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Poka–Yoke – solution to human errors in the production process

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Abstract
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. Poka- yoke has been used most frequently in production environments. Production defects or errors are always the key concerns of any production industry. The success of any organization depends on the quality of product especially right product produced.

Keywords: error, method, production process, POKA-YOKE

I. INTRODUCTION

Poka – Yoke is a quality management concept developed by a Matsushita manufacturing engineer named Shigeo Shingo to prevent human errors from occurring in the production line. Poka – Yoke (pronounced "poh-kahyoh-kay") comes from two Japanese words – "yokeru" which means "to avoid", and "poka" which means "inadvertent errors." Thus, Poka – Yoke more or less translates to "avoiding inadvertent errors".

The main objective of Poka – Yoke is to achieve zero defects. In fact, it is just one of the many components of Shingo's Zero Quality Control system, the goal of which is to eliminate defective products.

II. POKA – YOKE IN GENERAL

Increasing emphasis on the quality of performance in each area of production characterizesthe present work environment. Organizations focus on improving existing quality management system, quality tools and methods.

However, on the human and his activity in the production process must also focuses attention. This stance views people as inseparable part of production. It is natural for a human being to make mistakes. People are not able to repeat hundreds times the same operation without any differences. In Fig. 1 below, we can see the most common errors that occur in the production process.

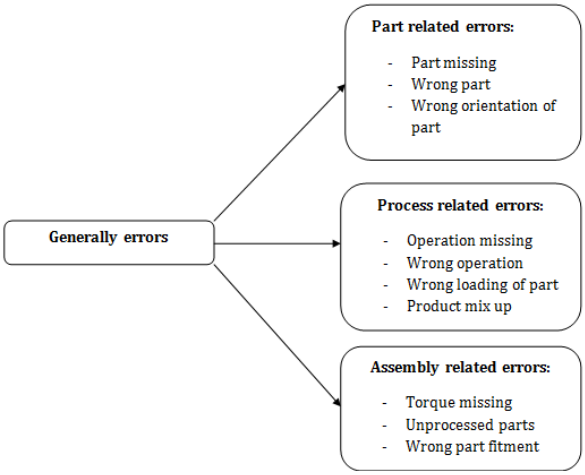

Fig. 1 Most frequent errors in the production process [1]

Previous methods of addressing human errors in the production process involved counselling workers and insist them to be more careful. Today´s methods exist to help workers avoid mistakes by using a wide range of actions and devices. These methods prevent workers from committing and repeating errors. Fig. 2 highlights principles of these methods and their fundamental differences.

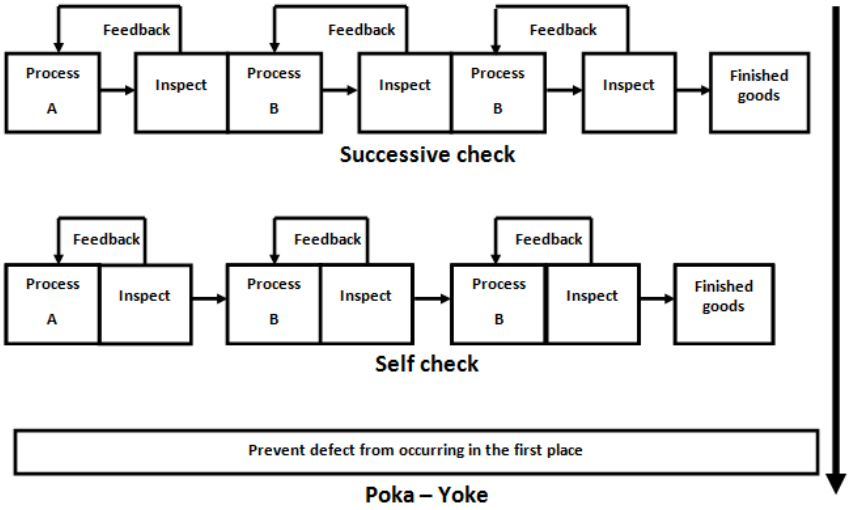

Fig. 2 Defect detection and prevention strategies [1]

The first method illustrate is The Successive check. It demonstrates that improvements occur more rapidly when quality feedback is timely. The key element of Successive check is frequent inspections. The focus of this method is for the nearest downstream operation to check the work of the prior operation in terms of production and quality inspection.

The Self – check method is based on control of individual operator work. This provides even faster feedback than Successive check. Since the worker checks each unit produced, he can recognize changes in conditions and detect error. Self – check is preferred to Successive – check whenever possible.

Both, Successive – check and self – check provide information after defects occur. The Poka – Yoke method instead of emphasizing the detection of errors focuses on preventing. [1, 2]

III. THE CORE PURPOSE OF POKA – YOKE

Shingeo Shingo in Toyota Motor Corporation introduced the Concept of Poka – Yoke in 1961. Its original term Baka – Yoke represented Fool – Proofing. In 1963, this term was change to Poka – Yoke that means Mistake – Proofing, because of connotative associations inherent in the previous title.

Poka – Yoke is based on 5 basic principles. Table 1 enumerates these principles as well as their descriptions.

Table 1. Basic principles of Poka – Yoke [2]

Principle	Objective	Way
1. **Elimination**	Eliminating the possibility of error	Redesigning the process or product so that the task is no longer necessary
2. **Replacement**	Substituting a more reliable process	Using automation
3. **Facilitation**	Making the work easier to perform	Color coding
4. **Detection**	Detecting the error before further processing	Developing software which notifies a worker when a wrong input is made
5. **Mitigation**	Minimizing the effect of the error	Utilizing fuses for overloaded circuits

This concept is used in processes, which are known as lean manufacture processes. Poka – Yoke is one element of Zero Quality Control. Its aim is to achieve zero defects and eliminate or reduce control of quality. Poka – Yoke ensures the existence of proper conditions before performing even the first step of a process. "The Purpose of Poka – Yoke is to eliminate defects by preventing, correcting or drawing attention to human errors as they occur." A technique makes it impossible to commit errors. Due to the implementation of fail-safe tools, operators cannot select a wrong part or leave part out. Poka – Yoke encourages production without defects and increases of reliability. This method can be applied to entire processes such as production, sales and purchasing. [3, 4]

IV. PRINCIPAL FORMS OF POKA – YOKE

As was previously mention in general there exist two different ways of implementing Poka – Yoke in the production process. Poka – Yoke can take prevention or detection forms, as illustrates Fig. 3.

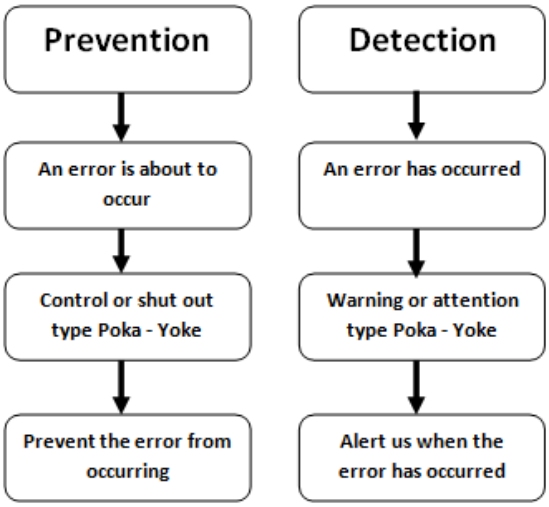

Fig. 3 Major categories of Poka – Yoke [5]

The Prevention form of Poka – Yoke ensures that a defect is not going to reoccur throughout the entire process. Suppose an abnormality is about to happen. Prevention based Poka – Yoke provides two approaches, control and warning.

The Control approach halts the process immediately after detection of defects in a product so corrective action can be performed. The result is to keeping a suspect part in place when an operation is incomplete. Serial defect generation is prevented. The Control approach does not depend on assembler. A practical example of the Control method is when a component missing a part. The process will pause if the component is discovered before the next assembly step.

The Warning approach aims to attract the attention of an operator when a mistake is occurring. The operator should stop the process and correct the problem. Unlike the Control approach, a disadvantage of the Warning approach is that an operator can miss the signal and continue to process the defective product. Warning approach depends on assembler. With the warning method, it is typical to use signal devices such as buzzers, lights and other warning kinds of devices. This approach is cheaper but also less effective in comparison with the Control approach. [5, 6]

Stilly the total prevention of defects may not be feasible in real conditions. One of the reasons is the economy of Poka – Yoke measures and considers production costs. The Detection form of Poka – Yoke focuses on cases where mistakes have been made. The Detection form distinguishes three categories, Contact method, Fixed value method and The Motion step method.

The Contact method identifies product defects by testing the product's shape, size, colour or other physical attributes. Testing is realized through mechanisms that are kept in direct contact with a particular part. The Contact method also includes a subset category, The Non – contact method. This method works on the basis of photoelectric cells.

The Fixed – value method uses physical and visual methods to ensure that all components are available in the right quantities. This method tends to be used in operations in which a set of steps are sequentially performed. Typical mechanisms used by The Fixed – value method are automatic counters and optical devices built into progressive

stamping, welding and automatic insertion equipment. This method can be combined with The Contact method for better detection.

The Motion step method ensures that the correct number of steps will be taken and the correct sequence of steps. In other words, that a step that is not part of the normal process cannot be mistakenly performed. [5, 6, 7]

After determination of the purpose and core forms of Poka – Yoke arises the question of the implementation of this system through the whole organization.

V. IMPLEMENTATION PHASE OF POKA – YOKE

The initial implementation of Poka - Yoke should forego the phase of the identification of possible errors and how they occur in the design stage. It is important to identify The Poka –Yoke opportunities that will have the biggest impact on the customer and yield the best return on investment. One way is through the failure mode effects analysis (FMEA). After that, Poka – Yoke can be implemented at any step of the manufacturing process where it was found that an error could be made.

An unnecessary condition for the implementation of Poka – Yoke management is where a strong foundation exists in total quality management. There are five other conditions for effective implementation of Poka – Yoke [8]:

1. Organization has to be strongly customer focused.
2. Organization must promote quality ownership at the source.
3. There must be a clear distinction between good versus bad quality.
4. Organization must adopt a PSP philosophy, meaning Pre-, Self-, Post- Inspection at the source.
5. Real – time feedback and corrective action are required.

The implementation of Poka – Yoke can proceed on three different levels. At the physical level, focus is on the elimination of conditions that may lead to errors by installing components. The operational level includes installing devices to fortify correct assembly processes. Philosophical level deals with identifying the causes of errors and their disposal.

Applying the process of Poka – Yoke consists of six steps [9]:

1. Poka – Yoke should mainly focus on the most valuable process for organizations based on The Pareto principle.
2. Identify five possible reasons for failure of the process and understand them.
3. Choose application form of Poka – yoke in the organization. As it was mentioned and described, distinguish the two basic forms, the prevention and detection form of Poka – Yoke.
4. Choose a particular method of the selected form such as contact method or control method etc.
5. Test the method and observe the results.
6. Train the operator of production and evaluate performance.

Poka – Yoke is implemented by using simple objects and devices such as fixtures, jigs, and warning devices. These devices should have the following features [8]:

- They should be characterized by exceptional suitability for eliminating defects.
- They should be simple and cheap leading to cost effectiveness.
- They have to be part of the inspection process.
- They need to be placed close to where mistakes occur for effective feedback and instantaneous corrective action.
- They need to be capable of being used all the time by all operators.

Poka – Yoke uses physical contact devices, energy sensing devices and warning sensors. Each of these categories includes a wide range of devices that can be used depending on the process.

The next Fig. 4 represents the most common devices.

Fig. 4 The most commonly used physical contact sensors, energy sensors and warning sensors[9]

Besides manufacturing industries Poka – Yoke is used also in service based - organizations. In both areas, the customers are the mainstay. The difference in implementation is that manufacturing typically only considers errors made by the operator. Because service organization interface in many ways to transfer a service to the customer, they must consider errors from server and customers. Due to this consideration, Poka – Yoke distinguishes between Server Poka – Yoke and Customer Poka – Yoke.

Server Poka – Yoke errors can be classified as errors in task, treatment and tangible aspects of service (see Fig. 5). These three areas are critical because they explicitly relate fail – saving actions to specific dimension of service.

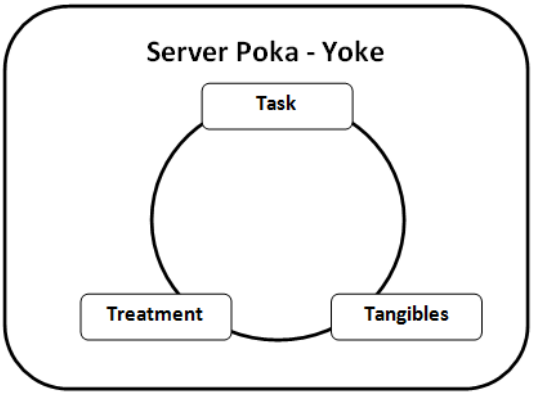

Fig. 5 Server Poka – Yoke [10]

Task Poka – Yoke concentrates on common sever errors, which may occur during performance of the task for the customer. This may include doing work incorrectly, not requested or in the wrong order.

Treatment Poka – Yoke focuses on the social interactions between customer and server such as greeting and eye contact. Particular examples of this type include failure to acknowledge the customer, listen to the customer or reacting appropriately to the customer. The aim is to ensure that customers receive proper, fair and consistent treatment.

Tangible Poka – Yoke involves connecting with physical elements of service such as clean facilities and proofread documents for content. Additionally, it is the direct task of the server in this area to improve the tangible, physical impression and experience of the customer. [11, 12]

Customer Poka – Yoke errors are commonly composed of errors in preparation for encounter, the encounter and the resolution of the encounter (Fig. 6). The customer has an integral role in the service. Their actions need to be fail – safe at each stage of service to ensure that service works as was designed.

Preparation Poka – Yoke struggles with full preparation of a customer before entrance to the service. Possible errors may relate to bringing necessary materials to the encounter, understanding and anticipating the role of the customer in the service transaction and engaging the correct service.

Encounter Poka – Yoke attempts to solve customer errors during the encounter, which can be due to inattention, misunderstanding or memory lapse.

Resolution Poka – Yoke reminds the customer of the value of their input for the continuous improvement of a service. Customers should evaluate their experiences and provide feedback to the service provider. Problems can also appear in areas such as signal service failure or the execution of appropriate post – encounter actions.

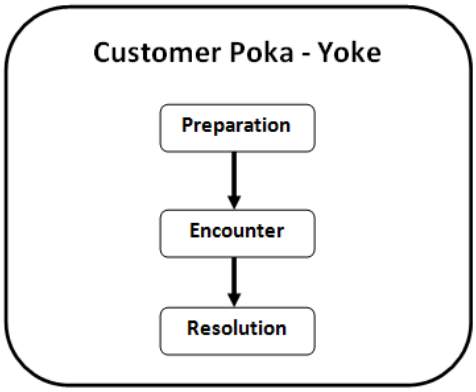

Fig. 6 Customer Poka – Yoke [11]

VI. POKA – YOKE AND SOFTWARE APPLICATIONS

Poka – Yoke is not just a manufacturing technique. It is rarely mentioned in terms of software use. However, software in the present time is coming more and more to the fore. Therefore, it is important to find application possibilities for Poka – Yoke in this area.

In both, manufacturing processes and software use, Poka – Yoke can has prevention or detection forms. Prevention forms are represented in the development of computer languages. One object of this language is to prevent creating codes that are prone to errors. Software testing is a detection form of Poka – Yoke. Programs such as Lint (tools that flag suspicious usage in software) can do this testing. These tools examine the syntax of programs and alert the programmer of possible mistakes.

CONCLUSION

Quality costs are a significant part of total cost. Continued effort to decrease quality cost brings significant competitive advantage. Quality costs originate in many cases from human error. Poka – Yoke is concerned about understanding and solving human mistakes in production. It analyses the process of knowing where mistakes occur and the root causes them utilizing a range of approaches and devices. Poka – Yoke represents an excellent method for the elimination of human errors in the production process and thereby reducing costs in production.

Acknowledgements

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