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ADVANCED PRODUCT QUALITY PLANNING IN THE AUTOMOTIVE INDUSTRY[1]

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Abstract

Quality engineering and especially the automotive industry, is facing the advanced challenges arising from global changes in the technical, economic and social environment. There is accelerating the need for products with higher added value, based on the customer needs and satisfaction. The responsible and continuously innovative agile approach, aimed to increase the level of product quality, as well as the quality of innovation process, is for the European countries the only possibility, how to compete with both mass production of low-cost. Submitted article analyzes the approaches to advanced product quality planning, with a primary focus on the automotive industry.

Keywords–Advanced Product Quality Planning; agile approach; customer needs and satisfaction; innovation;

INTRODUCTION

Present development in the all fields of automotive industry is connected with increased requirements for product quality.The need to face new challenges arising from global changes in the technical, economic and social environment creates the pressure on reducing the innovation cycles and increasing the overall quality of the product and process. The essential influence on products quality belongs to quality planning. Automotive industry challenges are: Innovation, more complex product, Reduce new product development times, Complicated Supply chain and increasing customer and quality requirements. It is important to recognize that the

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automobile is becoming more complex. Market and social forces are driving the industry to create vehicles with higher levels of performance. This applies not only to their traditional purpose of safely transporting drivers and passengers, but also to the driving experience itself. Technology changes are occurring in every aspect of the vehicle. This situation creates complexity not only because the systems themselves are complicated, but also because the interaction between the systems is often difficult to understand and predict. Further, while the market forces demand these systems in the product, they must be designed and produced at lower cost. Besides the market forces mentioned above, additional factors are driving the industry to structural changes. The industry is getting more efficient, and market share is shifting between companies. This factor has led to overcapacity in the industry, which in turn leads to consolidation. Further, in an effort to lower cost, companies are outsourcing the manufacture (and to some degree the design of subsystems) to suppliers. These suppliers are generally distributed worldwide; they are quite competent and have a lower cost structure. Advanced Product Quality Planning is a structured method to assure that a product satisfies the customer (both internal and external). The goal of APQP is to facilitate communication with everyone and to assure that all required steps are completed on time. Particular emphasis must be placed on identifying high risk long lead requirements or items which require focused upfront, effort. It means planning before acting, anticipation and prevention of issues, validation before moving towards and overall facilitation. The product quality planning cycle have four sequenced various phases: Plan, Do, Check, Act (PDCA). They represent planned timing to execute and emphasize:

-Up-front product quality planning through product/process validation and

-The act of implementation as the last stage of the PDCA cycle.

Fundamentals of APQP are: Organizing the team, Defining the scope, Training, Simultaneous engineering, Control plans, Costumer and Organization involvement, concern resolution, Product quality timing plan and Plans relative to the Timing chart.

METHODS

The never-ending cycle of Advanced product quality planning is a pursue towards a continual improvement, that can only be achieved by taking the experience from one program and applying it to the next program. Quality planning represents many of activities, which decide about resulting quality. The summary is that we should first design quality (DFMEA, PFMEA), then

manufacture quality (control plans, process flow diagrams, measurement system analysis, capability analysis, process validation, run at rate, etc.) and satisfy all costumer needs and specifications (PPAP, first article inspection, tooling, testing). The key methods and elements to assure the APQP are the following:

- Product/process design (Process Flow Chart - PFC, Failure Mode Effects Analysis – FMEA and Control Plan- CP)
- Product/process validation (Measurement System Analysis – MSA, Capability Study).

PFC is a visual diagram of the entire process from receiving through shipping, including outside processes and services. Its purpose is to help people "see" the real process. Process maps can be used to understand the following characteristics of a process: Set-by-step process linkage; Offline activities (measurement, inspection, and handling); Rework, scrap. It's used to understand how a process is done and prior to completing the PFMEA. Process Flow must include all phases of the process: Receiving of raw material; Part manufacturing; Offline inspections and checks; Assembly; Testing; Shipping and Transportation Process Mapping. It provides Inputs to: Potential Failure Mode Effect Analysis; Control Plan; Capability Studies and MSA.

FMEA allows us to take a proactive approach to what can go wrong in a process and manage our risks better. Process FMEA is a tool used to identify and prioritize risk areas and their mitigation plans. Its purpose is to: Identify potential failure modes, causes, and effects. Inputs come from the process flow diagram. It also identifies key inputs which positively or negatively affect quality, reliability and safety of a product or process. It Denotes Special Characteristics of Product/Process that impact the ultimate safety/performance of the end product. We should use it after completion of the process flow diagram and prior to tooling for production. It is important to note that the PFMEA should be completed using a cross-functional team.

In each instance, the assumption is made that the failure could occur, but will not necessarily occur. Each failure mode should be credible. There should be a description of non-conformance. We should assume that incoming parts are correct and remember to consider subsequent operations. Potential causes are defined as how the failure could occur, and described in terms of something that can be corrected or controlled. After listen the Current Controls for each Cause we should assign Severity, Occurrence and Detection ratings.Severity can only be improved by a design change to the product or process. Occurrence can only be reduced by a change which removes or controls a cause. Examples are redundancy, substituting a more reliable component or function or mistake-proofing. Detection can be

reduced by improving detection. Examples are mistake-proofing, simplification and statistically sound monitoring. In general, reducing the Occurrence is preferable to improving the Detection. Than we calculate the RPN – Risk Priority Number followed by determination of Recommended Actions to reduce High RPNs. We should take appropriate Actions and Document and Recalculate RPNs.

All high RPN process concerns should be carried over into the control plan. All critical failure modes must be addressed like: Safety; Form, fit and function; Material concerns etc.

It is a tool used to define the operations, processes, material, equipment, methodologies and special characteristics for controlling variation in key product or process characteristics within the manufacturing process. Its objective or purpose is to: Communicate the supplier's decisions during the entire manufacturing process from material receipt to final shipping; Verify existence of production controls at each step defined in the Process Flow/PFMEA; Define reaction plans at each step should a non-conformance be detected; and Denote Special Characteristics of Product/Process that impact the ultimate safety/performance of the end product. We should use it after completion of the process flow diagram/PFMEA for a Prototype, Prelaunch and Production; Implementation of new process and Implementing a process change.

Since Auditing is an important tool for control, Audit plans can be included in the control plan as a separate line. Process auditing should be a key element of the quality system of a business. Audits generally cover: • Effectiveness of controls • Control plan (say) vs. what is actually done (do).

MEASUREMENT SYSTEM ANALYSIS

The MSA is a statistical tool used to determine if a measurement system is capable of precise measurement. Measurement systems must be analyzed BEFORE embarking on process improvement activities. MSA helps understand how much observed variation is from the measurement system. Its objective or purpose is to determine how much error is in the measurement due to the measurement process itself; to quantify the variability added by the measurement system and to be applicable both to attribute data and variable data. We should use it on the critical inputs and outputs prior to collecting data for analysis and for any new or modified process in order to ensure the quality of the data. Everyone that measures and makes decisions about these measurements should be involved in the MSA. The involvement of people is the key to success, so we need to involve the people that actually work the process and the supervision. The Involvement of the suppliers and customers of the process is also another

key element. We should notice that the observed variation in process output measurements is not simply the variation in the process itself; it is the variation in the process plus the variation in measurement that results from an inadequate measurement system. MSA will tell us about the repeatability, reproducibility and discrimination. Sample selection is very important – sample during normal production to capture total range of process variation MSA should be done on a regular basis. An MSA primarily addresses precision with limited accuracy information. MSA should be done on a regular basis once per year.

CAPABILITY STUDY

Capability studies are measures of how well the process is meeting the design requirements. In performing a capability study, the team determines from sample data the process average and a spread (capability) of the process, and compares this variation with the specifications Capability ratios are used to compare the Voice of the Customer (specs) to the Voice of the Process (natural process limits). For a capability ratio to be a good predictor of future performance, the process must be stable. Otherwise, the ratio is just a descriptor of past performance! The two key ways to improve process capability are to reduce variation and to improve centering. A capability ratio should never be interpreted without also looking at a control chart to verify stability and a histogram of the process to ensure normality. The supplier should set warning tolerances and track changes – to give a pre-emptive warning. We must ensure that the results are acceptable, and that the process is stable and capable of producing a quality part, because PPAPs (Production Part Approval Process) should only be approved if the capability is greater than 1.67 for critical dimensions and greater than 1.33 for non-critical dimensions.

RESULTS

Manufacturing process functions that are clearly planned, validated, documented and communicated will result in: Robust and reliable designs; Reduced process variation; Enhanced confidence in supplier's capabilities; Better controlled process changes; Defect free launches; Improved Customer satisfaction; Improved Delivery and Service; Maximum Risk of Investment; Minimum Waste and Minimum Cost of Non- Conformities. The aim is to achieve values like: Integrity- strengthens relationships across businesses and functions; Innovation- there is always a better way; Customer Satisfaction - future depends on serving as customer advocates; Sustainability - the efficient use of resources to benefit all people and the

planet; Employee Engagement - foster a culture that promotes excellent performance, teamwork, inclusion, leadership and growth. The employee and leader diversity mirror in global markets and population.

CONCLUSION

Quality is responsible for driving continuous improvement for all automotive industry brands to deliver top quality products and services to delight customers. It can be concluded that the customers, product quality and product cost and are the significant factors governing theAPQP. The organizations are trying to implement these techniques and methodology as per their requirement, applicability and economical conditions. Advanced Product Quality Planning is one of the best techniques for new product development in now days. It incorporates all the advantages of Six sigma, QFD as-wellas Lean Product Development. APQP helps build confidence in a supplier's engineering practices by proving the consistency of a product's quality. However, the process for acquiring approval can take some time. Fortunately, the value of APQP is increased in that its streamlined nature helps facilitate faster PPAP. At each of the stages, Advanced Product Quality Planning provides multiple benefits to both the supplier and customer. Not only does it inherently improve quality, it lowers costs and ensures a streamlined - more efficient - manufacturing process. This translates into better customer satisfaction and increased revenue generation.

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