

TOYOTARITY



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THE USE OF ISHIKAWA DIAGRAM AS MEANS OF IMPROVING THE QUALITY OF HYDRAULIC NIPPLE

Abstract: The formation of a non-compliant product that does not meet customer's specifications can occur at various stages of the production process. Some of the common factors: equipment failure and human error cannot be eliminated completely, however, it is the responsibility and goal of each business owner to track and minimize the losses. One of the traditional tools applicable to identifying the causes of errors is Ishikawa diagram. Thanks to the teamwork using the skills and knowledge of those involved in the implementation of specific process it is possible to carry out effective analysis of the possible reasons of observed defects. In a company producing metal components for the automotive industry, especially in the multi-step processes identification of poorly functioning components prevents transmitting of the defective product into subsequent operations. On the basis of an analysis of the production process of cause and effect resulting errors are shown graphically using Ishikawa diagram.

Key words: Ishikawa diagram, hydraulic nipple

15.1. Introduction

Quality assurance for companies operating on the global and national levels in the twenty-first century is one of the main objectives of the organization. This is due to the increasing globalization and the intense battle for the client. Shortening the production time and lengthening of

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the life cycle of the product stimulates the innovation introduced to the finished product until it has the best features for the lowest price. Fulfilling the needs of the customer by the organization requires the implementation of the philosophy which will reduce costs and ensure the quality of the product with the same or higher level than the competition. An example of this philosophy is the concept of TQM. It provides the most important tools needed to solve quality problems in the company and optimize performance in the area of production and organization. Quality assurance and continuous improvement can be described by a brief statement of "who does not develop, goes backwards." Companies must be aware that in the twenty-first century, a world that is constantly changing, there is no place for the organization employing the traditionalist tendencies. The only solution that will help to overtake the competition is improving the quality and keeping up with changes and international trends (HAMROL A. 2007).

The automotive industry puts a strong emphasis on the improvement of quality management systems. The suppliers must adapt to the specific mandatory requirements to make sure the product is safe to be released to the purchasers (SIKORA T. 2010). Despite all precautions taken in the production process, sub-par products may occur regardless of the controls put in place. To pinpoint the reasons for those occurrences it is imperative to use the quality control tools. It is very difficult to eliminate entirely natural factors that contribute to the formation of non-compliant product. Such factors include, but are not limited to, equipment failures or man mistake when the employee does not comply with the requirements of his job.

15.2. Traditional tools

TQM strategy requires the company to use different ways of having an impact on the creation of the product with the quality required by the customer. There are many methods of collecting and analyzing data as well as their graphical presentation. The type of business and the manner

of its implementation have a major impact on the choice of method or tool that will influence the quality. Seven traditional and basic tools of quality management include:

- flow diagram,
- cause-and-effect diagram (Ishikawa),
- Pareto-Lorenz diagram,
- histogram,
- check sheet,
- correlation chart,
- control charts.

Certain tools can be used independently; however, in practice, application of multiple tools at the same time leads to better results. This comprehensive approach allows a better demonstration of the relationship between processes and subsequently affects the stages of production leading to its final form. The tools can be combined applying the great seven elements but also with statistical tools such as SPC, new management and planning tools and teamwork elements such as: brainstorming and quality circles (ŁUCZAK J. 2007, ŁADOŃSKI W. 2007).

An invaluable instrument for ranking causes of any deficiencies and for presenting their mutual relationship is cause-and-effect diagram. This method has several varieties that are adapted to the skills and experience of the task team. Cause and effect diagram can be presented in the following ways:

- 5M (Man, Machine, Method, Material, Management),
- 5M + 1E (Man, Machine, Method, Material, Management, Environment),
- 7M (Man, Machine, Method, Material, Management, Measurement, Money, Environment),
- 5S used in service industry (Surroundings, Systems, Skills, Suppliers, Safety).

The 5M variation involves the use of five groups of causes of the problem (ŁUCZAK J. 2007, WAWAK S. 2006):

Management-relevant work conditions, if there is a shift system, is the organization of work appropriate, how does the organizational structure look like.

Man - the most important link in the production process is when the group defines what it needs to keep in mind e.g. the motivation to work, an internship in a company, satisfaction with the work habits of the people, but also their qualifications.

Material - this group defines the type and quality of items such as semi-raw materials or substitutes.

Machine-Maintenance, compliance with the work to be performed, all kinds of licenses, as well as precision, efficiency and safety should be taken under consideration.

Method - understood as specifications, standards, relevant instructions and procedures.

In most qualitative tools as well as for Ishikawa diagram a few different steps can be pointed out to achieve efficient and uninterrupted improvement process (ŁUCZAK J. 2007, WAWAK S. 2006). The steps which should be taken are as follows:

First Carefully define and identify the problem, by appropriate tests or interviews with members responsible for the production or administrative area. In this step, it is important to set goals we want to achieve in solving the problem and put the main problem on the central axis on the right (Fig. 15.1).

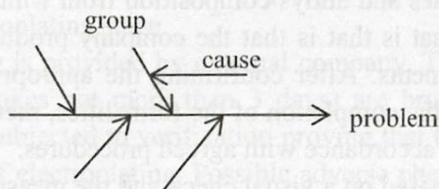


Fig. 15.1. A model of Ishikawa diagram.

Source: personal resources

Second The next step is to identify the main causes and grouping them. The other quality tools, directly aimed at sharing ideas and solutions can be used. A good example of such a tool is brainstorming.

Third Diagram should comply with the problems that may be encountered during the analysis of the error. Here the specific direct causes of the problem are listed divided into very important, important and less important ones. It is good to systematize them on the axle so that the most important issues are the closest to the main axis and the following are the less important issues.

Fourth Filling in the diagram through work in groups e.g. brainstorming. The aim of the discussion is to clarify the different solutions and add more reasons that have not been given before.

Fifth The last step is crucial. It is connected with reading and analyzing the resulting diagram, so that the conclusions derived from it made it possible to solve the problem. Reading the chart from the main axis should give the answer to the reason why the problem occurred. On the other hand, when the diagram is read in the opposite direction it answers the question of what effect did the issue bring (ŁUCZAK J. 2007)?

15.3. Production process of hydraulic nipple

Production of hydraulic nipple begins with metal bar supply being delivered by an external company (Fig. 15.2). Metal bars have different lengths, thicknesses and alloys composition from which they were made. The reason for that is that is that the company produces parts that have different requirements. After confirming the appropriate number of ordered goods and the completion of the formalities, metal bars are subjected to selection in accordance with agreed procedures.

Selection is based on a visual check and the measure of the condition and quality of the delivered goods. They are then separated according to the classification and requirements. Bars are transferred via platforms on wheels for specific devices, where they are treated.

Metal bar treatment requires that the employee by himself put the single bar into the machine, which cuts the desired component by knife which is controlled by appropriate software. After inserting the bar into the machine and setting the program, the machine starts automatically. Excision of the bar component having a length between 1.5 m and 3 m is not supposed to take more than 3 hours. Depending on the length and complexity of the part, from one supplied basic bar about 50-80 components can be cut. The machine is cooled by special oil counteracting overheating of both, metal bar and knives. Each mechanically cut element is transferred to a special tray on the outside of the machine. The first six items should be examined visually for possible errors such as: shavings, impurity. If non-compliant elements are created it is necessary to calibrate the machine and start the tasting stage from the beginning. Only when all of the first six elements are free from defects then the continuation of further treatment steps is possible. Upon completion of this production phase, elements are selected and cleaned.

Selection and cleaning are preventative actions, provided to make sure that the product which does not fulfill the standards set with the client is not sent out. The product after treatment may have some precipitates that can be removed using appropriate solutions. Therefore, it is important that those responsible for the cleaning to pay special attention to the impurities, when the impurities cannot be removed the supervisor should be informed. The selection stage allows checking elements delivered from cutting section. Products that pass the selection and cleaning follow to the electroplating stage.

Electroplating is provided by external company. The elements after electroplating (it takes not more than 3 days) are brought back to the company and are subjected to verification proving that the product meets the requirements of electroplating. Possible adverse phenomenon is inaccurate coverage of component by zinc. This can be determined by observing the different shades of the item. Another potential drawback is only partial coverage of an item. Products meeting the company's requirements are directed to the assembly.

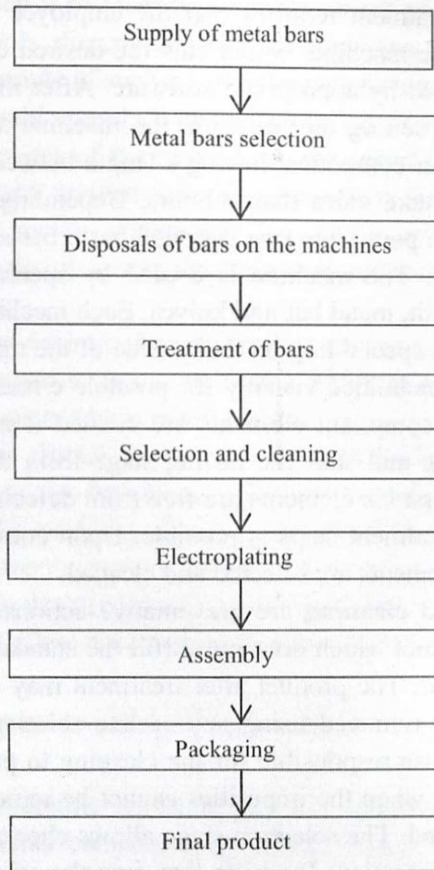


Fig. 15.2. A scheme of production of hydraulic nipple.

Source: Internal document of the company

Assembly - at this stage elements are permanently screwed together, if required and appropriate seals are applied (Fig. 15.3). The process takes about 1 minute per element depending on the amount of seals. Then the product is transferred to the packing department.

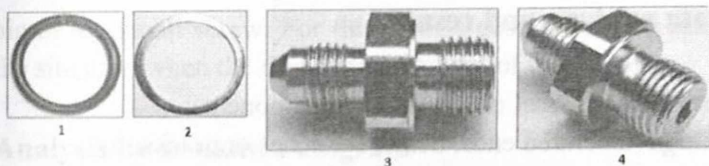


Fig. 15.3. Parts of nipple (1- rubber seal, 2- metal seal, 3, 4- corps of nipple).

Source: Internal document of the company

Packaging - each product is packed in a plastic bag with all the elements that are a part of it (seals, nipples and rings) (Fig. 15.4). Then all of bags containing the product are packed in boxes, and the packaging is sent as a finished product to the headquarters responsible for the division.



Fig. 15.4. Final complex nipple.

Source: Internal document of the company

15.4. Materials and methods

During the production and assembly of components a lot of phenomena arise that give star to a non-compliant product. Based on interviews and observations of production process the errors of product and its components were identified. One of the observed defects of hydraulic nipple is its ending. This problem should be understood as lacerated ends, any dents, scratches or cracks. Using the Ishikawa diagram types 5M + E the causes and effects of the existing problem were analyzed. It is justified to carry out this type of analysis using teamwork that enables the use of experience of the employees involved in the production.

15.5. Data analysis and results

Identified defects of nipple and its components:

Endings- lacerated ends, dents, scratches or cracks.

Shavings- the problem is the presence of small shavings inside or outside of the component, the cause of this error is the final stage of cutting when the cutting knife is caught in a part of the element for a while before exiting.

Impurities- widely understood stains, fingerprints left on the pieces immediately after the operation.

Zinc error - error resulting from incorrect electroplating done by an external company. It is an inaccurate coating of component by zinc, which can be determined by observation of the different shades of a single item. Often the element is covered only partially. Other possible defect is based on the fact that zinc layer does not adhere to metal element. This defect results in the creation of non-compliant product and submitting a complaint to the supplier. The external company has to repeat the electroplating process.

Corrosion - keeping the product in inappropriate conditions, gives rise to corrosion appearing in different parts of the element.

Defect of the component-The error was created in the assembly department when the packing person did not add the seal element to the set due to fatigue or routine. It should be noted that not all components require seals. In the packing department, where different parts of the various components are packaged together as a finished product an employee can mix the elements which results in a set consisting of parts from different types of nipples.

White spots-delivering metal elements made of unsuitable alloys, by an external company, which ultimately gives rise to the so-called white rust after plating.

Inconsistence with the requirements of the drawing - each element is described by technical drawing, bearing dimensions and tolerances on a given dimension. Error must be interpreted broadly, as it can be equally

a too big or too small screw. For this error's description we can also include the situation when the dimensions are out of tolerance.

15.6. Analysis by Ishikawa diagram

- Man

According to the policy of quality management, company established lean department responsible for introducing lean management. The information provided by the employee shows that, the company has too many procedures. They are unstructured, every department in the company has its own rules and procedures, and sometimes they conflict. Therefore, quality inspectors and production workers often do not know for sure how to proceed. This introduces unnecessary confusion and tension between the employee and the supervisor (Fig. 15.5).

- Method

Benchmarking is directly related to the speed of the changes that occur in the company. Division has a set of tools to be implemented in each factory. They are imposed and not always necessary in the organization. The benchmarking is a good thing, but only if the solutions adopted for a particular plant are actually needed and if the results of their implementation can be assessed.

Managers of the relevant departments have the schedule of input the utility, but it is not designed properly. During one of the meetings with leaders, the quality department discussed to introduce a new utility and trainee the employees. It was mentioned by the leaders that the changes are going too fast and are not able to use properly the previous tool, where there are many imperfections.

- Machine

When a factory was set up, the machines have been delivered from another unit belonging to the corporation. The supplied equipment was not new and often failed. After the repair, during which the machine is switched off from the production process, the calibration of the machine

has to be done, which takes from 4 to 6 hours. This causes delays in the production which can be generally understood as losses and costs.

- Material

The company orders the materials and components and uses the services of suppliers. Collaborators are chosen by the division. After numerous notices of poor quality of delivered products, and many complaints the decision to change the suppliers was taken. Due to the terms of the contract the cooperation must continue until the defined date. It should be emphasized that the supplier has provided a significant amount of the defective products. In response to the 8D report informing that a new shipment of the product can be sent. However, the delay generated high costs due to the nipple production being stopped. It is worth to add that the contractors are chosen by the division (central unit). It can be assumed that the problem at this level is a poor fluctuation of information and the components ordered by the CPU do not meet the requirements of production level.

- Environment

Analyzing the group called environment (Fig. 15.5) it can be seen that it is loud in the production hall. Trying to solve the problem, ear plugs were recommended to workers but this solution was not effective enough to deaden the sound. Next idea was to use the headphones which would absorb the sounds but the problem with them was that they were destroyed quickly or employees lost them. Until now, the problem is not solved and workers use the ear plugs. Other problem occurring during production is the oil mist caused by the application of refrigerant oil used in machinery for the processing of the bar. This mist settles on the different parts of the machines and the floor, causing it to be slipper. So far, the complete elimination of the fog failed. Measures undertaken were the introduction of safety glasses and non-slippery work boots. The effect of the mist is the negative disposition of employees at the workplace.

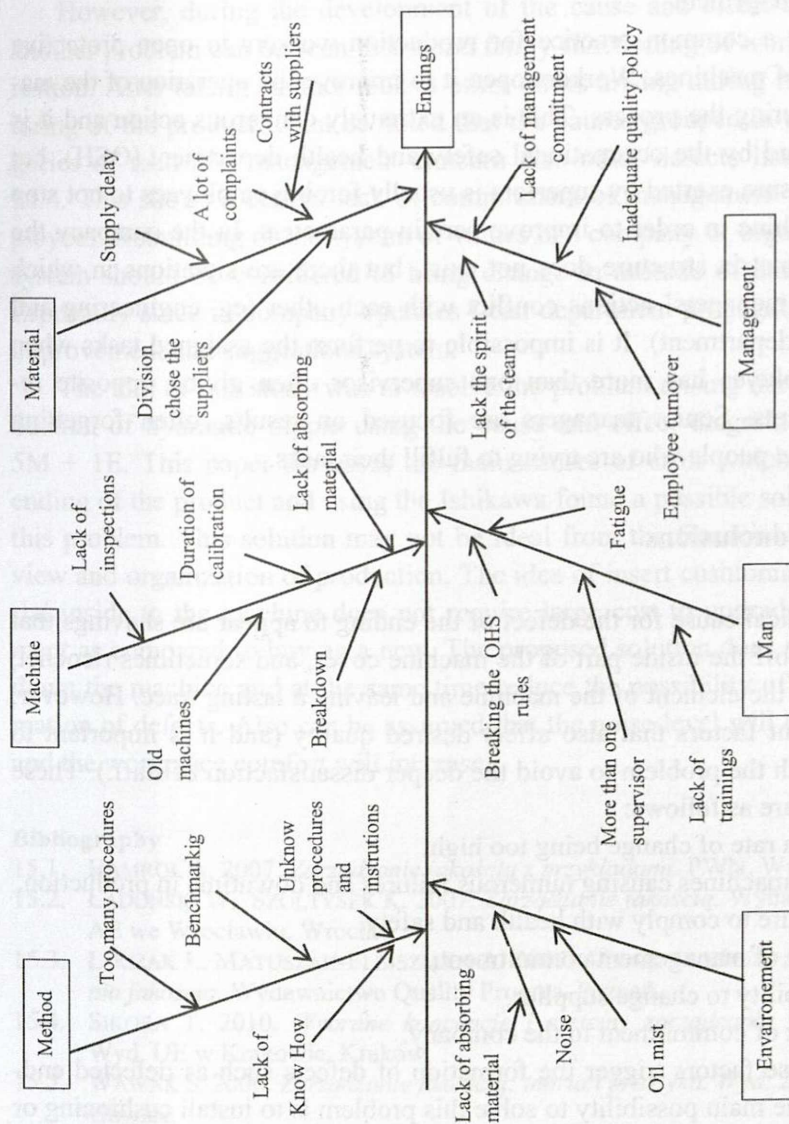


Fig. 15.5. Ishikawa diagram

- **Management**

It is a common practice for production workers to open protective covers of machines. Workers open it to improve the operation of the machine during the process. This is an extremely dangerous action and it is prohibited by the occupational safety and health department (OSH), but the pressure exerted by superiors is usually forcing employees to not stop the machine in order to improve certain parameters. In the company the formal matrix structure does not exist, but there are situations in which various managers' actions conflict with each other (eg, engineering and quality department). It is impossible to perform the assigned tasks when the employee has more than one supervisor often giving opposite requirements. Senior managers are focused on results, often forgetting about the people who are trying to fulfill their tasks.

15.7. Conclusions

Typical cause for the defect of the ending to appear are shavings that bounce off the inside part of the machine cover, and sometimes ricochet, striking the element of the machine and leaving a lasting trace. However, important factors that also affect desired quality (and it is important to deal with the problem to avoid the deeper dissatisfaction of staff.). These factors are as follows:

- high rate of change being too high,
- old machines causing numerous failures and downtime in production,
- failure to comply with health and safety,
- lack of management commitment;
- inability to change supplier,
- lack of commitment to the company.

These factors trigger the formation of defects such as defected endings. The main possibility to solve this problem is to install cushioning or power shock absorbing material. This could significantly reduce the frequency of this error formatting.

However, during the development of the cause and effect diagram, another problem can be seen that is the faulty functioning of work organization. After taking another look at other errors arising during manufacturing of the product it can be noted that the causes grouped in the categories of man and management concern also other defects listed in p. 15.4. This shows a certain lack of commitment of management and employees. Rebuilding of the system of values in a company or organization system should be considered to bring change in attitude of employees. Especially since in company operates Lean department propagating self-improvement and suggestions system.

The aim of this study was to resolve the problem arising during production of hydraulic nipple using the cause and effect diagram version 5M + 1E. This paper discusses the main causes of error which are the ending of the product and using the Ishikawa found a possible solution to this problem. This solution may not be ideal from the financial point of view and organization of production. The idea of insert cushioning material inside to the machine does not require large cost to upgrade equipment as compared to buying a new. The proposed solution does not slow down the machine and at the same time reduce the possibility of the formation of defects. Also can be assumed that the noise level will decrease and the workplace comfort will increase.

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