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## REDUCING THE TIME CONSUMING “COMING BACK” IN MANUFACTURING PROCESS BY USING THE ANTI-ERROR SYSTEMS

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**ABSTRACT:** The paper presents the theoretical researches on preventing the errors intervening in products manufacturing flow by means of poka yoke techniques. Poka Yoke is one of techniques aimed at preventing the faults, representing in fact a quality management concept.

**KEYWORDS:** acoustic, poka - yoke, quality, zero faults, human errors

### ❖ INTRODUCTION

Increasing the complexity of products, raising productions and extending the commodity markets are possible only whether the quality ensuring concept is adopted in all the stages of the manufacturing process. Manufacturing “*by charges*” and often introducing new models/variants represents a frequent reality in products manufacturing. Therefore, implementing the concepts of “*total quality*”, “*zero faults*”, “*preventing errors*”, has determined to embrace *anti-error* systems as a solution which could simultaneously meet the requirements of flexibility of production process and strictly monitoring the quality.

In engineering and industry, *the concepts of quality and quality control* are related to the creation of systems which should assure products and services complying to or even surpassing the customer requirements. Quality is a multidimensional concept related not only to products and services, but also to processes and activities of the company and its relations with the relevant environment. The quality of the production is the amount of following factors:

- Quality of raw materials and matters, which should respond to manufacturing specifications;
- Quality of technological design which determines the quality of component parts and sub-assemblies according to the elaborated execution documents.

Reducing as much as possible the time consuming “*coming backs*” in manufacturing process, and globally optimizing the product represent a new method of organization of production process, which should assure the increase of productivity. This new method of creating innovative products is called *integrated engineering*.

Integrated engineering is the methodology allowing an integrated design of products and processes of production or maintenance associated. It aims at eliminating all the errors irrespective of their type, namely obtaining zero faults products of high quality at small prices.

### ❖ MATERIALS AND METHODS

*Preventing the errors* is better than *detecting* them and much better than detecting *faults*. When a certain situation is not detected is necessary an additional processing (the so-called “*coming backs*”) or rubbish goods result. Therefore, it is important to supervise the manufacturing flow and detect or control the errors before coming to rejects. Similarly, it is much more efficient to prevent errors than control them.

Thus, an economic agent should use all the practical methods to prevent, detect and correct the errors appearing within the different stages of products manufacturing process. In order to achieve a real control of quality, the variables that influence the product quality and which are the result of people action, materials type or equipment performances should be checked.

Related to principal or causal reasons, the errors of manufacturing process do not depend only of persons involved in the technical process. The result of a process, figure 1, (outputs, product) is a function of *personnel* who work within the process, of materials and *methods* used, processing *equipment* and working *environment*.

Besides the 5 elements of process input (the 5 M: Machine, Method, Material, Worker, Environment) there are thousands of variables with less influence on the respective process.

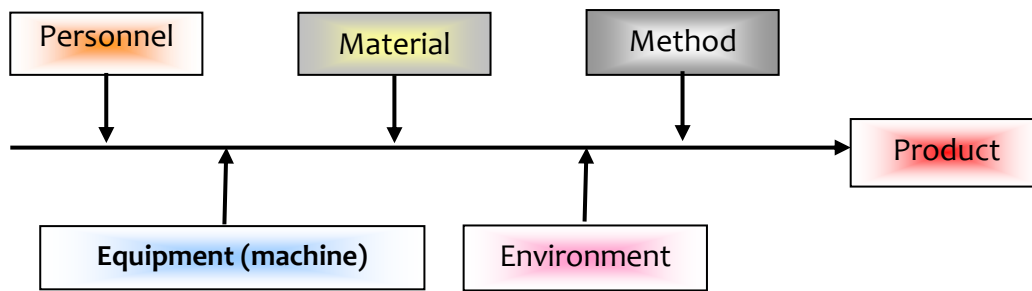


Fig. 1. Variables of a technical process

Following the analyses performed on influences above, it has been found that:

- Influence of equipment (machines) is minimum, as the initial adjustments can be maintained unchanged during a longer period of time;
- Influence of the methods manifests only on precision of execution or productivity;
- Influence of lack of homogeneity is of great importance in process dynamics;
- Influence of human factor is also very relevant (therefore, the personnel should be trained and motivated for achieving, developing and checking the processes).
- Influence of the environment (both internal and external working environment) where these processes are run represents the most important variable.

The process errors appear every time when one of the 5 variables is out of order.

In order to prevent the errors, many economic agents use the products statistic control and the processes of flow sheet. Utilization of static control of products and processes quality leads to:

- Avoiding the production errors;
- Reducing the checking methods for the final inspection;
- Possibility of detecting the errors that can be emphasized only on final check bench;
- Surveying the manufacturing process so that in the following stages any part be rejected for initial dimension faults.
- Detecting and removing the process disturbing dimensions (e.g. material and tolerance of the part, specifications related to machinery etc.);
- reducing costs, rejects percentage and checking expenses .

In order to eliminate the recurrent errors, the *anti-error techniques* should be used.

*Poka Yoke* is comprised in the techniques of preventing the faults, being in fact a quality management system and which may be translated by “avoiding the accidental errors”, “eliminating the errors ” or „self-protecting operations”. *The human errors* come especially from *tired, troubled, absent-minded or unmotivated persons*.

The main objective of poka yoke techniques is that of obtaining zero faults products, by using simple devices of fixing, assembling, warning and other related devices, which prevent people to make mistakes, even if they wanted to. These devices known as poka yoke are normally used for stopping the machine and warning the operator if something is wrong.

The anti-error devices apply in all the fields where equipment is involved and even in the offices and they are devices aimed at preventing and detecting the errors. At the same time, the poka-yoke concept may be implemented in other activity domains, such as selling, purchasing or developing products, where the errors cost can be very high. These mechanisms can be electric, mechanic, procedures, human or of any other kind able to prevent the unappropriate achieving of a process stage.

A poka yoke device is a good solution for avoiding the errors when it presents the following characteristics:

- can be used by all the workers;
- is easy to fit up;
- does not require the operator’s continuous attention (it would be ideally he ignores it);
- has a low purchasing price;
- reacts very quickly and prevents and corrects the error.

Poka-yoke systems are divided in two big classes: *preventing* and *detecting*.

*The preventing poka-yoke systems* are based on two methods:

- ❖ *Method of control* by which a problem is found and the line is stopped, so that it be corrected immediately. The majority of techniques by which a certain process is stopped are governed by an electronic sensor.
- ❖ *Method of warning* signals when appearing or is in course of appearing a process variation by acoustic sound signals, light signals or other warning methods, without stopping the manufacturing process for each possible error.

*Poka-yoke control system* has the following characteristics:

- takes out the human element out of the equation, does not depend on the operator or worker who performs the marks assembling;
- has a good capacity for reaching „zero faults”;
- The machine stops when a fault in the manufacturing process appears.

The effects resulting from errors forced control are better than those of other type. Within a process it is aimed at finding the number of times when the anti-error techniques which lead to a forced control are used. Such controlling system example would be a mounting operation, which automatically stops if one of the assembly parts is missing.

Zero control poka-yoke methods are also *quality software*.

Testing software is a form of detecting device. Testing the traditional system takes place too late within the process for allowing rapid corrective reactions to respective errors.

The software tools, which resemble very much to poka-yoke devices, are programmes such as: lint, printfck, cache, clash, which examine the programme syntax and alert the programmer about a possible error.

Certain recent works of Hewlett Packard in placing software applications explained the areas more liable to a poka-yoke approach than traditional tests.

Systems implementing control algorithms become more and more complex, having reduced power consumption and an increased flexibility which allow them to extend continuously their operating mode and enhance control accuracy.

The logical programmable circuits respond to these requirements by integrating on a single chip both control algorithms and the other peripheral functions at high speeds, determined by computer using.

*Devices and poka-yoke systems aimed at detecting* use the following methods:

❖ *Contact method*

This method detects the form deviations, dimensional characteristics and other specific shortcomings through devices directly connected to the respective part. A sub-category of this is represented by the non-contact method, which performs the same functions by means of equipment such as optic cameras. Detecting devices by contact method can be classified in:

- ✓ Devices with direct contact: limiting switch; micro switches; cut-out interrupters
- ✓ Devices without direct contact: proximity switches; photoelectric switches; fibbers sensors; surface detectors; position detectors; dimension detectors; displacement sensors; sensors of metal passing; colour-code sensor; vibration sensors; sensors for welding position; flowing sensors.

In figure 2 are shown poka-yoke devices physically bound to the product.

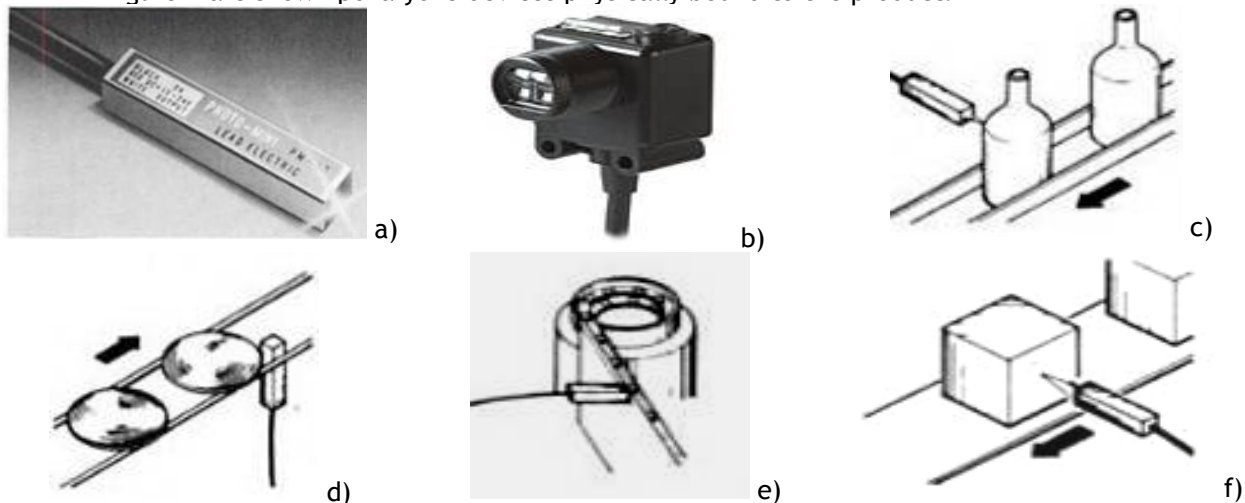


Fig. 2. Utilization of physical contact sensors a and b-models of electric switches; c) sensor for inspecting transparent objects; d) sensor for verifying the plate feeding (food industry); e) sensor for checking the parts on technological flow; f) sensor for verifying similar objects

The method used in figure 2 c is based on light reflection: the piezoelectric sensor responds to the light reflected by the respective object for detecting its presence. If the object interrupts the transmission, the machine receives the stopping signal.

The best contact methods use the passive devices. They can be extremely simple: (for example: different type of guides, which should not allow to component parts to be inappropriately placed before processing).

❖ *Method of fix value*

This method is used in operations in which a sequence of steps is performed, including self-counting or optic means and controls the number of movements, the rate and length of travel besides other critical operation parameters.

Such an approach which uses the fix value method is that of counting the number of component parts necessary for achieving an operation before the due time. When the operator finds certain parts remained after using this method, he will know that something has been left out during the manufacturing process.

❖ *Pitch method*

This method prevents the operator of the process to act inappropriately (e.g. marking the electronic parts by colours, in order to prevent the utilization of wrong parts). This poka-yoke method

use sensors to determine if a movement or a pitch in a process were performed. If the pitch did not appear or it appeared outside the sequence, the sensor transmits signals to a chronometer or other device announcing the operator to stop the machine. This method is especially applied when more component parts similar as shape and size are used.

Errors appearing during the production and requiring the creation of Poka-Yoke devices aimed at avoiding these errors are most determined by inappropriate designs and lack of productibility.

Solutions of Poka-Yoke type include different modalities of visual signals or others which point the state of a process, devices aimed at limiting the force, displacing the moving elements, ensuring the colour code for the assembling cables, assembling devices, welding equipment, etc.

Each method can be used within a control system or a warning system.

There is a large variety of poka-yoke devices used as technical solutions for „lack of attention” in products manufacturing flows:

- Device orienting the part for mounting;
- Asymmetrical holes for preventing a wrong assemblage;
- Electric connectors to be connected only to plugs designed to them;
- Guide pins for inserting the plates into the connectors;
- Caps for preventing the accidental pressing on buttons.

#### ❖ RESULTS AND DISCUSSIONS

Producers should face the challenge of a competitive market as price-quality. The quality levels they should reach require and enforce the utilization of inspection systems.

The enterprises become more and more convinced that measuring the component parts in primary phases improves the product quality and diminishes the control time. The companies wanting to obtain the maximum quality should eliminate the errors systems. Eliminating the errors takes place when the applied method follows the steps shown in figure 3.

Although many preventing and control techniques were developed, they are rather inefficient. Effectively removing errors can not be achieved without a good understanding of their real characteristics.

The mistake appears when a necessary action is not accomplished or is inappropriately accomplished, a forbidden action is performed or essential information is not available or is incorrectly understood.

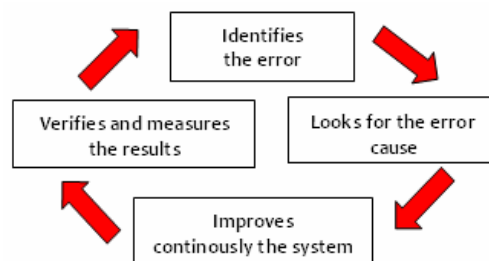


Fig. 3. Applied method

#### ❖ CONCLUSIONS

Analyzing those above, we can conclude that Poka Yoke:

- Is the first step in detecting and avoiding the errors interfering in a system;
- Is a technique of designing the product/production which prevents the errors to appear by designing the processes, equipment and instruments;
- Assures simple, cheap solutions identified by those directly involved in production process;
- Finds the errors before manufacturing a wrong product during the whole manufacturing(100% out of time);
- means: preventing the errors; detecting in due time the respective errors when they appear; stopping immediately the processes, for avoiding the faults, removing the initial cause generating them, before re beginning the output.

The most Poka-yoke devices are sensors or limitators, which assure 100% conformity on the whole period of manufacturing.

#### ❖ ACKNOWLEDGMENTS

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