

Significance of the validation Of Design Failure Mode Effect Analysis -A Review

Mr.Sachin Patil¹,Prof. A.P.Shrotri², Mr. A.R.Dandekar³

¹M.E.Student (Department Of Mechaniccal Engineering P.V.P.I.T.-Budhgaon, Maharashtra, India)

² Associate Professor & P.G. Guide (Department Of Mechaniccal Engineering
P.V.P.I.T.-Budhgaon, Maharashtra, India)

³Assistant Professor & Co-Guide (Department Of Mechanical Engineering
P.V.P.I.T.-Budhgaon, Maharashtra, India)

ABSTRACT

Now-a-days for design of a new product; the exercise of FMEA is essential. This will help to reduce the risks of failures and rejection in the future. Design Failure Mode Effect Analysis is an approach to find out the potential failures that may exist in the design of the product. In initial stages DFMEA of the product is to carry out the estimate the effect of the failures and severity of these effects on the function of a product. On the basis of this study other designs and technical specifications are further decided.it is a widely adopted technique in Automotive sector, initiated by Ford Motors, and now it is emerging as a common practice in manufacturing sector. Estimation of risk associated with the new design is indicated by the risk priority number (RPN) and criticality of design parameters is decided on the basis of RPN. There are some possibilities of misjudging of RPN which leads to improper approach. Hence it is a must to validate the RPN. This paper discusses significance of the validation of RPN and subsequently that of DFMEA.

Keywords:-New product design, DFMEA,Risk priority number (RPN),Validation

1.INTRODUCTION

While doing the design of a new product, it is important to carry out the exercise of Design Failure Mode Effect Analysis (DFMEA) and to document it. DFMEA is an approach to find out the potential failures that may exist in the design of the product. This will help to reduce the risks of failures and rejection in the future. DFMEA is the technique that identifies the potential failure modes of the product design during its life cycle, effect of these failures and severity of these effects on the function of a product. It was first developed by US Army in their missions. Later in the decade of 1970 it was adopted by Ford Motor in Automotive sector. And now it becomes a common practice in manufacturing sector.

II. RELEVANCE

The traditional product design approach starts from idea generation and ends at product design and product specifications. The effectiveness and outcome of the approach depends on innovation and safety aspects.

Idea screening, technical viability and safety evaluation of the product are the crucial stages in the process of product design. The exercise of DFMEA is essential for these crucial stages in the process of product design. This will help to reduce the risks of failures and rejection in the future.[11]

III. THEORY OF DFMEA

Design Failure Mode Effect Analysis is an approach to find out the potential failures that may exist in the design of the product. It particularly focuses on the failures that can be caused due to the design related deficiencies. The DFMEA of the entire assembly and individual component is important in case of any product.[10]

In initial stages DFMEA of the product is to carry out the estimate the effect of the failures and severity of these effects on the function of a product. On the basis of this study other designs and technical specifications are further decided.[12]

IV. DFMEA PROCEDURE

While performing the exercise of DFMEA following steps should be taken [10].

- i) Formulate the team/s and appoint their leaders within the organization.
- ii) Decide the policy of organization:-Formulate the rules, policies and boundaries to carry out the exercise.
- iii) Take review and gather the information:-Gather the information that can help to conduct the DFMEA exercise.
- iv) Identify the components:-It is not necessary to conduct the exercise of each and every component. From the information gathered in previous stage, the crucial components can be identified.
- iv) Identify functions, design parameters, potential mode of failures, causes and effects of the selected components.
- v) Calculate the Risk Priority Number (RPN).
- vi) Assign the corrective actions.

V. DFMEA TERMINOLOGY

Following terms and their meanings are important in the entire process of DFMEA[12]

- i) Function:-A function can be defined as what the component or item is intended to perform.
- ii) Failure mode:-It is defined as the manner in which the component or process potentially fails to deliver the intended function.
- iii) Effect:-An effect can be defined as the result of the failure or effect of the failure on the end user.
- iv) Cause:-It is the specific reason for the failure.

v) Severity:-It is the ranking number related with the most serious effect for a given failure mode. The ranking number ranges from 1 to 10 depending on the effect of severity.

vi) Occurrence:-It is the ranking number related with the like hood.

vii) Detection:-It is the evaluation of the like hood that the current control mechanism will detect the cause of failure mode, thus preventing it from reaching the customer. This is also ranges from 1 to 10. The higher detection number indicates that the chances of detection of failure are lower.

viii) Risk priority number:-The product of Severity, Occurrence & Detection is called as Risk priority number or RPN.

ix) Risk Priority Number (RPN)=Severity*Occurrence*Detection

The priority of the design parameters which should be focused is decided by referring the value of Risk priority number. Generally RPN value of 100 or more than that are to be considered as more critical. However there are certain limitations of this process discussed as under;

VI.LIMITATION OF DFMEA

- 1) It is based on Past experiences, simulations and sometimes on certain assumptions.
- 2) The parameter values (Severity, Occurrence, Detection) vary from person to person, though there is standardization.
- 3) Actual performance of the product cannot be predicted correctly before at least trial run.

VII. NECESSITY OF VERIFICATION OF RPN NUMBER

As discussed earlier, there are some limitations of DFMEA process. And these limitations can create following situations.

Assignment of higher RPN number for the parameter which is not actually critical.

Assignment of lower RPN number for the actual critical parameters

Due to the said situations, the organization may have to face following problem

Assignment of higher RPN for actually non critical parameter may leads to overcautious approach. That can lead to higher factor of safety and unnecessary burdon in the material costs of the product.

Assignment of lower RPN for actually critical parameter may affect product performance ,hence damaging the brand image of organization.

Hence it is suggested that validate the DFMEA within the trial run and before entering in the Market.

VIII. LITERATURE REVIEW

Florina-Cristina Filip[1] et-al described the FMEA as a structural approach documentation for the future. Ultimately FMEA provides you the guideline about your future results. How ever they pretended that FMEA is not a problem solver tool, but it can be used with other tools. The traditional method to conduct the FMEA

exercise is discussed in detail in this research. Also they pointed out some limitations of FMEA process, like high time, definition problems.

Frances Boylan[2] et-al has plotted the FMEA process in a different approach. The researcher has established a new concept i.e. Failure Mode Reflective Analysis. However the paper is associated with risks in the higher education; the finding of the author is crucial. The new technique(FMEA) is more effective than traditional way. The author has modified particularly in the area of Severity and Occurrence number. The mentioned parameters are classified in 4 classes as low risk, Moderate risk, High risk and Extreme risk. This technique is very useful to decide the priority of the issues. Also different color coding is allotted for the class which immediately reflects the situation of the issue.

Pinnarat Nuchpho[3] et-al concluded that FMEA is very important quality and reliability analysis tool. However the conventional method to calculate RPN has been criticized extensively for the variety of the reasons like uncertainty of the risk factors. It was observed by the researcher that the traditional DFMEA based on RPN is not supportive and robust enough in priority ranking of failure modes. It is essential to measure the effectiveness of Risk Priority Number (RPN). As per the researcher it is essential to modify the existing method of calculation of RPN by considering future demands of Quality Management System.

Tejaskumar S. Parsana[4] et-al has discussed the utility of the FMEA for the improvement in the quality. The entire exercise is completed by taking the reference of existing procedure of FMEA. Though there are some limitations of traditional approach of FMEA, it will definitely help to improve quality standard. But modification in existing process gives the better results. FMEA is systematic approach, hence it should be carried out with some logical process, then only it will give the better results. Also FMEA can be a legal document, hence proper should be taken while developing the FMEA.

Rohit Ravasaheb Shinde[5] et-al have completed the exercise of Design Failure Mode Effect Analysis for the Bush Manufacturing purpose. They have carried out this exercise with traditional process only. However some other aspects of this method is also discussed by the researchers which are unveiling the loopholes in the existing method of calculation of RPN. The author has pointed out that FMEA for capability enhancement requires great level of knowledge and competency. Also FMEA tends to give the importance to prevention efforts. As compared to that the various aspects of detection and occurrence are being neglected in the tradition approach

RiddhishThakore[6] et-al emphasized on documentation process of FMEA. FMEA documentation is very important, because basically when Customer is approving the Supplier's product The standard procedure followed by the Customer is Production Part Approval Procedure (PPAP). It is mandatory for supplier to submit some standard documents to Customer. Design Failure Mode Effect Analysis and Process Failure Mode Effect

Analysis (PFMEA) is the complex exercise having rigorous documentation. Hence FMEA is the authentic document between Supplier and Customer. That indicates the requirement of accuracy of FMEA.

Thanh-Lam Nguyen[7] et-al discussed the modification in Risk Priority Numbers in detail. As traditional way to calculate the RPN number is simple multiplication of Severity, Occurrence and Detection index, the authors have chalked out some issues related to the prioritization of the failures. This research concludes that the MRPN(Modified Risk Priority Number) which is associated with quality cost and capability of failure detection system is more accurate than the traditional method.

A.P.Shrotri[8] et-al discussed the necessity for the validation in the Risk Priority Number. As we are calculating the RPN based on Severity, Occurrence and detection index, it's a theoretical treatment. It is essential to check the things in actual. Because it can be possible of allotment of higher RPN for not critical parameter or lower RPN for a parameter which is critical in practical. Its not desirable to allot higher RPN for non-critical parameter, because it blocks money and manpower in testing activities. Similarly the allotment of lower RPN to actually critical parameter is also dangerous. Because it can cause severe failure and damage. These research advices to validate practically the theoretically calculated values.

Sidhartha Pattnaik[9] has utilized DFMEA technique to list out all modes of failure for various components of an all-Terrain Vehicle (ATV), their causes, effects and remedial for preventing them. Risk Priority Number methodology of FMEA is used to find out the susceptibility to failure of components which call for more attention than others.

Cooper Industries(Houtson)[9] et-al published a manual on Production Part Approval Procedure(PPAP).A detailed procedure of DFMEA and PFMEA exercise is described in the manual along with the various charts and table. For PPAP submission the company has enlisted list of documents for suppliers, in which DFMEA is fifth numbered document. This shows the importance of DFMEA process in Industrial practice. A guideline is provided to supplier to complete the exercise.

General Motor Corporation[10] et-al also published the suppliers quality manual for the completion of the Advanced Product Quality Planning (APQP) .In the manual guidelines are provided for the suppliers of GM to complete the task of DFMEA. However it is concluded that DFMEA as an important integral part of APQP.As APQP is globally accepted process for new product development, the task of DFMEA is also very important.

IX.CONCLUDING REMARKS

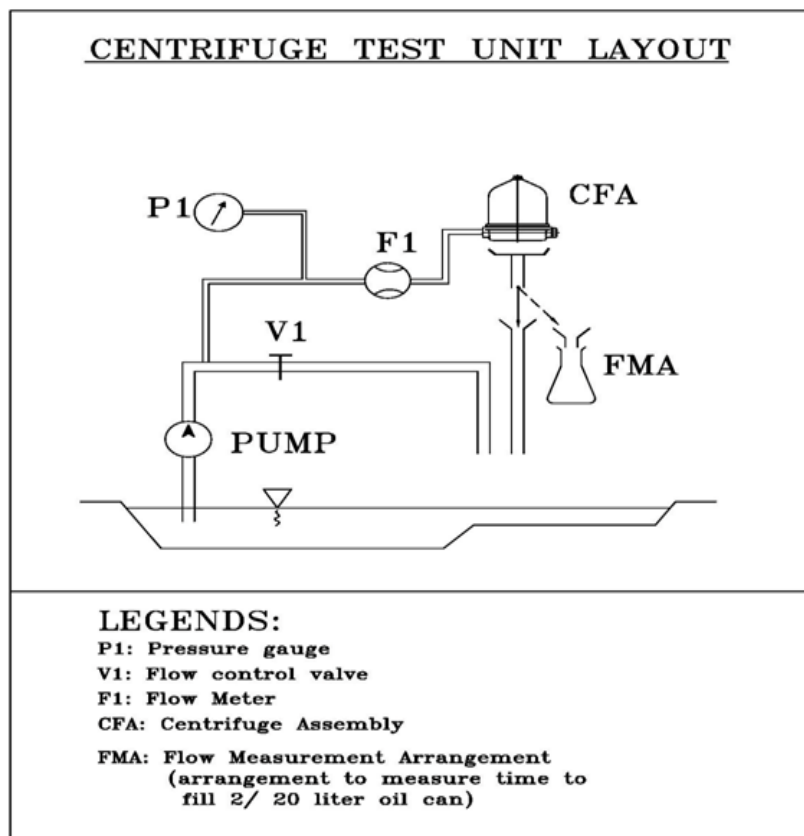
- i) The traditional DFMEA procedure provides guidelines about future risk.
- ii)The traditional process DFMEA is defiantly helps to improve the quality and reliability. But it has certain limitations.
- iii) The crucial limitation about the RPN is its subjective nature about the value of risk priority numbers.

- iv) To overcome the limitations various researchers have suggested different creative plan.
- v) However among the suggested plans the plan of actual validation of RPN number by conducting actual experimentation look likes more feasible.

X. SCOPE FOR FURTHER WORK

From literature survey it is concluded that DFMEA has certain limitations. Hence there is a good scope to testify the validity of FMEA outcomes We will be validating RPN numbers by conducting actual experimentation. The said work of “validation Of Design Failure Mode Effect Analysis(DFMEA) of a new product will be conducted at Bhgyashree Accessories Pvt.Ltd.Pune.for their new design of centrifugal oil cleaners.

XI.EXPERIMENTAL SETUP



The validation will be done by comparing results of experimentation with the criticality of parameters (RPN is greater than or equal to 100) described in DFMEA.

REFERENCES

- [1.] Florina-Cristina Filip, “Theoretical Research on the Failure Mode and Effects Analysis (FMEA) Method and Structure”, *Recent Advances in Manufacturing Engineering*, ISBN: 978-1-61804-031-2
- [2.] Boylan F. Introducing the Failure Mode Effects Reflective Analysis Technique for the field of Higher Education and research .*EDULEARN11 International Conference on Education and New Learning Technologies, Barcelona, July 4th 2011*.
- [3.] Pinnarat Nuchpho, Santirat Nansaarn, Adisak Pongpullponsak, “ Risk Assessment in the Organization by using FMEA Innovation: A Literature Review”, *Proceedings of the 7th International Conference on Educational Reform (ICER 2014), Innovations and Good Practices in Education: Global Perspectives, Pg.781-789*.
- [4.] Tejas Kumar, S. Prasana, “A Case Study:A Process FMEA Tool to Enhance Quality and Efficiency of Manufacturing Industry” *Bonfring International Journal of Industrial Engineering and Management science Vol.4 NO. 3 ,Agust 2014*.
- [5.] Rohit Ravasaheb Shinde,Ranakant Shrivastava, RupeshB. Morey, “Failure Mode Effect Analysis case study for bush manufacturing process”. *International Journal of scientific Engineering and Applied science (IJSEAS)Volume-I,Issue-4,July 2015Pages 283-294*.
- [6.] Riddhsish thakore,Rajat Dave Tejas Parsana,“A Case Study:A Process FMEA Tool to Enhance Quality and Efficiency of Bearing Manufacturing Industry”.*Scholars Journal of Engineering and Technology(SJET),2015,3(4B)pages 413-418*.
- [7.] Thanh-Lam Nguyen,Ming-Hung Shuand BI Nin Hsu.“Extended FMEA FOR Sustainable Manufacturing: An Empirical study in Non-Woven Industry; Sustainability 2016.
- [8.] A.P.Shrotri, Satyjit Chitale, N.V.Hargude, G.S.Joshi, A.R.Dandekar, “Design Failure Mode Effect Analysis Of A centrifugal Oil Cleaner And Plan For Validation of The DFMEA” *International Conference on Futuristic Trends in Engineering, Science, Humanities, and Technology(FTESHT-16) ISBN: 978-93-85225-55-0, January 23-24, 2016, Gwalior,Pp.70-76*
- [9.] Sidhartha Pattnaik “design failure modes and effects analysis (dfmea) of an all-terrain vehicle”, *International Journal of Research in Engineering and Technology, Volume: 04 Issue: 06 | June-2015,Pp.339-345*
- [10.] “Poornima M.Charantimath, “*Total Quality Management*”, Pearson publication, second edition2011 ISBN978-81-317-3262-5.
- [11.] Kevin Otto et-al, “*Product Design-techniques in Reverse Engineering and new product development*”, Pearson publication, first Indian reprint2004, ISBN81-297-0271-1.
- [12.] Joseph M. Juran ,A. Blanton Godfrey,Robert E. Hoogstoel ,Edward G. Schilling “*JURAN’S QUALITYHANDBOOK*”, Fifthedition,McGraw-Hill New York ,1988

- [13.] Cooper Industries Suppliers Quality Management Production Part Approval Process Manual”, Revision 6, February 2009, Pages 5-51.
- [14.] General Motors Corporation, “Global APQP”, “APQP Task definitions”, Global Supplier Quality Manual, September 2008, Page 3-26