Research Inventy: International Journal Of Engineering And Science
Issn: 2278-4721, Vol. 2, Issue 4 (February 2013), Pp 19-24
Www.Researchinventy.Com

Review Paper On "Poka Yoke: The Revolutionary Idea In Total Productive Management"

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Abstract: *Poka-yoke is a concept in total quality management which is related to restricting errors at source itself. It deals with "fail-safing" 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). The concept was generated, and developed by Shigeo Shingo for the Toyota Production System.*

Keywords*— Mistake-proofing, Total quality management, Total productive management.*

I INTRODUCTION

In today's competitive world any organisation 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, JIT, JIDCO, POKA YOKE, FMS etc. organisation is intended to develop quality culture.[2,6] The paper is intended to focus basic concept of poka yoke, types of poka yoke system, ways to achieve simple poka yoke mechanism. It also covers practical study work done by various researchers .

II What Is Poka Yoke?

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. [1, 5]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.[2]The poka-yoke concept was generated in the mid-1960s by Shigeo Shingo who is Japanese industrial engineer. Shingo was working for Toyota and other Japanese companies, where he developed entire production systems focused on achieving zero defects in production and gave birth to this revolutionary work. The basic concept behind poka-yoke is that it is not acceptable and allowed to produce even a small amount of nonconforming product. [1,2]To stay in market and to become a world-class competitor, an organization must go with new philosophy and technology along with side by side practice of producing zero defects. Poka-yoke methods are the very easy and simple concepts for achieving this goal and are a key component of the continual improvement strategy in many leading Japanese companies on this moment. 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"[Shingo 1986, p.50].[4] 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"[Shingo, 1986, p. 82].[4]

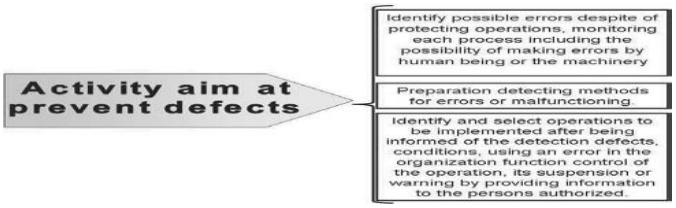

Fig. 1 General activity aim at prevent defects [1]

During actual manufacturing of any product there are too many very 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. [5]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 This involvement of everyone in organisation is basic need to rise roots of quality culture in the organisation.

III Need Of Mistake Proofing

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. As per philosophy of lean manufacturing it focuses on speed of production and productivity also. In order to follow this concept of speed we should prevail against defects and rework. To increase profit percentage the cost pressures always become headache for top management so they never accept continued mistakes like scrap, rework, lateness etc out of tolerance 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 don't insure 100% defect-free products. [1]Hence we are going to root cause of any problem and avoiding it which gives us defect free product. The above discussion concludes that to get defect free products one should go with the concept of Poka Yoke.

IV Types Of Poka Yoke

The Poka-Yoke is a technique for to keep away human error at work. A defect or imperfection exists in either of two states; the defect either has already occurred in that case calling for defect detection, or is about to occur in that case calling for defect prediction. 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.

Depending on the basic functionality Poka-yoke has three types:[2]

1] Shutdown Poka yoke
2] Control Poka yoke
3] Warning Poka yoke

Fig. 2 Types of poka yoke [1]

4.1 Shutdown (Prevention) Method

In shut down i.e. prevention method Poka-yoke devices checks critical process parameters and shut down the process when a situation moves out of the tolerance zone, it is indication of a defective product has either been produced or is about to be produced. [2]It is well known note that prevention is always better than cure. By implementing shutdown method we can assure about 100% defect free products.[1] It has 0 % chances to produce defective product, up to this level we can reliance on it.[2] E.g. Use of fuse in electric circuit. When there is short circuit then fuse is operated and cut down the supply of electricity resulting in avoiding any further accidents.

4.2 Control method

In control method Poka-yoke devices are regulatory in working which are installed on process equipment and/or Work pieces which make it impossible to produce defects and/or to flow a nonconforming product to the next process.[2] As like shut down method control method gives 100% defect free products. [1]The control make certainty that if there is any defect, it's not coming outside the production line and does not reach to the customer. E.g. To avoid wrong job loading in reverse direction on machine we can provide work rest for the job which will avoid wrong job loading.

4.3 Warning (Alert) method

This is the method which makes the operator conscious about something is going wrong. The mechanism or simple idea is generated in such a way that Poka-yoke devices indicate or shows to a worker that a defect has been produced. When operator gets such warning then he must immediately interfere the process to correct the process (es) responsible for causing the defect. In case of irresponsible behavior of operator irrespective of getting warning notice the next products will continue the same defect and produce nonconforming products. [2] In short again this method depends on human nature and behavior. It is concluded that alert method gives 30% of the guarantee of good products. Actually this method tells about existence of defect but does not assure and does not produce 100% quality. [1]The common warning methods are use of blinking light and use of beeping sound as alarm. e.g. Beeping sound or flashing of light in ATM machine after removing ATM card from machine to warn operator that he is safe and ensure that card is not in machine.

V Methodology of poka yoke [1]

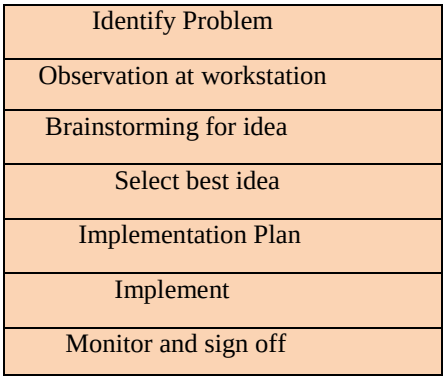

Fig. 3 Steps to implement poka

yoke

Once top management decides to implement TPM culture in organization then to compensate for defect free products successfully one should follow the following methodology

5.1 Step 1 Identify problem

In this stage the complaints coming from the customers (Both internal and external customer) 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 results of the collected data company plans for developing poka yoke system for the selected problem. In this way in first stage the problem is selected,

5.2 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 sort out by using fishbone diagram (fishbone diagram is cause and effect diagram given by Japans management guru Ishikawa).The causes may be related to man, machine, material or method accordingly the complete sorting is carried out.

5.3 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 has one uniqueness this step concludes with various alternative solutions for same problem.

5.4 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, opportunity to develop new solutions, simplicity in operation etc. By referring all selection criteria's committee concludes With one best solution.

5.5 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.

5.6 Step 6 Monitoring and sign off

The manufactured products are checked for defects under study also the performance of poka yoke system is also monitored and project is shut downed.

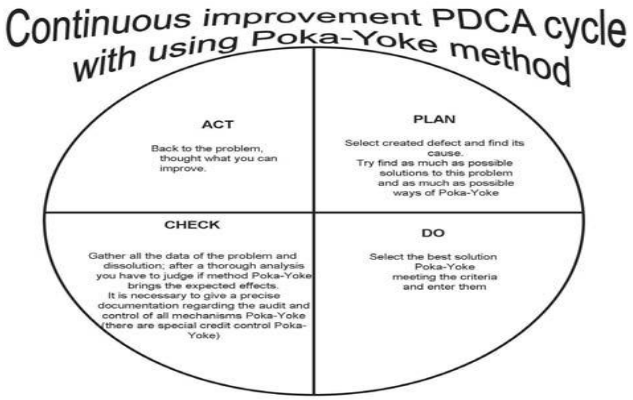

Fig. 4 PDCA cycle to implement poka yoke [1]

Example:-

Problem: - Job loading in reverse direction causing job rejection, damage to tool and machine geometry

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 reverse loading of job.
- Use of photo sensor.
- Instructions to operator.
- Separate fixtures to keep the incoming job to enable operator to load the job correctly.
- Painting the correct and wrong end of job with different colors.
- Use of color sensors to differentiate between correct and wrong end of job.
- To provide work rest for the job.
- To provide mechanical stopper. Etc.

From the analysis of various solutions the meeting concludes that they should go with last option i.e. to provide mechanical stopper.

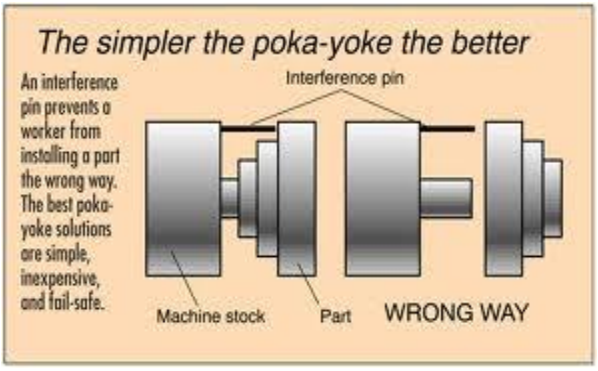

Fig. 5 Poka yoke the simple practical implementation [3]

Now they will plan for implementing the selected solution and monitor for the result and switch over to next problem.

VI Principles Of Poka Yoke

Imperfections faults arise most as a result of human errors and mistakes. Even though the worker is conscious of the mistake he makes, he repeats to do the same.

Here is list of some most common errors incurred by operators as below- [1, 5]

1) The errors due to the misunderstanding
2) Incorrect identification
3) Good intentions but improperly implemented
4) Processing omissions (a step was forgotten)
5) Processing errors (something was done incorrectly)
6) Error in setting up the work piece
7) Assembly omissions (a part was forgotten)
8) A wrong part / item was included
9) Wrong work piece
10) Operations errors (incomplete information, Lack of training ,procedures not followed)
11) Adjustment, measurement, dimensional errors
12) Equipment maintenance errors
13) Errors in preparation of tools, fixtures, blades etc. Etc.

All errors arising in the company are kept on record and then analysed. Most of them can be prevented by using techniques Poka-Yoke.

VII Methods Of Obtaining Poka Yoke

Poka yoke ideas are simple but creative in operation and generation. According to Shingo [Shingo, 1986, p.71], "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: - [5]

1) Using Shapes and Colors
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.

VIII Challenges And Limitations Of Poka Yoke

As per up till discussion in the paper it seems that poka yoke is one of the best tool in total quality management but we have to think about the obstacles and challenges against poka yoke.

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Some of challenges are listed below-

1. Practical implementation of the mechanism or solution is not possible.
2. Process parameters don't allow changing the existing system.
3. Sometimes the poka yoke is not cost effective.
4. Interdepartmental relations between production and quality dept are not good so each one think that I don't have to do anything with that issue.
5. Now also we are depending on statistical process control.
6. Expert advice is needed for new creative and challenging tasks .It may happen that experts are not available with small scale industries and expert advice is not economical for their financial health.

IX Examples Of Poka Yoke

1. Spindle of CNC machine starts only after closing the safety door. If door is open then machine will not run. It is shut down poka yoke to avoid accidents.
2. The guide pins are used in stamping dies for correct alignment of upper and lower portion. If there is improper matching assembly of dies will not take place. It is shut down poka yoke.
3. If we want to close any file in operating software (e.g. Microsoft Word) it asks for save it or cancel dialogue box. This is warning system against by mistake closing of file. It is warning poka yoke.[5]
4. To avoid parallax error in reading the measuring instrument small mirror is placed below the moving pointer. By referring pointer and its mirror image we can take proper reading. It is warning poka yoke.
5. The socket for USB on the computer is designed in such a way that we can't connect pen drive or any corresponding pin in opposite or wrong way. It is control poka yoke system.[5]
6. Pressure relief valves are used in hydraulic circuit to prevent damage to system due to high pressure. In case of high pressure the excess oil bleed off through check valve to the reservoir. It is control poka yoke system.
7. Check list is used to confirm that all subcomponents in assembly are assembled. It is control poka yoke system.[2]

X Conclusion

To err is human nature so we can't blame human being for each and every mistake. As like err, 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. About mistake proofing we can say that it is a system for organizing work that eliminates any chances of error by new user also. 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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