THE IMPORTANCE OF ROOT CAUSES IN SOLVING PROBLEMS IN THE AUTOMOTIVE INDUSTRY

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A key element of any quality management system is continuous improvement and a systematic approach to managing non-conformances. The aim of this paper is to use selected statistical methods and quality control techniques to present a way in which an organisation can achieve quality improvement. The 8D methodology was used to solve the observed front grid problem on the bumper of a Porsche Cayenne using a structured eight-step Plan-Do-Check-Act (PDCA) approach to problem solving. As this was an important customer originating from Dubai, it was imperative to immediately start solving the issue that arose with the ACC grid on the front bumper, the problem identified was an existing cut-out in the radar grid. Using the 8D methodology and supporting tools such as the Ishikawa diagram or 5Why, the root cause of the problem was identified and permanent corrective actions were planned and implemented as recommended in the 8D report to reduce the likelihood of the problem recurring and increase customer satisfaction.

KEYWORDS

Quality, Global 8D, problem solving, improvement, front grid

1 INTRODUCTION

The quality requirements were in the last time expanded to the point where quality in form as quality management become the decisive factor in company management. Implementing the quality standard allowed maintenance of one's position in the market, gaining a competitive advantage, and the ability to compete in the sector [Krenicky 2018, Bozek 2021, Zgirskas 2021].

The Global 8D is defined as a problem-solving methodology that strives to identify and eliminate root causes of failure after the fact [Aikens 2011, Lestyanszka 2023]. The FMEA (Failure Mode and Effect Analysis) attempts to anticipate and correct problems before they occur [Ignaczova 2016, Uslu 2022]. Global 8D deals with the modes and causes of failure after the fact. Once used, Global 8D results can help improve the quality of future FMEA analysis of a product, process, or service [Lestyanszka 2022, Prajova 2023, Dyadyura 2021].

The eight disciplines (8D) model is a problem-solving approach typically employed by quality engineers or other professionals and is most commonly used by the automotive industry but has also been successfully applied in healthcare, retail, finance, government, and manufacturing. The purpose of the 8D methodology is to identify, correct, and eliminate recurring problems, making it useful in product and process improvement [ASQ 2024].

The 8D problem solving model establishes a permanent corrective action based on statistical analysis of the problem and focuses on the origin of the problem by determining its root causes. Although it originally comprised eight stages, or disciplines, the eight disciplines system was later augmented by an initial planning stage [ASQ 2024].

The 8D Problem Solving Process focuses on the origin of the problém by determining root causes and establishing permanent corrective and preventive actions. It follows a systematic eight-step process with integrated basic problem-solving tools [OEC 2024].

2 METHODOLOGY

The aim of the study is to improve quality to meet expectation of customers. The advertised product of one of the most important customers of the monitored organization was selected for analysis, monitoring and improvement. As the most appropriate method, the 8D methodology has been applied. The study was conducted in an organisation in western Slovakia dealing with products for automotive. The customers' requirements for quality in automotive production are very strict. The project's issue has been an improvement of front bumper grid by using the 8D methodology. The 8D methodology was used to analyse the problem, which allowed identifying a critical cause of the defect and helped eliminate it. The 8D methodology includes an 8D report consisting of eight steps, as shown in Figure 1.

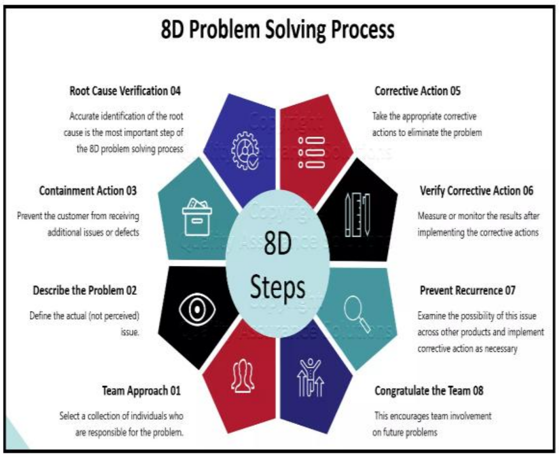

Figure 1. 8D Problem Solving Process [QAS 2024]

Global 8D employs a gateway step (D0) followed by eight discipline steps (D1 – D8) [Skurkova 2016, Lestyanszka 2022, Dziuba 2021, Uslu 2022, Aikens 2011].

Gateway step discipline **D0** – Prepare for Global 8D. This step confirms that the Global 8D methodology is needed.

Symptoms are documented, showing that a problem has occurred, and a formal assessment is performed to justify the deployment of the resources required to perform a team-based cross-disciplinary problem-solving effort [Dyadyura 2021]. Immediate damage control is taken in the form of emergency response actions to prevent further undesirable consequences.

Discipline **D1** – Create a team: Put together a cross-functional team consisting of a core group plus a selection of subject matter experts (SMEs). Be sure to provide everything the team will need to be successful, including any training needed to properly execute the process (isixsigma.com).

Discipline **D2 -** Define and describe the problem **-** Specify the problem by identifying in quantifiable terms the who, what, where, when, why, how, and how many (5W2H) for the problem.

Discipline **D3** - Handle the problem. Medium-term measures to contain the problem will be developed and implemented. The measures are intended to protect customers from the problem until permanent corrective action is taken. (For example, production potentially affected by the problem must be isolated for control. Orders that have been shipped may have to be withdrawn from the market). The team must verify the effectiveness of these measures.

Discipline **D4** - Identify Root Causes and Leak Points. the team identifies all potential causes and gathers as much evidence as possible to reliably test each potential cause against the problem data. Once the cause-and-effect relationship is established, a detailed description of how the cause led to the failure is formulated. At this point, the escape point at which the control mechanism broke down and allowed the problem to go undetected is identified. Tools such as the Ishikawa diagram, the 5 Whys, brainstorming... are used.

Discipline **D5** – Develop permanent corrective actions (PCAs). Discipline D5 is concerned with choosing permanent corrective actions and documenting the rationale for each. The team confirms that the recommended PCAs will solve the problem and will not produce any negative consequences. The implementation of PCAs can require a preliminary evaluation and, in some cases, a small pilot study. During this step, PCAs must also address control issues posed by the escape point.

Discipline **D6** - Implement permanent corrective actions. the team implements the PCAs identified in Discipline Five. Data is collected demonstrating that corrective actions are effective in preventing recurrence of the root cause. This includes demonstrating how the leak point control mechanism's ability to detect the root cause in a timely manner has improved.

Discipline **D7** – Prevent recurrence. Preventing recurrence of the problem requires expanding the scope of the PCAs and controls to apply to other similar products, processes, or services. The standardisation and deployment of corrective actions across all products or services that might be subject to the same or similar problem leverage the problem-solving effort, becoming a preventative and proactive measure across the production facility.

Discipline **D8** – Give the team credit. The last step of the Global 8D process is formally recognising the collective efforts of the problem-solving team and formally approving its report. Achievements should be widely publicised, and the acquired knowledge and learning should be freely shared.

3 RESULTS

The study was carried out in a company producing components for the automotive industry, mainly made of plastic. As mentioned above, the quality requirements of customers for automotive production are very stringent. The product under consideration was a front bumper grid.

Table 1. 5W2H [Topolcany 2024]

5W2H Analysis	
What?	On the line detected falsch front grid. Bumper should have included grid without ACC radar but we sent with ACC
Where?	VW assembly line
Why?	NOK   OK
When?	20.11.2023
Who?	assembly worker
How?	visual inspection
How many pieces?	1

The customer's complaint was filed on 21.11.2023, it was received by the organization the next day.

D0 and D1 - **team building.** The team consisted of a Customer Quality Engineer (CQE), a Project Manager (PQ), a Quality Manager (QM) and a Shift Manager.

D2 - **problem description.** We performed the problem description using the 5W+2H method (Table 1). At this point, it is necessary to collect and summarize the data and correctly answer the following questions:

What/What? (What is the subject of the complaint?)

Where/Where? (Where was the problem investigated by us detected?)

Why/Why? (Why is there a problem?)

When/When? (When was the problem discovered?)
Who/What? (Who discovered the problem?)
How/How? (How was the problem discovered?)
How many pieces/How many? (How many defective pieces were involved?).

D3 – immediate corrective action. The first step was to inform the responsible persons of the problem, which resulted in increased attention on the production line, and also alerted them to the need to correct the problem. The person responsible for informing those responsible was the customer quality engineer. The next step of immediate corrective action was a post-assembly inspection of the parts by Plastic Omnium, as well as a re-inspection on the part of the customer, Volkswagen. In our case, this involved the inspection of 36 pieces of the grid without the ACC cut-out, and no defective parts were found during the inspection. The person responsible for checking the parts after assembly was the quality manager. When applying immediate measures, it was also necessary to control the assembly process, in our case especially the clipping of the grid. The project manager was the person responsible for this type of control.

Lastly, it was necessary to check the functionality of the sensor to detect the ACC grid, which takes place before the actual clipping of the bumper. The check was carried out by the quality manager.

D4 - Root cause analysis. The method chosen to analyse the problem was the Ishikawa diagram, which, using brainstorming, effectively outlined the possible root causes for us in terms of different aspects (see Figure 2).

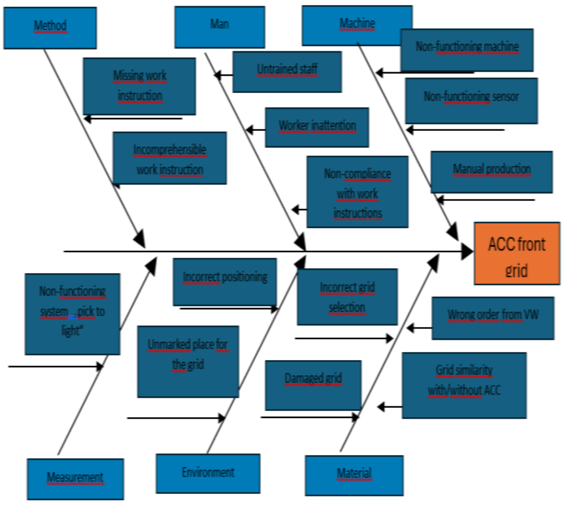

Figure 2. Ishikawa diagram for ACC grid [Topolcany 2024]

Using simulation, the three most likely root causes of the problem were selected. In the simulation of the sensor functionality, it was found that the sensor itself was working, but was rendered inoperable during the assembly of the subject grid under investigation. It was also found that the sensor itself is not properly calibrated and therefore objects are being erroneously recorded. In the case of the glossy painted grating, there was a reflection of the sensor light beam.

With the help of camera footage and further simulation, it was found that the root causes also include worker inattention and improper grid selection, due to the placement of grids with and without ACC cutouts next to each other. Since both cases were human error failures, it is possible to consider both of these errors as a single root cause.

Based on observation and the experience of the team members, the 3 most likely root causes were identified and subsequently investigated using the 5x why method (see Table 2, 3, and 4).

Description of the problem	Incorrect grid selection
Why?	Worker inattention
Why?	The parts were stored side by side
Why?	Incorrect placement of components in the workplace
Why?	Responsibility of the lead person for the deployment of components
Why?	Unawareness of possible consequences

Table 2. Using the 5x Why method for incorrect grid selection [Topolcany 2024]

Description of the problem	Non-functioning sensor
Why?	The sensor did not correctly detect the ACC cutout
Why?	The span of the light sensor was too large and the sensitivity too low
Why?	Incorrect setting of the span and its sensitivity at initial introduction
Why?	Error by technicians during installation
Why?	Human factor

Table 3. Using the 5x why method for a malfunctioning sensor [Topolcany 2024]

Description of the problem	Worker inattention
Why?	The EOL worker did not inspect the part properly
Why?	The worker was exhausted
Why?	Because he did 8 hours
Why?	Because the organisation works on the principle of three changes
Why?	Because it is the most efficient distribution of finances in relation to the workforce

Table 4. Using the 5x why method for worker inattention [Topolcany 2024]

D5/D6 - Determination and implementation of corrective actions.

Point D5 and D6 in the 8D report have some elements of similarity and are also directly related to each other, which is why they are dealt with as one unit in the Plastic Omnium organization.

Therefore, as a result of the previous findings, specific corrective actions were subsequently selected:

- Replacement of laser sensors for ACC and non-ACC grids.
- Grid scanning for component picking (part is scanned before entering the picking assembly to confirm the correctness of the prepared part).
- Grid scan installation prior to assembly. Before the actual installation of the grid into the bumper, the operator must scan the barcode that is stuck on the

grid otherwise the machine will not allow him to proceed to the next step of the assembly.

- Installing the program on the station, where the operator must confirm the correct version on the touch screen after mounting the grid.

Corrective measures were implemented within three weeks. The next step was to verify their effectiveness. The verification procedure consisted of simulating and checking individual corrective actions on production line. The overall validation was the responsibility of the customer quality engineer and the manager Quality Manager, whose task was to evaluate the overall effectiveness of the corrective actions. It was confirmed that the complaint was not repeated.

D7 – Preventive actions

In order to avoid errors of a similar nature in the future, it is necessary to correctly set up preventive measures to ensure the smoothness of the production process. In the case under review, the FMEA and control plan were updated. Last but not least, the problem was presented to the crawler staff and subsequent retraining in case of the occurrence of a problem of a similar nature. The overall implementation of preventive of the measures occurred on December 13, 2023.

D8 - Give the team credit.

In this final step of the whole 8D report, the team leader thanked all team members for their efforts in solving the problem with the front grid on the bumper.

4 CONCLUSIONS

This paper discusses the application of the 8D method in an organization focused on the production of plastic products for automotive. The subject of the customer complaint was front grid on the bumper, with a cut-out that the customer said shouldn't have been there. By applying various auxiliary tools such as Ishikawa diagram, 5Why, 5W2H, brainstorming... it was found that three main root causes were identified, namely worker inattention, improper grid selection and a malfunctioning sensor. Four corrective actions have been identified, namely replacement of laser sensors, scanning of grids when selecting components, installation of grid scanning prior to assembly, installation of a program on the station where the operator has to confirm the correct version on the touchscreen after grid assembly.

The total claim took 21 working days, and after calculating the total time spent in the claim process, it can be said that it was 29 standard hours. In terms of financial losses, the total cost was quantified at € 2 500. The amount of € 640 was for the purchase of a new replacement grid, which was subsequently sent to the end customer. At the vehicle in question, the deficiency was corrected and the problem was closed.

The remaining €1,860 was spent on the analysis, installation of the new system and application of the set changes. All the above processes were carried out by an external organisation XY. As there was no suspension of the production process and the corrective measures set up related to with the XY organisation were carried out during the weekend, it can be said that, from the point of view of financially, the organisation did not suffer any serious losses.

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REFERENCES

[Aikens 2011] Aikens, C.H. Quality inspired management. The key to sustainability. New Jersey: Pearson Education/Prentice Hall, 2011, 623 p.

[ASQ 2024] American Society for Quality. Online [cit. 23-07-2024]. Available from: https://asq.org/quality-resources/eight-disciplines-8d.

[Bozek 2021] Bozek, P., Nikitin, Y., Krenicky, T. The Basics Characteristics of Elements Reliability. In: Diagnostics of Mechatronic Systems. Series: Studies in Systems, Decision and Control, 2021, Vol. 345, pp. 1-15. ISBN 978-3-030-67055-9.

[Dyadyura 2021] Dyadyura, K., Hrebenyk, L., Krenicky, T., Zaborowski, T. Modeling of the Manufacturing Systems State in the Conditions of the Lean Production. MM Science Journal, 2021, Vol. June, pp. 4408-4413.

[Ignaczova 2016] Ignaczova, K. FMEA (Failure mode and effects analysis) and proposal of risk minimizing in storage processes for automotive client. Acta Logistica, 2016, Vol. 3, pp. 15-18. doi:10.22306/al.v3i1.54.

[Krenicky 2018] Krenicky, T. and Ruzbarsky, J. Alternative Concept of the Virtual Car Display Design Reflecting Onset of the Industry 4.0 into Automotive. In: IEEE 22nd Int. Conf. on Intelligent Engineering Systems (INES), 2018, pp. 407-412. DOI: 10.1109/INES.2018.8523962.

[Lestyanszka 2022] Lestyanszka Skurkova, K., Prajova, V. 8D report application in production process of the rear seat. MM Science Journal, 2022, Vol. November, pp. 6074-6077.

[Lestyanszka 2023] Lestyanszka Skurkova, K., et al. Quality Improvement of the Forging Process Using Pareto Analysis and 8D Methodology in Automotive Manufacturing: A Case Study. Standards, 2023, Vol. 3, Iss. 1, pp. 84-94. DOI: 10.3390/standards3010008.

[OEC 2024] Operational Excellence Consulting. Online [cit. 23.07.2024]. Available from: https://www.operational-excellence-consulting.com/opex-articles/8d-problem-solving-process.

[Prajova 2023] Prajova, V., Lestyanszka Skurkova, K., Praj, F., Bestvinova, V. The importance of applying selected industrial engineering tools and methods in process improvement. MM Science Journal, 2023, Vol. December, pp. 7115-7118.

[QAS 2024] Quality Assurance Solutions. Online [cit. 23.07.2024] Available from: https://www.quality-assurance-solutions.com/8D-Problem-Solving.html.

[Topolcany 2024] Topolcany, D. Application of the 8D report in the front bumper grid production process in the monitored organization. Bachelor thesis. Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, 2024.

[Uslu 2022] Uslu D.S., Tas, U. Application of 8D Methodology: An Approach to Reduce Failures in Automotive Industry. Engineering Failure Analysis, 2022, Vol. 134, 106019. DOI: 10.1016/j.engfailanal.2021.106019.

[Zgirskas 2021] Zgirskas A., Ruzevicius, J., Ruzele, D. Benefits of Quality Management Standards in Organizations. Standards, 2021, Vol. 1, pp. 154-166.doi.org/10.3390/ standards1020013.

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