Implementation of Poka-Yoke to Enhance the Overall Equipment Effectiveness Using the Manage By Fact Problem Solving Technique

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Abstract- *The principles and practices of lean production (LP) have been increasingly used by a number of industries. This study emphasizes the use of poka-yoke devices (PD), a LP practice especially tailored to eliminate the production of defective parts, complementing statistical process control techniques. Since this term started being disseminated in the West in the context of spreading the Toyota Production System, PD has been a topic of interest, mostly among practitioners, due to the apparent simplicity of how they function and their intuitive design features .PD have been used in a variety of contexts, such as construction, health care and information technology, but not necessarily associated with LP implementations.*

Keywords- poka yoke, overall equipment effectiveness, manage by facts problem solving

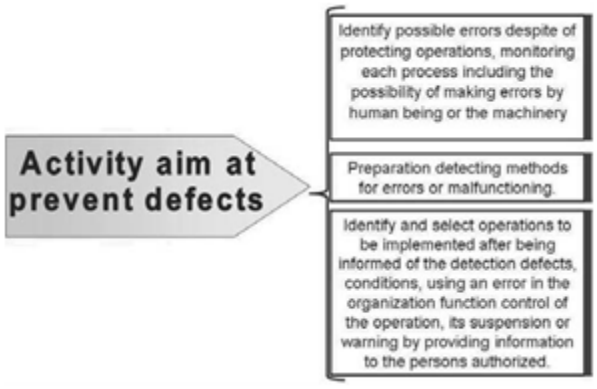
I. INTRODUCTION

Focused (Continuous) improvement is an essential requirement for sustaining and gaining a competitive advantage for the organizations. A successful continuous improvement program is one where in the operational defects are eliminated at the root cause level and are prevented from reoccurring. Total productive maintenance (TPM) methodology is a proven approach to increase overall equipment effectiveness (OEE) of equipment. It consists of eight pillars, focused improvement and autonomous maintenance are two important pillars amongst them to enhance overall equipment performance. These pillars aim to educate the participants in the concepts and philosophy of equipment maintenance and give them an opportunity to develop their skills and confidence. In the present work an attempt is made to identify the areas of improvement in equipment, kaizen and poka-yoke are implemented to enhance its overall performance to increase the productivity. The improved OEE resulted increase in availability, better utilization of resources, high quality products and also raised employee morale and confidence.

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. 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. 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 causes demonstrate. 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. 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. 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 The main objective of the project is to produce the defect free product, i.e. improving product and process quality of blow moulded product by implementing preventive tool –Poka Yoke.

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.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 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. 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.



II. LITERATURE SURVEY

POKA YOKE

Poka-yoke is a Japanese term that means "fail-safing" or "mistake-proofing". A poka-yoke is any mechanism in a lean manufacturing process that helps an equipment operator avoid (yokeru) mistakes (poka). Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The concept was formalised, and the term adopted, by Shigeo Shingo as part of the Toyota Production System. It was originally described as baka yoke, but as this means "fool-proofing" (or "idiotproofing") the name was changed to the milder poka-yoke.

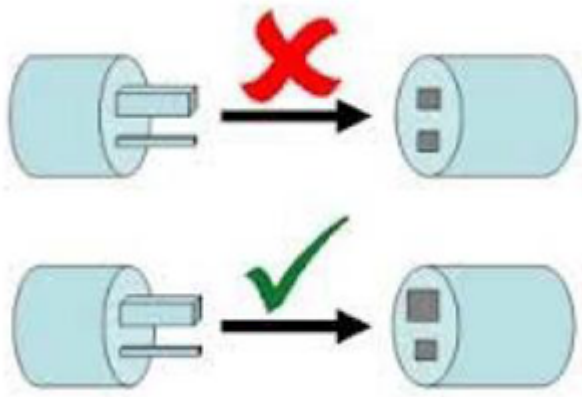


Fig 1:sample example of poka yoke Shigeo Shingo recognized three types of poka-yoke for detecting and preventing errors in a mass production system. The contact method identifies product defects by testing the product's shape, size, color, or other physical attributes. The fixed-value (or constant number) method alerts the operator if a certain number of movements are not made. The motion step (or sequence) method determines whether the prescribed steps of the process have been followed. Either the operator is alerted when a mistake is about to be made, or the poka-yoke device actually prevents the mistake from being made. In Shingo's lexicon, the former implementation would be called a warning poka-yoke, while the latter would be referred to as a control poka-yoke. Shingo argued that errors are inevitable in any manufacturing process, but that if appropriate poka-yokes are implemented, then mistakes can be caught quickly and prevented from resulting in defects. By eliminating defects at the source, the cost of mistakes within a company is reduced.

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. Analyze the process of product defects formation noted that between a mistakes 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:

- 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.

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 functions 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.

WHEN TO USE IT?

Poka-yoke can be used wherever something can go wrong or an error can be made. It is a technique, a tool that can be applied to any type of process be it in manufacturing or the service industry. Errors are of many types;

- Processing error: Process operation missed or not performed per the standard operating procedure.
- Setup error: Using the wrong tooling or setting machine adjustments incorrectly.
- Missing part: Not all parts included in the assembly, welding, or other processes.
- Improper part/item: Wrong part used in the process.
- Operations error: Carrying out an operation incorrectly; having the incorrect version of the specification.
- Measurement error: Errors in machine adjustment, test measurement or dimensions of a part coming in from a supplier.

MISTAKE PROOFING TECHNIQUES

There are basically two techniques used for mistake proofing

a) Design for Manufacturability(DFM)

- This technique results in designs that cannot be incorrectly produced
- This technique can be used to “Simplify” the design and therefore reduce its cost.

b) Use of mistake proofing system devices Set up devices or inspection techniques that assure that set up is done correctly. This means 100%production of good parts from the process from the first piece onward.

WHY MISTAKE-PROOFING IS IMPORTANT

- Today’s competitive environment does not allow extra inventory to compensate for scrap.
- Cost pressures don’t tolerate continued mistakes: scrap,rework and delay in delivery.
- High cost of poor quality will make survival challenging.
- Lean ideology focuses on speed.
- Speed cannot exists when defects and rework exist in the process.
- Value addition of inspection as a process.

BENEFITS OF POKE YOKA

- Company productivity: Increases because there are no production stoppages due to faulty processes or equipment.
- Creates safer work environment: Handling of the defective parts and its rework increases risk of hazardous instances.
- Eliminates the waste: It helps elimination of the post job inspection and rework which is a waste to the product and does not add any value.
- Better workers: Shop floor teams are motivated to share their suggestions on issues and its solutions, as they are often rewarded for that.
- Reduces the cost of poor quality: Reduction in defect free parts,reduction in inspection cost,rework cost etc leads to reduction in COPQ .
- Assures consistency during set up: As there are nno defects being produced there are consistency in set-ups.

Relevant Research Review

M. Dudek-Burlikowska and D. Szewieczek has

investigated the Poka-Yoke method as an improving quality tool of operations in the process. The Purpose of research is to 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. The possibility of usage of mistake proofing device is connected with monitoring and improvement of operations in the process. The finding of the research is, 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.

Arash Shahin and Maryam Ghasemaghaei describes Poka yoke as one of the effective quality design techniques experienced in manufacturing has been suggested and developed for service fail-safing. They also proposed a framework, by which the common and uncommon elements of service Poka yoke and Service recovery solutions have been classified and addressed schematically.

Manivannan S. (2007), have presented the ideally, Poka-yoke techniques ensure that the right conditions exist to make a good assembly, before a joining process is actually executed. Thus, there should be only one way two parts can be joined before they are snapped, welded, bonded or fastened together. Where this is impossible, Poka-yoke techniques detect defects as soon as they are made, preventing faulty assemblies from being passed to the next station. Many people think of Poka-yoke mechanisms as limit switches, optical inspection systems, guide pins or automatic shutoffs that can only be implemented. by the engineering department and this is a very narrow view. These mechanisms can be electrical, mechanical, procedural, visual, human, or any other form that prevents the incorrect execution of a process. Poka-yoke techniques can also be implemented in areas other than production, such as sales, order entry, purchasing or product development, where the cost of mistakes is much higher than on the shop floor. Truly, Poka-yoke techniques for preventing, detecting and removing defects have widespread applications in most organizations.

III. METHODOLOGY & PROBLEM IDENTIFICATION: MANAGE BY FACT PROBLEM SOLVING

Manage by facts is structured (scientific) 8-step problem solving technique, which consists of the following steps

1) Describe the problem
2) Analyze current condition
3) Identify the performance gap
4) Perform root cause analysis/identify the improvement needs
5) Determine the proposed countermeasures
6) Review performance
7) Implement controls/standardize improvements
8) Recognize successes

STEP 1- DESCRIBE THE PROBLEM

- Clearly defines the “what” and “when” by formulating a statement identifying the improvements, opportunities and team objectives.
- Between the problem statement, team objectives and metrics from the team charter document, the team should satisfy the SMART acronym.
  - Specific
  - Measurable
  - Actionable
  - Realistic
  - Time based

STEP 2- ANALYZE CURRENT CONDITION

- To clarify the problem statement by charting past and present performances of the metric that defines “what” will be accomplished.
- Key tasks:
  - Collect historical and current performance data
  - Identify performance gaps to target and benchmark
  - Evaluate trends
  - Determine improvement focus
- Basic tools:
  - Run chart
  - Check sheet
  - Process map
  - Histogram

STEP 3- IDENTIFY THE PERFORMANCE GAP

- To explain the performance gap by prioritizing the contributing categories directly affecting the metric.
- Determine the technical/lean problems needing to be eliminated.
- Key tasks:
  - Determine the gap between expected and actual performance and categories that makeup the gap
  - Break down the largest columns on the first level pareto chart into 2nd and 3rd level pareto charts
  - Collect additional data as necessary
  - Identify the waste
- Basic tools:
  - Pareto chart
  - Check sheet

STEP 4- PERFORM ROOT CAUSE ANALYSIS / IDENTIFY THE IMPROVEMENT NEEDS

- To identify the underlying causes of the problem
- Key tasks:
  - Use 5 where process to understand where the problem is specially located(component, area on component)
  - Categorize possible causes using fishbone diagram
  - Use nominal group technique to select the key contributors or conduct trials to determine key contributors to the problem
- Basic tools:
  - Fishbone diagram/5 why analysis
  - Nominal group technique
  - Brainstorming and teamwork

STEP 5- DETERMINE THE PROPOSED COUNTER MEASURES

- To document proposed countermeasures that are thought to affect or eliminate the error conditions.
- Key tasks:
  - Implement containment actions to protect the customer
  - Capture all items that address root causes identified in step 4
- Basic tools:
  - Activity list
  - Action/implementation plan
  - Fishbone diagram
  - Brainstorming

STEP 6- REVIEW PERFORMANCE

- Determine the impact of activities and countermeasures on the primary metric
- Key tasks:
  - Update the historical run chart from step 2 with current results as the project progresses
  - Document when proposed countermeasures were implemented
  - Verify that implemented proposed countermeasures do result in the anticipated improvement
- Basic tools:
  - Run chart
  - Check sheet
  - Histogram

STEP 7- IMPLEMENT CONTROLS / STANDARDIZE IMPROVEMENTS

- When problem is solved in one location, the results are leveraged and implemented in all location.

STEP 8- RECOGNIZE SUCCESSES

- To recognize the efforts of the team and individuals supporting the team
- Key tasks:
  - Communicate the project results and performance gains to wide audience
  - Document the recognize of the team members for the accomplishing the project objectives
  - Start again
- Basic tools:
  - Communication media
  - Reorganization program
  - Brainstorming

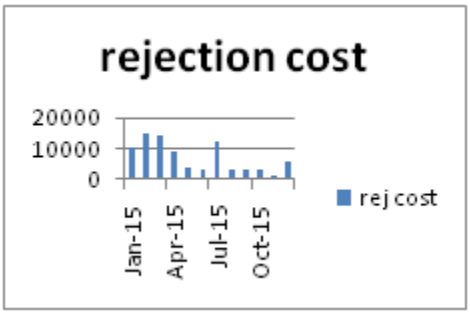
Machine	Rejection Cost	Cumulative	Cumulative%
GDS OLD	68145	68145	81.3
GDS NEW	10235	78380	93.5
CNC GDS	3663	82043	97.87
GDS NEW	1365	83408	99.50
GCL100	416	83824	100
	83824		

Example: Reduction Of Rejection In Face Grinding Machines By Manage By Facts Problem Solving Technique

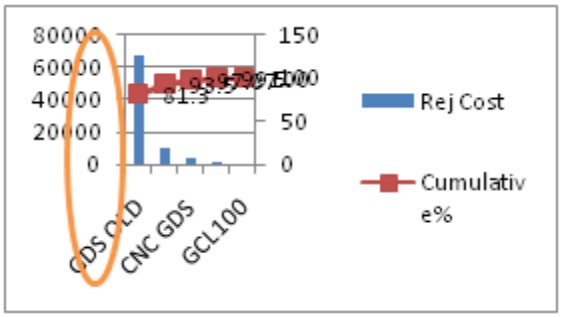
Step1: Problem Identification by analysing the current condition

First stage: Run chart for total length undersize(month wise)

month	rejection cost	cumulative	cumulative%
Jan-15	10051	10051	12
Feb-15	14634	24685	29.44
Mar-15	14113	38798	46.28
Apr-15	8736	47534	56.7
May-15	3661	51195	61
Jun-15	3382	54577	65.11
Jul-15	12398	66975	80
Aug-15	3485	70460	84
Sep-15	3259	73719	88
Oct-15	2980	76699	91.5
Nov-15	1605	78304	93.41
Dec-15	5518	83822	100
	83822		

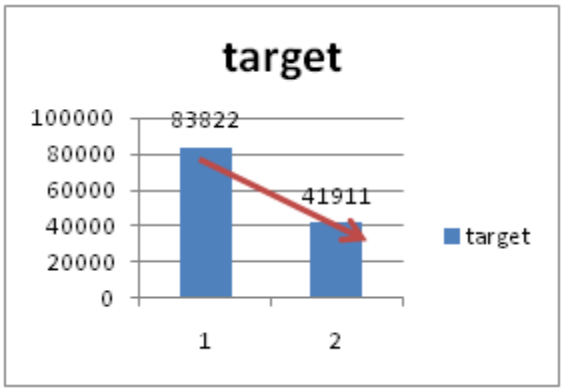


Second stage pareto for total length undersize (machine wise)



Step2&3: Analyze Current Condition And Identify The Performance Gap

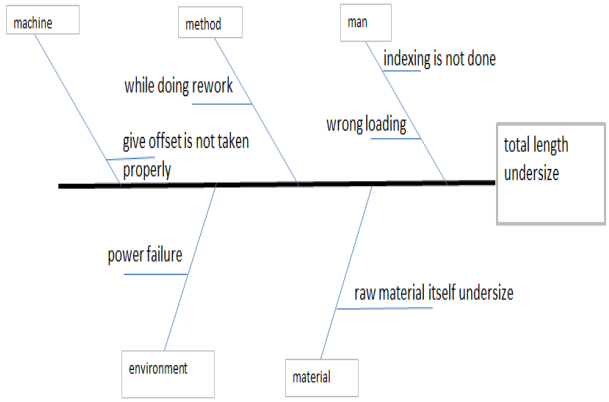
Total Cost Incurred Due To Rejection In 2015	83822
Average Rejection Cost Of 2015	6985
Target To Be Achieved (50% Of Rej In 2015)	41911
Target Average/ Month	3493
Target Average/ Day	116



Step 4- Perform Root Cause Analysis/Identify The Improvement Needs

fish bone diagram for total length undersize

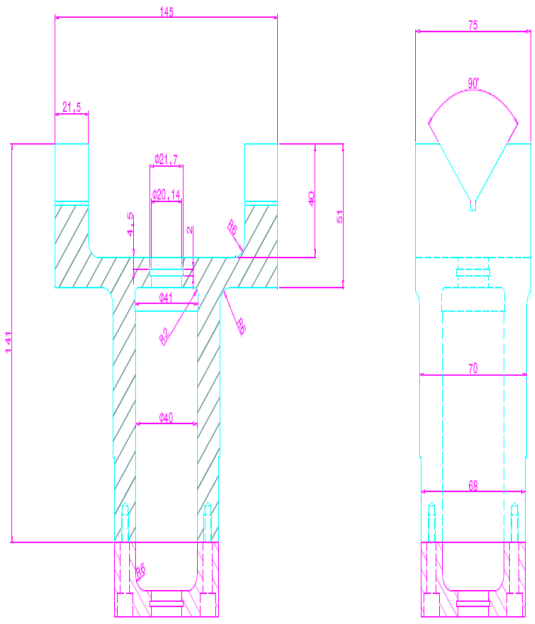
PROBLEM	Total length undersize	
ROOT CAUSE	Indexing is not done	While doing rework
why1	Standard sequence is not followed	When required dimensions were not achieved
why2	OE's negligence	Less offset was given
why3		OE's negligence
COUNTER MEASURES	implement the automatic indexing mechanism	Give proper offset



Why Why Analysis For Total Length

Undersize:

Step 5- determine the proposed countermeasures Indexing Mechanism:



Step 6- Review the Performance

	Tracking		
month	day	rejection/day	target
march	1	125	116
	2	590	116
	3	345	116
	4	0	116
	5	610	116
	6	0	116
	7	0	116
march	8	58	116
	9	0	116
	10	0	116
	11	734	116
	12	206	116
	13	0	116
	14	0	116
	15	0	116
	16	729	116
	17	0	116
	18	0	116
	19	0	116
	20	0	116
	21	0	116
	22	0	116
	23	0	116
	24	0	116
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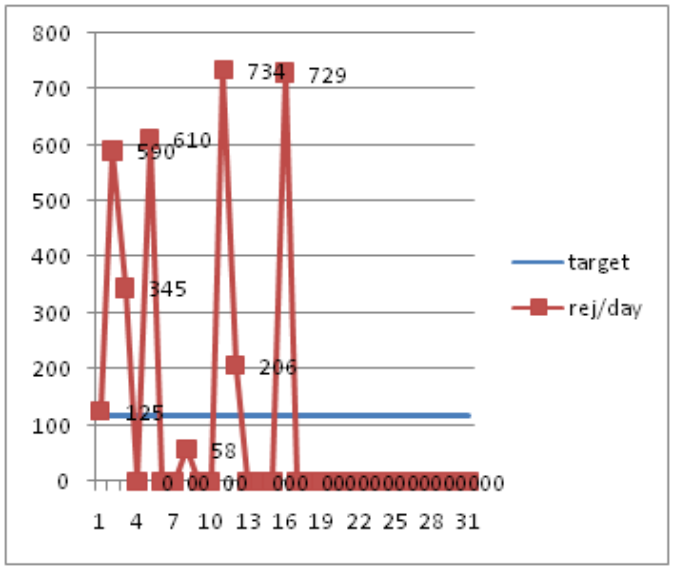
	30	0	116
	31	0	116



Summary:

Total Cost Incurred Due To Rejection In 2015	83822
Average Rejection Cost Of 2015	6985
Target To Be Achieved (50% Of Rejection In 2015)	41911
Target Average/ Month	3493
Target Average/ Day	116
Target achieved/month	3397
Target achieved/day	113
Total reduction	48%of total rejection in 2015

IV. 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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