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THE USE OF KAIZEN PHILOSOPHY TO IMPROVE THE PRODUCTION PROCESS – CASE STUDY

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Abstract: In times of innovation, rapid economic development and high competition, each producer tries to improve the condition of his company. Then the quality of services or products is improved, losses are minimized, production processes are optimized and costs associated with running a business are reduced. The Kaizen philosophy can be used to solve any problem and issue related to work in the organization. Its main value is to strive for the continuous company's development through small ideas, which incrementally cause continuous improvement of the company. The paper presents how the functioning of the Kaizen philosophy in a company affects the initiatives of employees, which directly affect the optimization of processes. The presented research results show how innovative solutions consisting in limiting the use of masking tapes influence the improvement of product assembly process.

Keywords: Kaizen, optimization, process capability, improvement, quality

1. INTRODUCTION

The Kaizen philosophy is a basic method supporting the natural company development of any industry, provided it is adopted in the company environment. This philosophy is widely described in the subject literature (Gabryelewicz et al., 2015), (Imai, 2007), (Sapór, 2004), (Maurer, 2007), Ulewicz and Kucęba, 2016), (Midor and Lenart, 2015), (Strecuła et al., 2017), (Lizak, 2016), (Taj, 2008) and therefore, due to the limited form of this paper, the description of methodology will be omitted. However, it is worth mentioning that this methodology helps to unite all the employees involved in the development, among others through a system of suggestions. It consists in placing the boxes on the company premises so that every employee has easy access to it. The boxes collect the ideas of the whole staff concerning each and every issue, whether improving the quality of work or the way of storage, through all safety issues. Therefore, the Kaizen philosophy can be used to solve every problem and issue related to work in the organization. Its main value is to strive for the continuous company's development through small ideas, which constantly improve the company. It is quite common that the suggestion boxes are filled by employees with proposed solutions to the difficulties encountered, which the top management was not even aware of. This is an ideal

argument for implementation of this philosophy in every organization. In a way, for these reasons, the Kaizen system is the best link between all employees in the company. Its great advantage is the fact that no idea is bad, and often unused ideas can contribute to the perception of a problem and then become an inspiration for someone else. Therefore, an extremely important argument for Kaizen's life in the company is employee involvement.

The article was written on the basis of research carried out as part of an engineering thesis (Wojciechowski, 2020).

The changes in the production process presented in the article, consisting in the optimization of machine parameters, were a consequence of employees' suggestions, which were implemented as part of the Kaizen system in the company. These suggestions concerned the elimination of sticking to the detail of a tape protecting against painting some of its areas. The elimination of these tapes was necessary to streamline the process and thus reduce the number of defective products. The presented activities were carried out by a group of employees under the supervision of the author of the article.

2. CHARACTERISTICS OF RESEARCH SUBJECT

The company discussed in the paper (the management has not agreed to the disclosure of the company's name) is a leader in the production of exterior painted body parts for cars produced all over the world. It is a company with a long tradition and extensive experience operating in 26 countries.

The area of improvement presented in the paper is the roof deflector assembly process. The production line of product in question is located in the assembly department, which is responsible for connecting finished elements provided from other departments, including the paint shop and injection department. The assembly is based on technical criteria developed and agreed upon, and deals with the shaping of final product by combining individual elements (semi-finished products) in a separate way by means of assembly or inseparably by means of specific technologies. The paper describes the product – passenger car roof deflector, which consists of two interconnected parts in an inseparable way: the inner part constituting the body and the so-called casing, i.e. the painted outer part. Both semi-finished products are connected to each other during the last assembly process consisting of ultrasonic welding. Figure 1 shows an illustrative schematic diagram of roof deflector.

Fig. 1. Schematic diagram of roof deflector. Source: (MINI Countryman F60)

The production so far has shown process stability. The quality control of material welding process consisting in testing the strength of welded joints was at the level of minimum 250N, and regularly conducted strength tests did not show deviations from the client's standards. Painted roof deflector casings delivered so far to the assembly department had paint tapes adhered to the inside of unpainted side – Figure 2. This masking was to protect the element against painting it from the unwanted side, because for the correct process of ultrasonic welding it is necessary to clean and degrease the deflector surface from any dirt. However, the process designed in such a way was exposed to possible mistakes of employees, e.g. wrongly applied tape or its lack, which resulted in producing an incompatible product. Moreover, such preparation of the semi-finished product generated costs in the form of using masking tapes. In order to optimize the process using the Kaizen philosophy, a suggestion was made to change the process of preparing the semi-finished products.

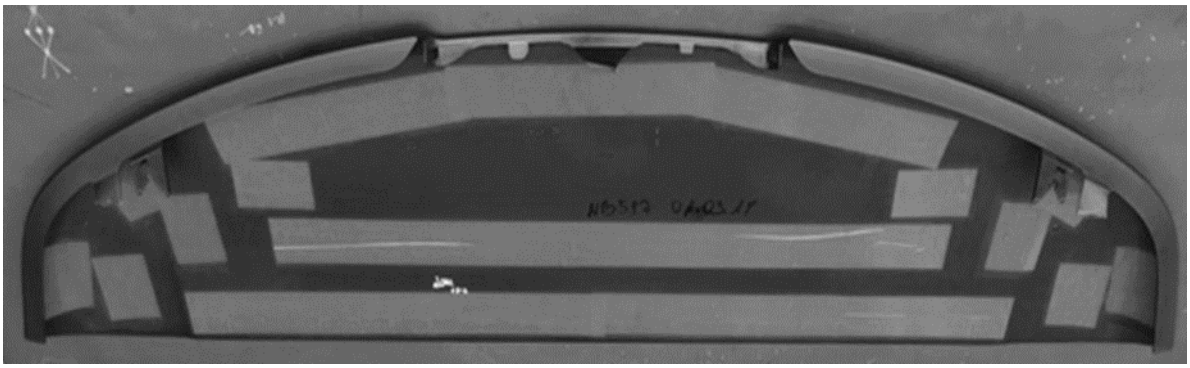

Fig. 2. Masking of painted element with masking tape

3. METHODOLOGY OF CONDUCTED RESEARCH

The change in semi-finished product preparation process was to achieve a stable welding process without masking tapes on the semi-finished product while maintaining the product features required by the client, such as weld strength at the five points that attach deflector to the car roof, no deformation after the welding process and no damage to the paint coating of finished product. Moreover, in accordance with the agreement in force between the client and the company concerning the quality of produced deflectors, the required strength of joints at the level of at least 250 Newtons

and Cpk process stability indicators at 1.33 points and Cpk process centering rate at 1.00 points.
The results of conducted tests are presented in the form of tables and diagrams. Tables present statistical data such as joint strength, mean joint strength, median of obtained results, standard deviation, lower and upper tolerance limit and indicators necessary for Cp and Cpk client. 4 tests were conducted. For the purposes of this paper, the results from tests 1 and 4 are presented.

3.1. First test

For the purposes of first test, nine finished products were produced without masking, using standard parameters of ultrasonic welder on the station of joining two elements into a semi-finished product. Figure 3 presents the results of strength tests of welded joints. Table 1 includes the Cp and Cpk ratios, mean, median and standard deviation from conducted tests.

Table 1
Summary of the first test results carried out on nine welded parts

Cp : 1.33	5.9	1.5	1.0	1.0	2.3
Cpk : 1.00	-0.4	1.0	0.9	0.8	0.7
Median	223.0	504.0	638.0	600.0	382.0
Mean	222.6	501.4	593.4	540.0	361.9
Standard deviation	21.3	84.1	123.8	127.7	55.0
Minimum value expressed in Niutons	250	250	250	250	250
Tol +	**750.00**	**750.00**	**750.00**	**750.00**	**750.00**
	0.00	**0.00**	**0.00**	**0.00**	**0.00**
Point name	**L1**	**L2**	**3**	**R2**	**R3**

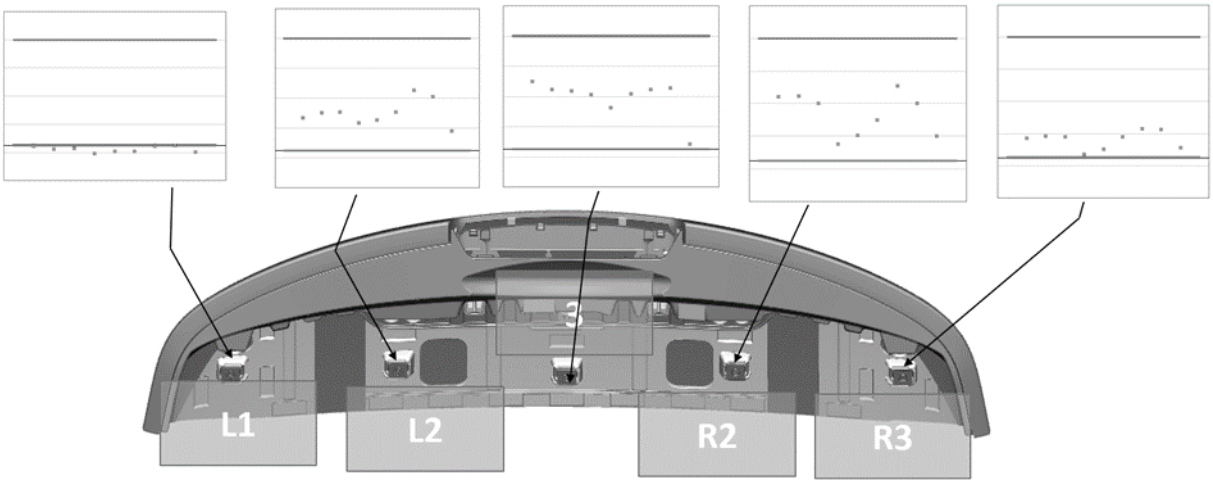

Fig. 3. Results of the first test

The test showed the strength of eight welds below the level required by the client. The mean strength is 223N with a minimum of 250N. Despite the low strength of joints at point L1, the test confirmed process stability at a very high level of Cp 5.9, unfortunately

Cpk 0.4 is poorly centred. The remaining points show the strength of welded joints at an acceptable level, but the capacity of Cp and the centering of Cpk process need improvement.

3.2. Second test

The second test was carried out on eight elements after changes of welding parameters. The changes were made by increasing the probe's clamping strength at points L1 and R1 0.2 mm. In points L2, 3 and R2 the strength was reduced by 0.1 mm. The results of this study showed an increase in strength for point L1 and an unexpected decrease in point R1. In turn, as planned, the process for three middle points lost strength properties in favour of stability.

3.3. Third test

Another strength test was carried out for sixteen parts after corrections in the welder pressure. From the previous test values for points L1 and R3 0.1 mm of clamping strength was deducted, and for points L2, R2 and 3 another 0.1 mm of clamping strength was deducted. The results obtained for the three middle reinforcements indicate high repeatability and process centricity, which is reflected in Cp and Cpk ratios. This level is highly acceptable for the company's client and allows the product to continue production. However, the external welds again show bad centering with high process stability, the Cp ratio for both points indicates their high potential.

3.4. Fourth test

The fourth test was carried out on sixteen elements without any changes in the parameters of welder, but in the weakened external points L1 and R1 masking tape was used. Previous strength tests and observations of test participants showed that these parts of deflector are characterized by high unpredictability. Hence the decision to mask difficult to adjust critical points. Figure 4 indicates the tape eliminated by testing. The remaining part by a compromise has been preserved to improve the process. Figure 5 shows the fourth test results from sixteen finished deflectors. Table 2 includes Cp and Cpk ratios, mean, median and standard deviation from the tests conducted in this study.

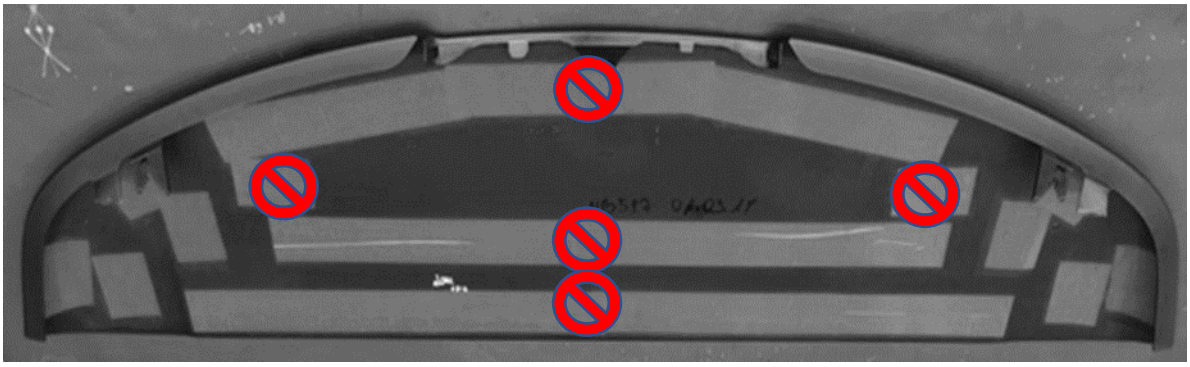

Fig. 4. New masking method

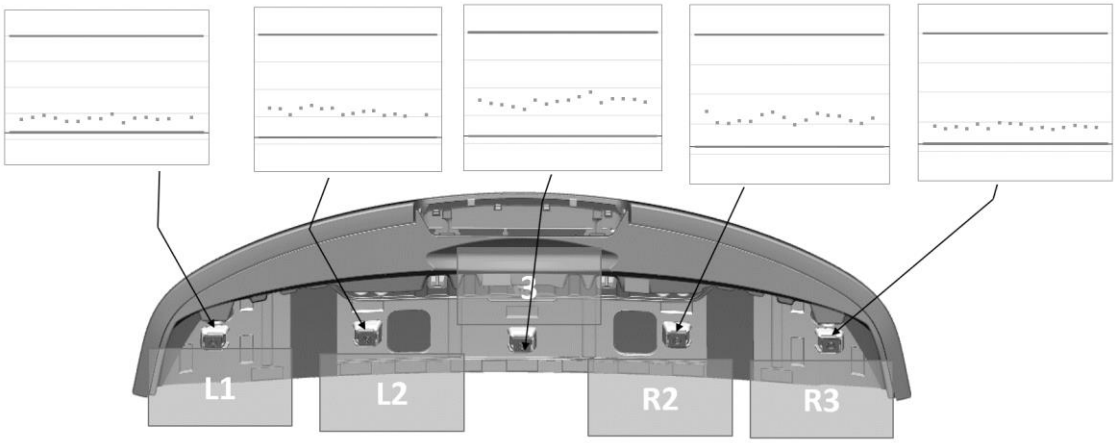

Fig. 5. Results of the fourth test

Table 2
Summary of the fourth test results carried out on sixteen elements

Cp : 1.33	7.4	5.0	4.3	4.4	9.0
Cpk : 1.00	2.2	2.5	2.9	2.2	2.8
Median	360.5	429.5	506.5	436.0	365.0
Mean	360.4	437.5	503.4	438.6	367.4
Standard deviation	16.9	25.0	28.9	28.3	13.9
Minimum value expressed in Niutons	250	250	250	250	250
Tol +	**750.00**	**750.00**	**750.00**	**750.00**	**750.00**
	0.00	**0.00**	**0.00**	**0.00**	**0.00**
Point name	**L1**	**L2**	**3**	**R2**	**R3**

This test resulted in positive results of weld strength and very good Cp and Cpk ratios. Such results, if maintained at a given level, are sufficient for the implementation team. The above graphs reflect high capacity and process center rates. The obtained repeatability L1 and R3 at levels 7.4 and 9.0 is highly desirable in every production process.

4. SUMMARY AND CONCLUSION

Thanks to the reorganization and improvement of preparation process of painted parts for further assembly, the company has minimized its production costs and the resources saved can be used to search for further innovations within Kaizen. The success of reduction in masking has opened up a wider perspective for other projects that also use these tapes for masking painted parts in their processes. The tape solution so far has often caused many problems, not only in terms of costs and staffing of the masking worker. A common problem was that the tape peeled off before the painting process, which was also related to throwing the finished semi-finished product away due to the inability to properly weld it to the next element because of the presence of paint residues.

This example perfectly illustrates how the philosophy of small steps improves the processes without any additional impairment of the quality of manufactured products.

Conclusions:

1. Analysis concluded that the change of parameters in the welding process helped to eliminate parts of the masking tape.
2. Risk of error, consisting of inaccurate adhesion of the tape or its detachment, was minimized, which resulted in the manufacture of a product not complying with the client's requirements.
3. Thanks to the introduction of partial masking solution, an improvement in process efficiency was observed.
4. The success associated with the undertaking of changes in welding parameters provides prospects for introducing such solutions in other similar production projects.

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REFERENCES

Gabryelewicz, I., Gawłowicz, p., Sadłowska-Wrzesińska, J., 2015. *Kaizen jako skuteczna metoda wspomagająca efektywne zarządzanie przedsiębiorstwem*, Problemy Profesjologii 2, Polskie Towarzystwo Profesjologiczne, Zielona Góra 139-148.

Imai, M., 2007. *Kaizen. Klucz do konkurencyjnego sukcesu Japoni*. Wydawnictwo, MT Biznes sp. z o.o., Warszawa.

Lizak, M., 2016. *Methods of measuring the effectiveness of Lean Management.* Production Engineering Archives. 13(4), 31-34

Maurer, R., 2007. *Filozofia Kaizen: jak mały krok może zmienić Twoje życie*. Helion, Gliwice.

Midor, K., Lenart, M., 2015. *Wdrożenie systemu kaizen w firmie branży motoryzacyjnej - studium przypadku*, Systemy Wspomagania Inżynierii Produkcji, 3(12), 119-131.

MINI Countryman F60 Cooper S ALL4 Reequipamiento spoiler trasero JCW at: https://www.realoem.com/bmw/es/showparts?id=YT11-EUR---F60-Mini-Cooper%20S%20ALL4&diagId=03_4189 [Accessed 25 May 2020].

Sąpór, A., 2004. *Kaizen – filozofia ciągłego udoskonalania organizacji*, Organizacja i Kierowanie, 4, 91-101.

Streculła, K., Tutak, M., Brodny J., 2017. *Application of chosen elements from Japanese production and maintenance management philosophies in Polish coal mines*. Conference proceedings. Vol. 17, Science and technologies in geology, exploration and mining. 17(13) , Exploration and mining, SGEM.

TAJ, S., 2008. *Lean manufacturing performance in China: assessment of 65 manufacturing plants*. Journal Manufacturing Technology Management., 19, 217-234.

Ulewicz, R., Kucęba, R., 2016. *Identification of problems of implementation of Lean concept in the SME sector*, Engineering Management in Production and Services, 8(1), 1925.

Wojciechowski, A., 2020, *Doskonalenie procesu produkcyjnego za pomocą filozofii Kaizen w przedsiębiorstwie w branży automotive*. Praca Inżynierska, WSZOP.