

# The Poka-Yoke method as an improving quality tool of operations in the process

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## Industrial management and organisation

### ABSTRACT

**Purpose:** A new approach for the implementation of quality philosophy Zero Quality Defects with usage of the Poka-Yoke method in the Polish organization has been presented.

**Design/methodology/approach:** The possibility of usage of mistake proofing device is connected with monitoring and improvement of operations in the process.

**Findings:** At the present time the organizations should implement quality tools, techniques, methods which support the prevention strategy and should pay attention to improving each element and operations in the process.

**Research limitations/implications:** Generally activity aim at prevent defects has been described. The Poka-Yoke method of preventing errors by putting limits on how operation can be performed in order to force the correct completion of the operation has been presented.

**Practical implications:** The possibility of implementing of the Poka-Yoke method as a factor of improving operation in the process in the motorizations companies has been shown.

**Originality/value:** value The aim of method Poka-Yoke in those practical examples is to eliminate or minimize human error in manufacturing process and management as a result of mental and physical human imperfections. The graphical proposal: connection the PDCA cycle with the Poka-Yoke has been created.

**Keywords:** Quality management; Mistake proofing; Poka-Yoke method; PDCA cycle

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## 1. Introduction

In the recent years intensifying competition in the international economy caused a major change in approach to quality management.

The quality action should therefore include its reach the whole product life cycle, starting from customer identification requirements and expectations, by the customer's service.

The organizations by focusing on quality process approach should improve the existing quality management system, the

(W.E. Deming, J. Juran), quality tools and methods of quality management (Figure 1) [1].

"Process approach" to management of organization is a field developing dynamically. This concept is very universal, it works for all companies, because it integrates in transparent way all key mechanisms which result from requirements for quality management system and quality processes [2].

In context of a new edition of standards ISO 9000:2000, ISO 9001:2008, ISO 9004:2000 is based on the process approach during preparation, implementation and improvement of effectiveness of quality system management aiming at increase of the customer's satisfaction by fulfillment of requirements [3-5].

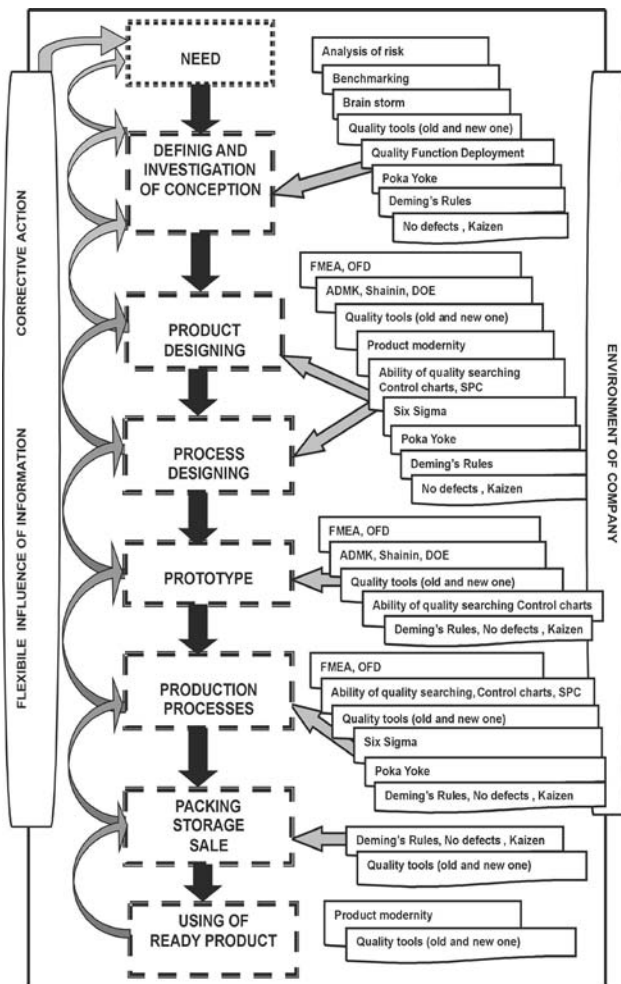


Fig. 1. Relationship between quality life cycle of product and quality estimation method and quality tools [1]

In practice, in each of the organizations exist a specific chain process, interoperable with each other, forming a network of processes, where outputs parameters are at the same time inputs parameters of the next process or base information for the process occurring in parallel. In consequence of such activities the total process of functioning organization has been created, taking account own resources: material and immaterial (Figure 2) [6-8].

Quality output operation in the process preceding becomes a condition for the success of the subsequent operation. Any unforeseen nonconformity causes maladjustment, which

results in deterioration of the process and possibility of errors in the operation process and defects in the final product [6, 7, 8].

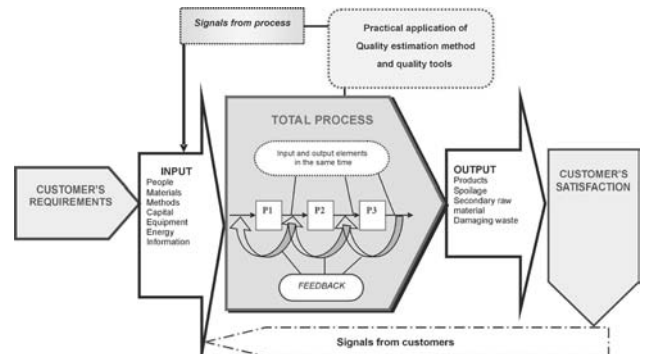


Fig. 2. Total process of functioning organization [8]

In this paper selected problems, connected with quality engineering, quality monitoring and quality control using Poka-Yoke method in company have been presented. Also suitable examples of usage of mistake proofing method in Polish companies have been given.

## 2. Prevention of defects in processes

An important factor in the functioning of company shall take appropriate selection constant improvement strategies of processes, where special emphasis is put on preventing strategy.

The prevention strategy replaced detection strategy, new strategy indicates shifting the focus on the functions and activities relating to improving each element and operation broader process [2, 6].

In the present time we have techniques, tools and methods which support such approach to the quality. Thanks to their implementation in the organization following minimizing costs, eliminate defects and thus more monitoring and improving the quality operations in processes.

Based on defect prevention is analysis and monitoring of each activity in the process and implementation at each stage of the process and each step operations tests and safeguards protecting against appearance of a problem. Collection of information on emerging deficiencies and prevent them is a much more efficient way of improving quality than the standard quality control. Observations of the current problems arising in processes can be their cause demonstrate [9, 10].

Information contained in standard ISO series 9000:2000, product life cycle and also rules of Deming confirmed a need for creating of modern quality control. The present definition of quality control is absolutely different from classic definition, which assumed that if the quality products has to be good – the cost of process production has to be high. According to today's opinions, the good quality can be achieved only by organization, which implemented the Quality Management Systems, which used idea of continuous improvement of all processes and also which used the quality tools and quality methods, recycling technology inside of production process [6, 11-13].

It is therefore an effective approach to apply mechanisms to prevent errors formation precisely at the moment they occur.

Idea of "grounds command defects" known as the method or technique Poka-Yoke is just such mechanism.

In an era of quality and use of such methodology as implementation, Zero defects, continuous improvement, Six Sigma and methods of quality: FMEA, QFD SPC it is worth set of general measures to prevent defects (Figure 3) [9].

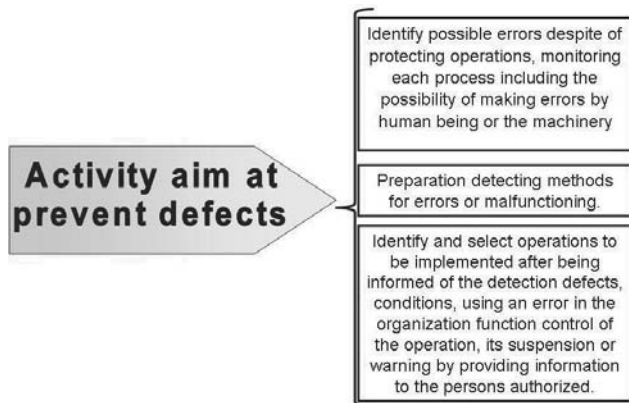


Fig. 3. General activity aim at prevent defects [9]

### 3. Poka-Yoke method (mistake proofing, error proofing)

#### To prevent defects through Poka-Yoke method

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

In the years 50 Shigeo Shingo being an advocate of statistical process control systems in Japanese companies realizes that such a solution would never improve the manufacturing process. It is therefore started in Japanese organizations to implement a Zero Quality Control (ZQC). One of its element implementing the principle ZQC is just Poka-Yoke method [4, 10].

The name poka-yoke Shigeo Shingo established in 1963, it is translated as "resistance to errors" (avoid (yoker) errors resulting from inattention (poka)) [10, 15].

The philosophy which is the core for Poka-Yoke method is respect for human rights, and above all his intelligence. In the course of repetitive operations which depend on vigilance or memory, poka-yoke may save time and release the mind of worker for operations more creative and increase their value [10, 14-17].

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

quantities of defective products. For the companies, production of products in 100% without any defects is not only challenge, but necessity [11-17].

Poka-Yoke method is a simple technique which allows you to reach just such a production [10].

#### Technical aspect of Poka-Yoke method

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 it is the task of Poka-Yoke methods is detection as soon as possible [10, 14-17].

Analyze the process of product defects formation noted that between a mistake resulting from the defect is yet one, the potential possibility: The observation mistake and its correct.

It is therefore the proposal -method for reducing defective is planning conditions in which error may not happen, or will be immediately visible and captured.

Take into account the above Shigeo Shingo developed a achieving "zero defects" in industrial conditions, i.e. in such a way as simple and cheap. Was itself at the matter, that it is not possible to reduce the defects using random checks. It is necessary to the total control - 100% control. Shigeo Shingo adopted following assumptions [10, 14-17]:

- in the case of confusion applying the statistical process control is ineffective,
- monitoring and control the poka-yoke should be:
  - autonomous, i.e. operations carried out by the contractor without intervention from the outside,
  - 100% - the total,
  - cheap.

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 in this moment when the customer unnoticed this defect. It should be therefore a maximum reduced and speed up action coupling back, and so on [18]:

- As soon as possible –and simplest should be detect errors (inspection of information, "after the fact", typical for statistical control),
- At the earliest as soon as possible signal error before it become the defect (in the inspection of information is amended to self-control 'upwards' means checking prior operations and material obtained),
- Eliminate possibility of the occurrence error (inspection at source, verify the conditions under which runs the operation in order to eliminate the possibility formation 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 [10].

Poka-yoke has three basic functions to prevent or reduce defects: shutdown, control, and warning [10, 14].

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 [17].

There are two approaches to implementation of Poka-Yoke method: control method and warning method (Figure 4) [10].

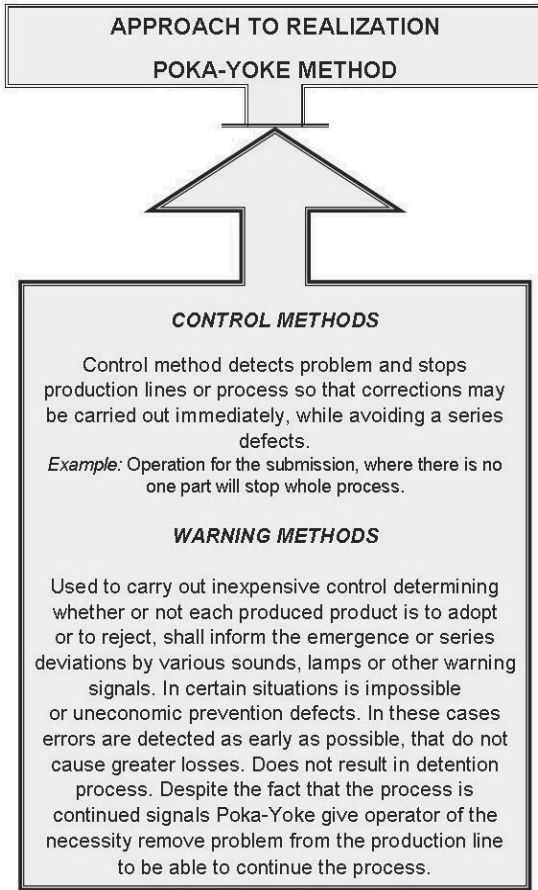


Fig. 4. Approach to realization the Poka-Yoke Method [10]

### 4. Practical using the Poka-Yoke method in the automotive companies

The first example of Automotive Company which used Poka-Yoke method.

Poka-Yoke method has been implemented in one of the companies of automotive industry. This organization shall have two main production sectors: manufacture and assembly gearboxes and manufacture of engines for factories belonging to its own group. The organization currently employs around 700 employees.

The main purpose is the manufacture of these elements of high quality, which meet quality standards in accordance with the principles processes continuous improvement (Kaizen). One of the ways of realization the improve strategy is to use Poka-Yoke

techniques. Taking into account that the engine shall consist of approximately 310-350 part, they are very useful in just such as companies concerned with putting together of elements and manufacturing of parts. The produced elements must have a large precision therefore should be to minimize in the processes possibility of appearance a large risk omissions "something" or errors.

In all organizations belonging to the group of company is functioning system of production based on its own idea, inside which alongside other systems operate SQC (system of Quality Control). This system is a combination of many standards and methods, which are using by many experts. They are working to ensure the highest quality manufactured products. Alongside such tools and philosophy as QC story, QRQC, MQA, 5D and basic tools quality (diagrams, histograms, research systems of the sample, graph Pareto-Lorenza, charts of quality control process) are also used Poka-Yoke techniques.

The company has developed the strategy which shows that these methods can be used for any defects, which was created as a result of human error. The aim of the system QC and techniques Poka-Yoke is to ensure 100% quality products and their delivery to the customer as soon as possible and at a minimum cost.

Customer is not here only the final recipient of the finished product but each of the following process, any activity in the process. This means that the company ensures the monitoring and prevention of defects at each stage of production.

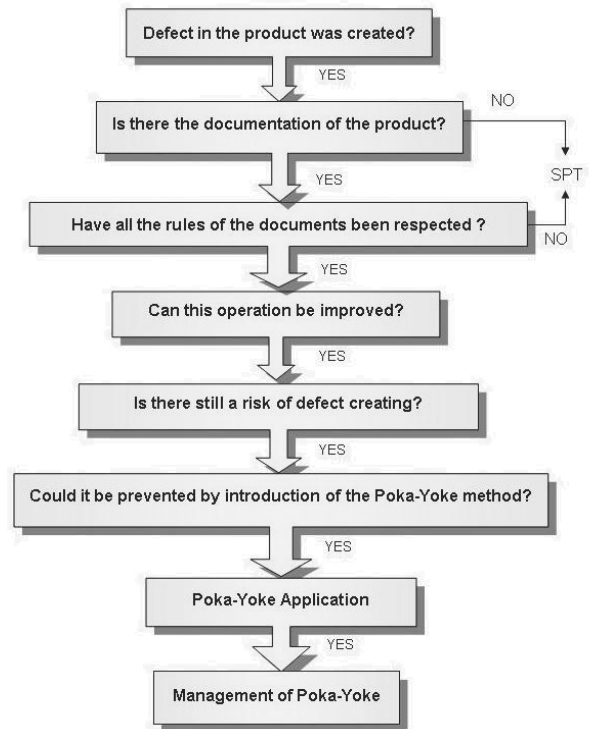


Fig. 5. Approach to realization Poka-Yoke according with organization's proceeding. SPT is a set all the documents, standards, instructions and guidance

The main motto of companies is "not to manufacture, not to release on the market and does not accept products with defects". If there is a defect before it can be used method Poka-Yoke it is necessary to use scheme drawn up by the company proceedings (Figure 5).

By introducing techniques Poka-Yoke company guided by the following principles:

- Defects arise most as a result of human errors. The following types of errors committed by people have been distinguished:
  - Although the worker is aware of the mistake he makes, he continuous to do the same,
  - The errors due to the misunderstanding,
  - Incorrect identification,
  - Forgetting,
  - Lack of training,
  - Good intentions but improperly implemented.
- All errors arising in the company are recorded and then analysed. Most of them can be prevented by using techniques Poka-Yoke.
- If there is an error it is necessary to an immediate reaction.
- Poka-Yoke techniques are a kind of response to errors in the short term. The reaction to obtain the information of the formation error must be immediate. Poka-Yoke must be exactly in the place where the error occurred or which may occur. It is also important that seek to provide, where error may arise.
- Use of Poka-Yoke causes, that the frequency of errors is less.
- Techniques used are simple, does not require the intervention of engineers, are cheap and effective.

In the automotive industry X there are three levels Poka-Yoke:

**ALERT**

Alert method gives 30% of the guarantee of good products. This method inform about appearance of defect but does not provide and does not produce 100% quality. The most igniting the lamps or activating the alarm, which shall return the operator to rise to an error.

**CONTROL**

The control gives 100% of the guarantee good products. The control ensure that if it was created defect, its not coming outside the production line and does not reach to the customer. *Example:* device controlling bolts volume. Each of the bolts is placed in the illustrative hole serving for checking whether the size of it is correct. Also produced steel sections with holes are placed in a similar devices in order to control whether openings have been carried out correctly.

Table 1. Division of Poka-Yoke devices according with departments

Department	S1		S2		S3		S4		S5		S6		S7		Sum	
Supervision	JP	PM	JP	PM	JP	PM	JP	PM	JP	PM	JP	PM	JP	PM	JP	PM
Number of Poko-Yoke devices			27				278				47	2	31	7	58	334
															Total amount	392

**PREVENTION**

Prevention gives 100% of the guarantee of good products. It is not possible to produce defective product.

*Example:* The equipment used for the passing elements; element is to be given the party which should be assembled, so that an operator shall not lose time for thinking how it should be fitted, the risk of confusion also was minimized.

**Second example of Automotive Company (Y) which used Poka-Yoke method.**

Poka-Yoke method has been implemented in the automotive company which offered roller bearing.

The organization of production in this company is divided into seven departments:

- S1 - plastic working
- S2 - ring internal,
- S3 - ring external,
- S4 - Japanese rollers,
- S5 - English rollers,
- S6 -baskets,
- S7 -assembly.

For the majority of the above streams Poka Yoke equipment is installed (Figure 6). These devices shall be supervised by the Measuring Laboratory and by the Department of Maintenance (Table 1).

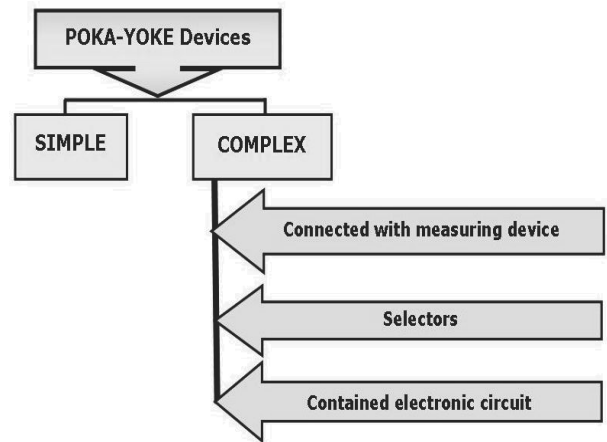
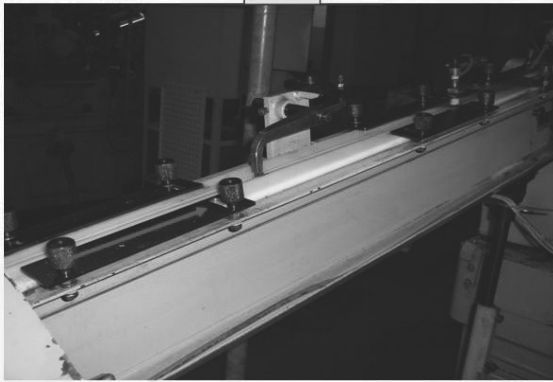


Fig. 6. Division of Poka-Yoke devices in company Y

A properly oriented element in the production process



Direction of element flow

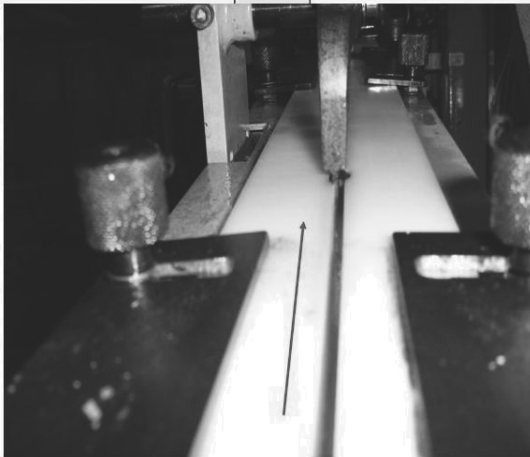


Fig. 7. Used a simple device Poka Yoke for bearing shaft

According with company plans of continuous improvement stages of implementation Poka Yoke have been elaborated, and so:

- The choice and describe process in which techniques Poka Yoke may be used. The criteria for the selection process can be distinguished: number of complaints from the customer, the quantity of defects detected by quality control, materiality defects (their impact on the customer, costs, implemented process).
- Identifying of defects forming in products. For this purpose it is necessary to collect information on deficiencies found in the technical inspection of product or making analysis of the returns causes from customers.
- Definition of defects validity. Criteria for determining hierarchy level may be: the incidence, the cost to remove product defect, opportunity to develop solutions avoiding any formation conditions. In the first instance shall be taken in trying to eliminate defects which are expensive and significant.
- Investigate formation selected defects in the implementation of the individual operations failing in the process.

- To find ways prevention errors and defects. Large capacity at the stage seek ways of preventing errors creates the benchmarking and adaptation other companies solutions to own needs.
- Implementation good solution.
- Correct control of functioning used solutions and possible corrective actions.
- The transition to a further problem identification

Implementation of Poka- Yoke solutions should be achieved gradually. In case of many similar positions, changes should first of all on one position and the innovative solutions and possible improvements, on the other.

#### Controlling device reversal of bearing shaft with Poka-Yoke method in company Y

This is a simple device Poka- Yoke (Figure 7), which main aim is elimination of reversal bearing shaft. The principle of operation that Poka- Yoke has been presented below. If a set is correct, then the selector not blocks shaft (Figure 8). If is set on the contrary, then the selector blocks shaft (Figure 9).

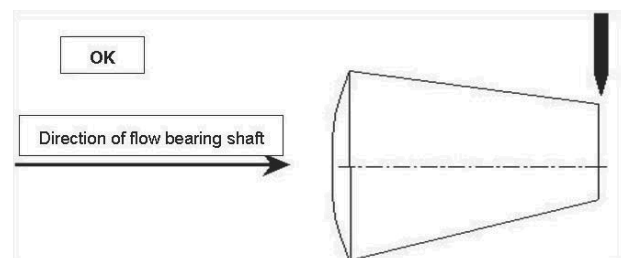


Fig. 8. Correct direction of bearing shaft flow

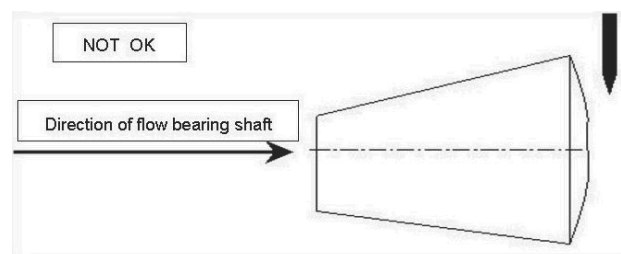


Fig. 9 Incorrect direction of bearing shaft flow

## 5. Relationship between Poka-Yoka method and cycle PDCA

According with standard ISO 9001:2000 the organization shall continually improve the effectiveness of the quality management systems, all processes and the same final product through the use of the quality policy, quality objectivities, audit results, analysis of date, corrective and preventive actions and use PDCA cycle.

All the rules of Poka-Yoke used in the companies shall be connected with continuous improvement cycle PDCA. Below is a graphic proposal of such approach (Figure 10).

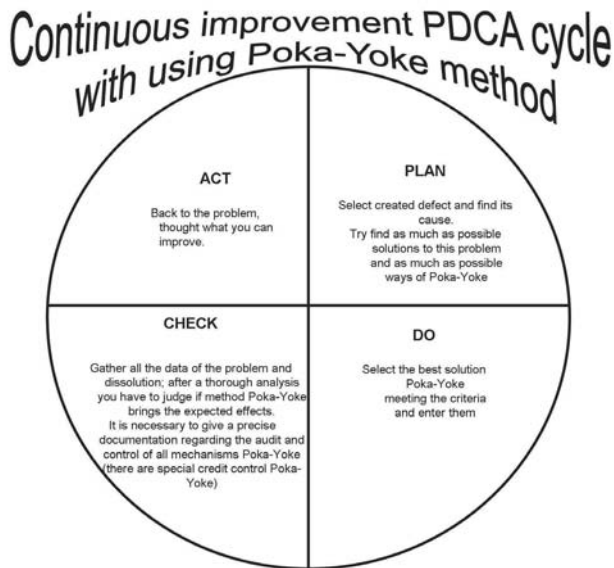


Fig. 10. PDCA Poka-Yoke link with the method in an organization selected

## 6. Conclusions

Each organization having implemented a quality management system and also plans and objectives recording in the improving strategy of organization should have intellectual capital resources which permitting for creating of quality processes and the same finished product. Management processes, their evaluation, monitoring and improving most assisted in eight fundamental principles quality management and quality: methods, tools and techniques. This form of management strategy of future organization calculated leading to increased efficiency of companies and preservation its position on the market. Thinking and action companies should be oriented to the processes to be included in the quality management system.

The aim of Poka-Yoke method is to eliminate or minimize human errors in manufacturing processes and management as a result of mental and physical human imperfections. For the main part is to eliminate errors independent (so-called problem resistance to stupidity while-en. fool proof). The main idea of this method is preventing causes, which may result in errors and use relatively cheap control system for determining compliance of the product with the model.

In the described organizations Poka-Yoke method in connecting with the quality methods ensure of high quality of produced engine elements, as well as by the continuous monitoring process all allow to minimize cost, and sharing not

great effort to improve. Such behavior organization calls for effective implementation of the objectives which are compatible with the system both by the highest quality management and management as well as all workers.

Use of Poka-Yoke requires strong basis in the overall quality management. Necessary are clear indications to distinguish between a defective and correct product and therefore company regularly carry out training crew. It should not be forgotten that the method Poka-Yoke requires an immediate reaction and the correction as well as a result in the operation.

Errors arise from various reasons, but most of them can be prevented if only people are be able to identify the problem at the time of formation, define the causes and make appropriate corrective steps. Prevention of defects in the process before their appearance, is the best way of defects reduction and thus reduce the costs.

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