Supplier Quality Management for Component Introduction in the Automotive Industry

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Abstract

This paper aims to present the requirements and expectations for the quality documents in the automotive business. The presented case study highlights the actual requirements and improvements which can be implemented in order to reduce from the beginning the potential scrap together with the timing spent for evaluations for the non-conform parts. But one of the most relevant aspects needed to be taken in consideration is the fact that this will increase the customer satisfaction as it will avoid unwanted discussions and disappointment during the product lifetime. Future research may demonstrate that preparing such documents will bring a value added in terms of costs and timing, but also in the development of the industry.

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1. Introduction. Quality expectations

In general, quality represents a superior way to treat things, but also with high expectations. If we are thinking at a Mercedes car or a Rolex watch we immediately think at quality and our expectations are accordingly.

The main problems appear when the technical specifications of the product are not according with the customer requirements or the costs for a high level of quality are over the customer expectations.

Customers expect certain things when they walk into a business, and those with the highest level of service will know how to identify those expectations and meet them to the customer's satisfaction.

However, this process is not as easy as it sounds – customer expectations are a dynamic feature that ebbs and flows regularly in accordance with a wide range of factors. However, when expectations are not met by the performance of your customer service representatives, customer dissatisfaction is the result.

Because customer expectations are an ever-evolving process, it can be very challenging to know precisely what those expectations might be.

The standards are dedicate to the increase of the interest and the management efforts in an organization in order to obtain and increase the customer satisfaction, that also means the market orientation and the adaptation to the local market requirements. The management has to adapt and continues take indentify the market flow, taken in consideration also the targeted market

One of the most important items that need to be avoided are the concepts that the quality is expensive or it is a luxury that can be afforded only by some persons.

In a lot of domains, but especially for the ones that are working in the automotive industry, the quality represents the conformity with all requirements and specifications.

1.1 Automotive industry

The strong tendency of automotive industry is to adapt permanently to the changes and introduce the market tendency in the new products that leads of the customer satisfaction.

The automotive industry is a growing business, especially in the East Europe. In Romania in the last years the automotive business has brought a high number of jobs and possibilities for development in several areas (production and development).

In the different area of the country we can find from the final cars producers (Dacia, Ford), TIER 2 suppliers (Continental Automotive, Hella, Dura, TRW, Mahle), TIER 3 suppliers (Thomas, Dedienne, Hock). All these companies have started to developed in the automotive directions and are in continues improvement base on the customer expectations.

According to an analyse performed by Mrs. Irina Hincu senior consultant in spite of a sharp decline in sales in the region during 2013, there is a positive outlook for 2014 in terms of automotive production. At regional level it is forecasted by the end of 2015 a 9.1% increase in the total number of units to be produced. This positive outlook is sustained with arguments which include competitive wages, an educated and productive labor force and ongoing investment in manufacturing. However, analysts expect some car manufacturers to encounter overcapacity problems in 2015 as a result of declining sales figures in the previous year.

Production of passenger cars (out of total vehicles produced) in Romania, in 2013, increased by 4.3% in comparison to figures in 2012, whereas in 2014 a 9.6% increase is expected. There are two key factors favoring the positive outlook in production. Firstly, there is a large number of companies investing in Romania and secondly, wages in the country continue to remain competitive when compared to neighboring countries.

Local automotive production hit a record high of 410,959 units in 2013. Out of the total production, 91% was exported. As a result, automotive exports increased by 12% in 2013.

According to APIA (Automotive Manufacturers and Importers Association), a 30% year-on-year rise in sales of passenger cars and slight recovery in the commercial vehicles segment have been observed in the first eight months of 2014 in Romania. By comparison, last year figures highlighted a decline of 13% in passenger car sales in Romania, from 66,436 in 2012 to 57,710 units in 2013 (OICA Sales Statistics, 2013). The 2013 decline was driven by the slowdown in consumption and a sharp decline in banking credit. Another important aspect directly affecting
automobile purchasing is oil price. In 2014, Romania witnessed further fuel price increases as a result of a 7% excise. Romania is reportedly the 9th member of the EU in terms of highest diesel fuel prices.

2. Component introduction requirements

In automotive area the target is quality without any compromise, the main focus is to make the mobility safer and more comfortable.

Fig. 1. Quality without compromise

Base on the paper of Mr. Pugna, Using Six Sigma Method to Evaluate and Predict Production Process Outcome, in order to plan a product’s quality and to develop a Control, the APQP (Advanced Product Quality Planning) concept is applied (Negru Străuți and Pugna, 2010). This method is defined for development system of products for companies from automotive industry (General Motors, Ford and Chrysler) and their suppliers. As per AIAG – Automotive Industry Action Group, the APQP method scope is to conceive and to prepare a product quality plan which will allow to develop a product capable of satisfying customer’s requirements.

2.1 The requirements for component introduction for the new products launches

In this direction one of the main targets for the Supplier quality management is the supplier development. In order to assure a good component introduction each engineer has to assure that each supplier respects the PPAP (Production Part Approval Process) standard and requirements. Between APQP method and PPAP requirements there is a close correlation, in which are presented the 18 elements PPAP concept requirements and the recommended moment for collection and approval of proofs and / or records. (Pugna, 2011).

There are different PPAP submissions levels that will support a new component introduction or any change that can occur in the supplier process.

- Level 1 - Part Submission Warrant (PSW) only submitted to the customer.
- Level 2 - PSW with product samples and limited supporting data.
- Level 3 - PSW with product samples and complete supporting data.
- Level 4 - PSW and other requirements as defined by the customer.
- Level 5 - PSW with product samples and complete supporting data available for review at the supplier’s manufacturing location.
The PPAP documentation is used in the automotive industry for the development of new components, using the standard theory developed in the PPAP standards and applied for each individual product (using the different methods for the physically tool development, part built and part release, assuring a physical product according to the customer expectations and requirements).

The responsible engineer will take the decision which documents are needed and what level has to be applied for each specific case.

The standard and actual requirements for a new component introduction are PPAP level 3 that implicates 18 documents that need to be submitted for approval to the customer.

1. Design Records
   If the customer is responsible for designing, this is a copy of customer drawing that is sent together with the Purchase Order (PO). If supplier is responsible for designing this is a released drawing in supplier's release system.

2. Authorized Engineering Change Documents
   A document that shows the detailed description of the change. Usually this document is called "Engineering Change Notice".

3. Engineering Approval
   This approval is usually the Engineering trial with production parts performed at the customer plant. A "temporary deviation" usually is required to send parts to customer before PPAP.

4. DFMEA
   A copy of the Design Failure Mode and Effect Analysis (DFMEA), reviewed and signed-off by supplier and customer. If customer is design responsible, usually customer may not share this document with the supplier.

5. Process Flow Diagram
   A copy of the Process Flow, indicating all steps and sequence in the fabrication process, including incoming components.

6. PFMEA
   A copy of the Process Failure Mode and Effect Analysis (PFMEA), reviewed and signed-off by supplier and customer. The PFMEA follows the Process Flow steps, and indicate "what could go wrong" during the fabrication and assembly of each component.

One of the most important document is the PFMEA, through this document the customer can identify all potential risk that can occur for his product in the supplier production process.
7. Control Plan
A copy of the Control Plan, reviewed and signed-off by supplier and customer. The Control Plan follows the PFMEA steps, and provides more details on how the "potential issues" are checked in the incoming quality, assembly process or during inspections of finished products.

8. Measurement System Analysis Studies (MSA)
MSA usually contains the Gage R&R for the critical or high impact characteristics, and a confirmation that gauges used to measure these characteristics are calibrated.

9. Dimensional Results
A list of every dimension noted on the ballooned drawing. This list shows the product characteristic, specification, the measurement results and the assessment showing if this dimension is "ok" or "not ok".

10. Records of Material / Performance Tests
A summary of every test performed on the part.

11. Initial Sample Inspection Report
The report for material samples which is initially inspected before prototype made

12. Initial Process Studies
Usually this section shows all Statistical Process Control (SPC) charts affecting the most critical characteristics.

A method to analyze the process is statistics which is the scientific application of mathematical principles to collection, processing, and analysis of data, and the interpretation of the results.

Mathematical distribution models are often used to approximate observed data, to model data relationships, to make probabilistic statements about parameter estimates, and to make comparisons between groups of data.
This is one of the most accurate methods to identify if the process is stable and if there are deviations in which step of the process this can be identified.

13. Qualified Laboratory Documentation
Copy of all laboratory certifications of the laboratories that performed the tests reported

14. Appearance Approval Report
A copy of the AAI (Appearance Approval Inspection) form signed by the customer

15. Sample Production Parts
A sample from the same lot of initial production run. The PPAP package usually shows a picture of the sample and where it is kept (customer or supplier).

16. Master Sample
A sample signed off by customer and supplier, that usually is used to train operators on subjective inspections such as visual or for noise.

17. Checking Aids
When there are special tools for checking parts, this section shows a picture of the tool and calibration records, including dimensional report of the tool.

18. Part Submission Warrant (PSW)
This is the form that summarizes the whole PPAP package. This form shows the reason for submission (design change, annual revalidation, etc.) and the level of documents submitted to the customer.
2.2 Improvements that could be implemented in order to decrease the ppm value

In the actual situation even the most important documents related to the supplier process are submitted (PF, CP, PFMEA, MSA, SPC) the ppm (parts per million rejected due to quality issue) level is quite high due to the missing clear alignment of the quality expectations for the cosmetically surface.

The case study aims to present a situation with the values were the cosmetically defects have a direct impact in the quality result (see table 1 and Fig. 5), reflected in the ppm values and the possible improved results by introducing as mandatory 2 items in the PPAP standard.

The calculated scrap rate for a painting process (which is one if the most important process for the cosmetically surface) is at approximately 35% in the stable phase of the production. But it is not taken in consideration that during the ramp up process the actual values are much higher at approximately 40% up to 50%. As this is not calculated from the beginning in 80% of the production ramp up’s the customer production lines are also affected, having a clear impact on the quality results and level of satisfaction point of view.

The ppm is the indicator that reflects most clearly the impact of the defects in the production line from quality point of view, and this reflects all supplier quality issues.

The total value of the ppm indicates the number of defects identified in a production line affected by the suppliers processes.

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<tbody>
<tr>
<td>Actual ppm value</td>
<td>0.52</td>
<td>0.39</td>
<td>0.37</td>
<td>0.42</td>
<td>0.25</td>
<td>0.33</td>
<td>0.34</td>
<td>0.27</td>
<td>0.31</td>
<td>0.25</td>
<td>0.14</td>
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Table 1. Actual ppm value

![Actual ppm value](image)

Fig. 5. Actual ppm value distribution

To evaluate the impact of the cosmetically defects on the total amount the value is split in defects caused by the cosmetically defects and other components (see below table 2 and Fig 6)
By coming to a clear agreement since early beginning of the project related to the cosmetically specification but also to a feasible scrap rate (with a decreasing trend base on the project evolution) the actual values could be decreased with approximately 20%. (see Fig.7)
So if a clear indication for the surface and defects definition together with a clear point to take in consideration the border sample definition would become a mandatory document in the PPAP handbook (see table 3) the ppm value could be decreased to an average of 50% (see fig 8)

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<tr>
<td>New ppm value</td>
<td>0.44</td>
<td>0.27</td>
<td>0.23</td>
<td>0.18</td>
<td>0.18</td>
<td>0.10</td>
<td>0.21</td>
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<td>0.14</td>
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<tr>
<td>Ppm improvement</td>
<td>16%</td>
<td>30%</td>
<td>37%</td>
<td>57%</td>
<td>37%</td>
<td>37%</td>
<td>37%</td>
<td>10%</td>
<td>35%</td>
<td>24%</td>
<td>37%</td>
<td>32%</td>
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Table 3. Improved ppm value

![New ppm value chart](image)

Fig. 8. New ppm values

### 2.3 Proposed model

The PPAP handbook should include 20 items as mandatory documents for a PPAP level 3, for step 18 the point should be Cosmetically agreements (with all necessary details depending on the product) and step 19 Border sample agreement. The final document should be as in the actual case the PSW that will be finally approved only in the case that all 19 points are fulfilled and respected from both sides.

<table>
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<th>DEFECT DEFINITION</th>
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<th>INSPECTION METHOD</th>
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Table 4. Example of cosmetically definition table
3. Conclusions

Comparing the two methods, it is found that by introducing two documents will help to decrease the ppm values and will increase the quality performance and the customer satisfaction.

The research also identifies one important aspect correlated to the actual values of the scrap rates in the different project stages. If the values considered at the project quotation will be more closures to the reality the project situation could be estimated since beginning with all possible risk and can be evaluated when the project will go in a stable mode.

In the situation of implementing of a new products line at a automotive industry company, taking in consideration decorative parts, is necessary a good correlation between APQP activities and PPAP requirements. This is necessary to identify the 18 elements of PPAP requirements, together with the above proposed additional steps that will help the decrease of the ppm rate.

Future research may demonstrate the appropriateness of updating such documents constantly base on the evolution of the products and the continues development of the automotive industry.

References

Article written by Irina Hincu senior consultant at EY Romania, Automotive Industry in Romania, in the magazine Doing Business, December 2014.
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