig 4 shows File cabinets, opening one drawer lock all the rest, reducing the chance of the file cabinet tipping.

D)



Fig 5

Figure 5 shows the sinks that are fitted with light sensors. These sensors ensure that the water is turned off when the tap is not in use.

APPROACHES TO MISTAKE PROOFING

A) **Control approach**

- Shuts down the process when an error occurs.
- High capability of achieving zero defects.

B) **Warning approach**

- Signals the operator to stop the process and correct problem or check for a problem.
- Sometimes an automatic shutoff is not an option.
- Dials, lights, and sounds to bring attention to the problem. [13]

TYPES OF POKA YOKE

Poka-yoke systems consist of three primary methods:

1. Contact Method
2. Counting Method
3. Motion-Sequence Method

Each method can be used in a control system or a warning system. Each method uses a different process prevention approach for dealing with irregularities.

I] Contact Method:

- *Do not have to be high tech!*

Passive devices are sometimes the best method. These can be as simple as guide pins or blocks that do not allow parts to be seated in the wrong position prior to processing.

- *Take advantage of parts designed with an uneven shape!*

A work piece with a hole, a bump or an uneven end is a perfect candidate for a passive jig. This method signals to the operator right away that the part is not in proper position. [12]

II] Counting Method:

Used when a fixed number of operations are required within a process, or when a product has a fixed number of parts that are attached to it.

A sensor counts the number of times a part is used or a process is completed and releases the part only when the right time is reached.

Another approach is to count the number of parts or components required to complete an operation in advance. If operators finds parts leftover, using this method, they will know that something has been omitted from the process as illustrated in figure 6. [12]



Fig 6

III] Motion-Sequence Method:

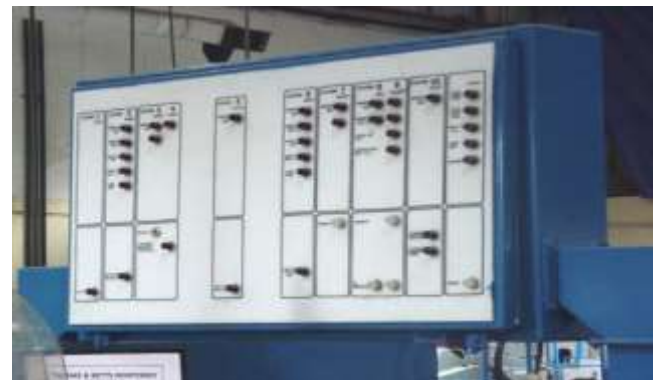
The third Poka-yoke method uses sensors to determine if a motion or a step in a process has occurred. If the step has not occurred or has occurred out of sequence, the sensor signals the timer or other device to stop the machine and signal

the operator. This method uses sensors and photo-electric devices connected to a timer. If movement does not occur when required, the switch signals to stop the process or warn the operator. [12]

The figure 7 is an example of motion sequence method. In this example, each step of the machine cycle is wired to an indicator board and a timer. If each cycle of the machine is not performed within the required "time" and "sequence", the indicator light for that corresponding step will be turned on and the machine will stop.



Machine



Indicator Board

Fig 7

CASE STUDIES

A] CASE STUDY I

Problem statement: Job loading in reverse direction causing job rejection, damage to tool and machine geometry.[2]

Aim: To ensure correct loading of job.

Ideas after brain storming:-

When problem is taken on the table of brainstorming the following options are obtained for above mentioned problem

- Use of proximity sensor to detect improper loading of job.
- Use of photo sensor.
- Instructions to operator.

- Separate fixtures to keep the incoming job in position and to enable operator to load the job correctly.
- Painting the correct and wrong end of job with different colours.
- To provide work rest for the job.
- To provide interference pin.

From the analysis of various solutions it is concluded that interference pin should be used to locate the job correctly.[2]

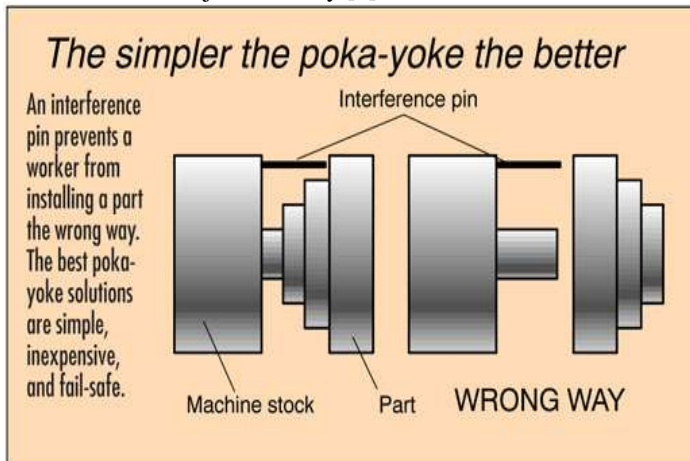


Fig 8

Now plan for implementing the selected solution is prepared and monitor for the result and process is done. [2]

Result:

Due to implementation of above Poka Yoke, the proper loading of the work piece is ensured and the time required in positioning of job is reduced, thereby increasing the productivity.

B) CASE STUDY II

Problem Statement:

The problem in this case was missing metal clips. That component which was to be punch sometimes sent further for punching operation without conforming all metal Clips are there on its place or not. These were results in wastage of time which indirectly affect productivity of the plant. [3]

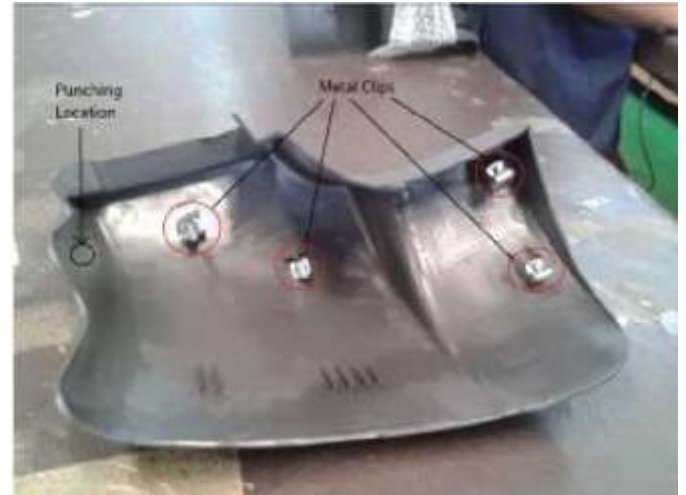


Fig 9: Location of metal clips and Punching location

From chart 1, we can conclude that in each lot of 50 components, we found 2 to 3 components such that metal clips were missed so if we calculate total PPM of the readings, we get that it was too high which leads to wastage of so much time.[3]

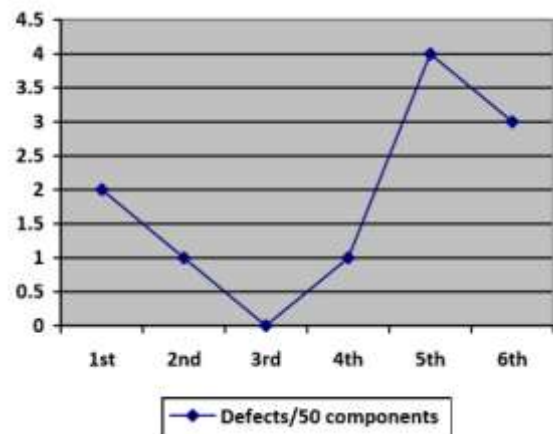


Chart 1: Number of Defects/ 50 Components (6 lots)

Problem Solution:

There is a very smart solution to this problem which is expressed in circuit diagram below. The main task we have to do is to stop the air flow from the compressor to pneumatic cylinder if any one of the metal clip is missing.

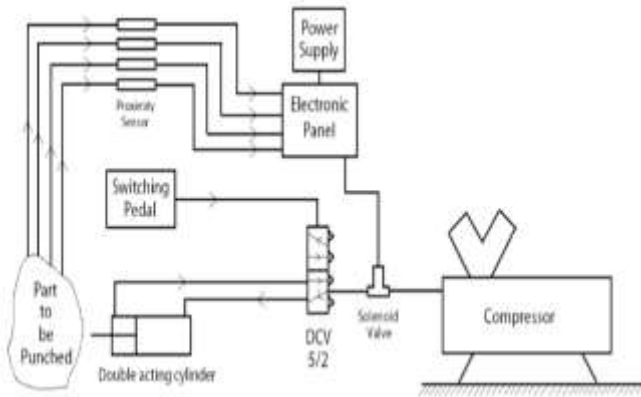


Fig 10: System Design (Problem solution)

Required components:

- 4 Proximity Sensors
- Solenoid Valve
- DCV (Pedal operated)
- Double acting Cylinder
- Electronic Control Panel (PLC)
- Power Supply and Compressor

Simple pneumatic circuit is made which can operate the cylinder according to its stroke. To integrate Poka Yoke system to this pneumatic system is done by adding a solenoid valve between compressor and direction control valve. The solenoid valve gets opened when it will get signal from electronic control panel (PLC). Programmable Logic Controller will take input from proximity sensor and will process the signal accordingly and send it to solenoid valve and solenoid valve will send air to pass through cylinder if the signal from proximity sensors indicate that all metal clips are in place, if not the air is not allowed to pass. [3]

Result:

Table 1: Result Data

Lots	No. Of Samples	Missed Clips components	PPM (Before)	PPM (After)
1	50	2	40000	0
2	50	1	20000	0
3	50	0	0	0
4	50	1	20000	0
5	50	4	80000	0
6	50	3	60000	0
Avg	300	11	36666.66	0

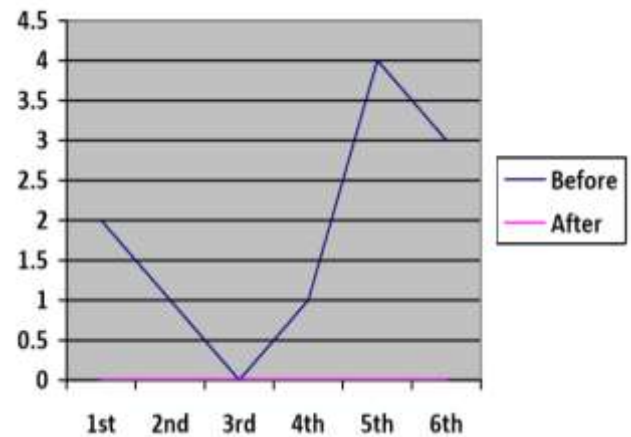


Chart 2: Result Before and After

From above table and chart we can see the result we obtained after implementation of the Poka Yoke concept to the punching machine.

Conclusion:

From this case study we have got positive output which meets organizational requirement i.e.

- Increased productivity
- Achieved 0 PPM defects
- Eliminated rework time
- No chance for mistake

A very simple technique is used to implement Poka Yoke to the punching machine which was so profitable. Poka Yoke eliminated mistakes and rework time.

CONCLUSION

To make errors is human nature so we can't blame human being for each and every mistake. As like error, Intelligence is also human nature so we can dominate preceding nature by next nature.

- Poka yoke is just a face of that intelligence. We can avoid the mistakes at the source itself by using above mentioned methodology.
- It also allow user to function without mistake or prevent error that are about to occur.
- In order to implement quality management system successfully each activity should aim towards excellence. Poka yoke is one of the most important tool in TQM.
- Successful poka yoke results in increased productivity with minimum waste (waste due to rework, scrap) because we are sure about the quality of product, as mistakes are blocked at source itself.
- There may be some practical limitations in poka yoke but we have to overcome all that for achieving the aim of "Zero Defects, Zero Waste and Zero Delays".
- In one sentence poka yoke is launching preventive actions for systematic movement on the success ladder of QMS with higher level of performance and productivity of system with high quality products at minimum cost.

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