MODIFIED FAILURE MODE AND EFFECT ANALYSIS USING FUZZY LOGIC

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ABSTRACT- In recent years, due to the growing complexity and the high cost incurred by the loss of operation and maintenance actions, the reliability assurance activities are becoming established as an integral part of the design process of engineering systems. Reliability assessment provides insight into the key areas of a system and highlights potential problem areas so that they can be dealt at the design, process and service stages of the system life cycle. Furthermore, it provides a deeper understanding of the system and it helps to improve the system safety. The factors considered in traditional failure mode and effect analysis (FMEA) for risk assessment are frequency of occurrence (O), severity (S) and detectability (D) of an item failure mode. Because of the subjective and qualitative nature of the information and to make the analysis more consistent and logical, an approach using fuzzy logic is proposed.

FAILURE MODE AND EFFECTS ANALYSIS (FMEA) – AN OVERVIE

Quality

Quality is the conformance to specifications and standards.

Reliability

Reliability is defined as the probability of performing a specified function without failures, under given conditions for a specified period of time.

Failure Mode and Effects Analysis

Failure mode and effect analysis is an engineering technique used to define, identify, and eliminate known and/or potential failures, problems, errors, and so on from the system, design, process, and/or service before they reach the customer.

Failure definition

This is a general statement of what constitutes a failure of the item in terms of performance parameters and allowable limits for each specified output.

Failure cause

The physical or chemical processes, design defects, part misapplication, quality defects, or other processes which are the basic reasons for failure or which initiate the physical process by which deterioration proceeds to failure.

Failure mode

The manner by which a failure is observed. Generally, describes the way the failure occurs and its impact on equipment operation.

Failure effect

The consequence(s) of a failure mode has on the operation, function, or status of an

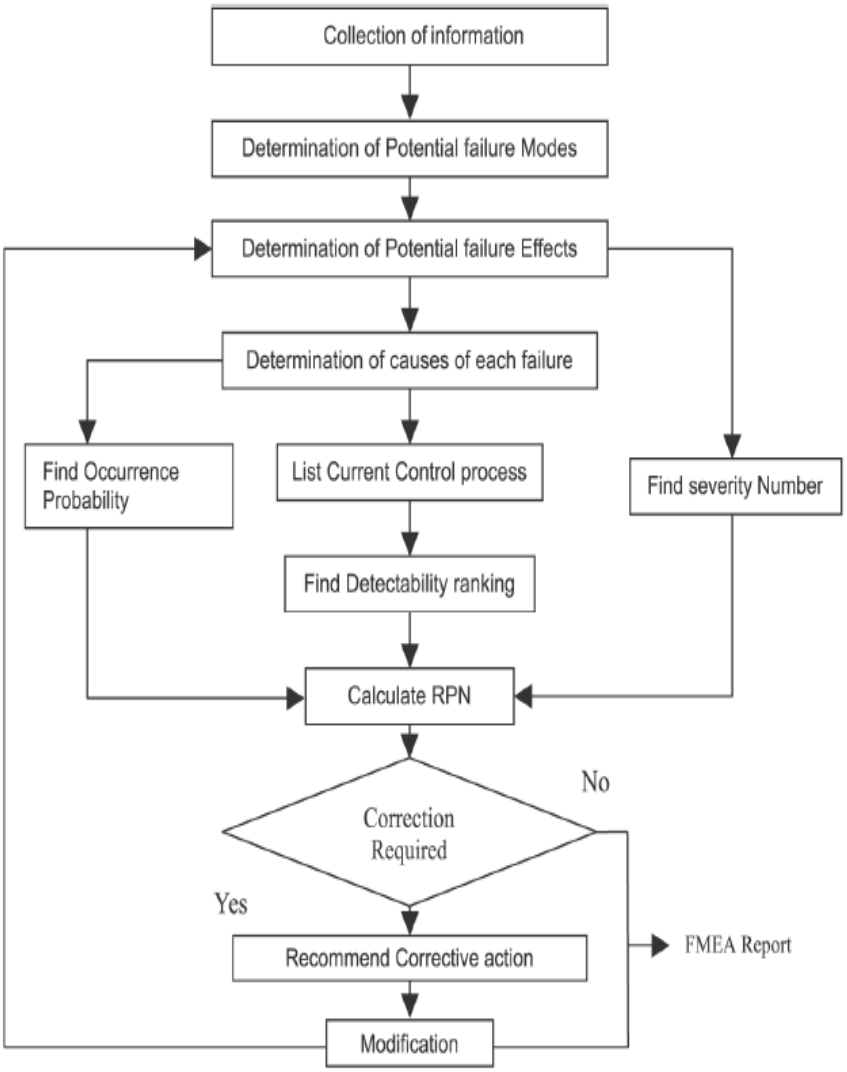
item. Failure effects are classified as local effect, next higher level, and end effect.

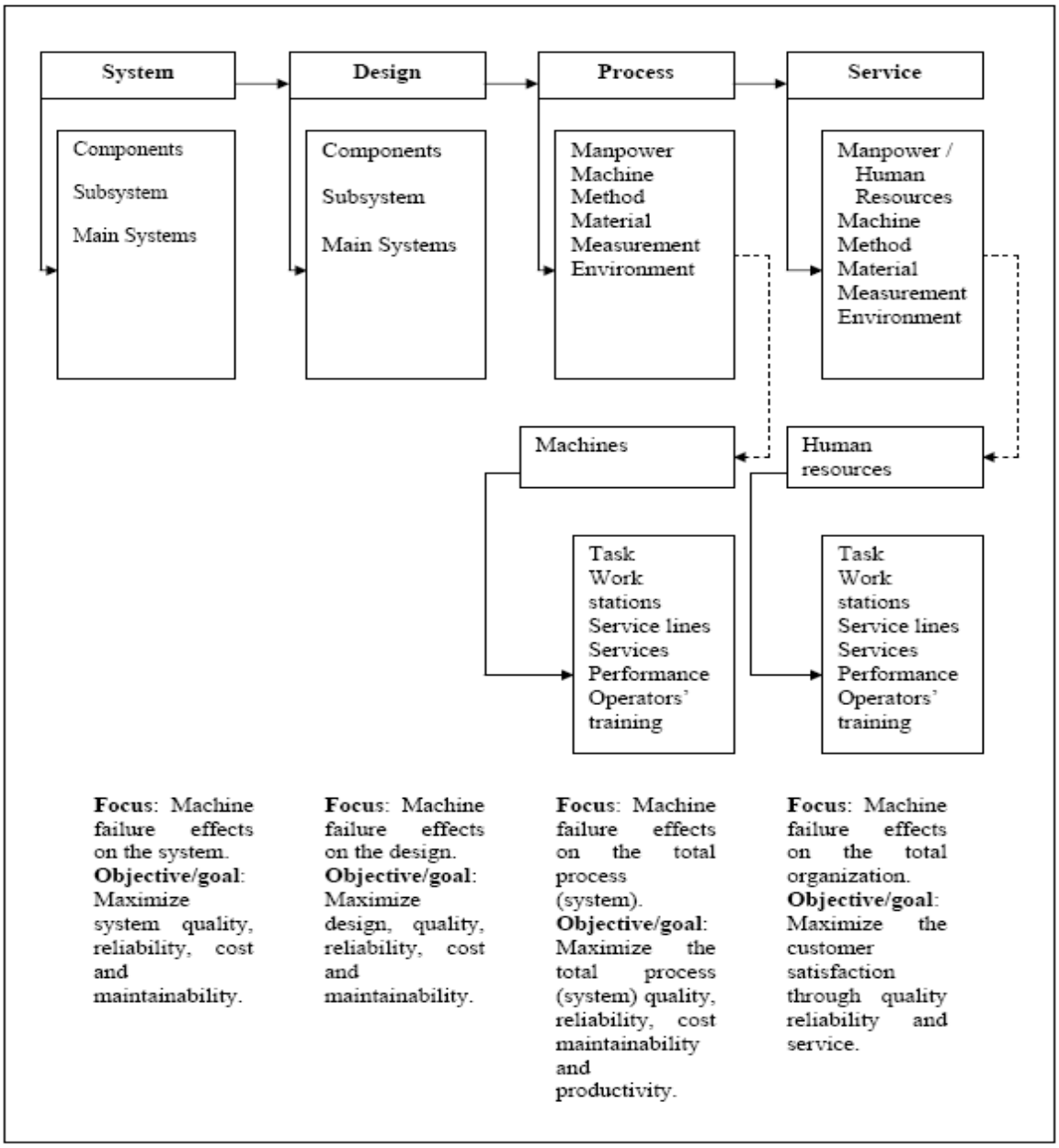
BENEFITS OF FMEA

- Improves the quality, reliability, and safety of the products or service.
- Improves the company's image and competitiveness.
- Helps to increase customer satisfaction.
- Reduces product development time and costs.
- Helps to select the optimal system design.
- Helps to determine the redundancy of the system.
- Helps to identify diagnostic procedures.
- Establishes a priority for design improvement actions.
- Helps in the analysis of new manufacturing and/or assembly of process.
- Helps in the analysis of tasks, sequence, and/or services.

System FMEA - Used to analyze systems and subsystems in the early concept and design stage. A system FMEA focuses on potential failure modes between the functions of the system caused system deficiencies. It includes the interactions between system and elements.The main phases of FMEA are The analysis process starts from the identification of the scope of the system and the functions; the FMEA is to be applied on. After the subject for the FMEA is confirmed, the next step is to identify the potential failure modes in a gradual way. The technique of brainstorming has often proven to be a useful method for finding failure modes.

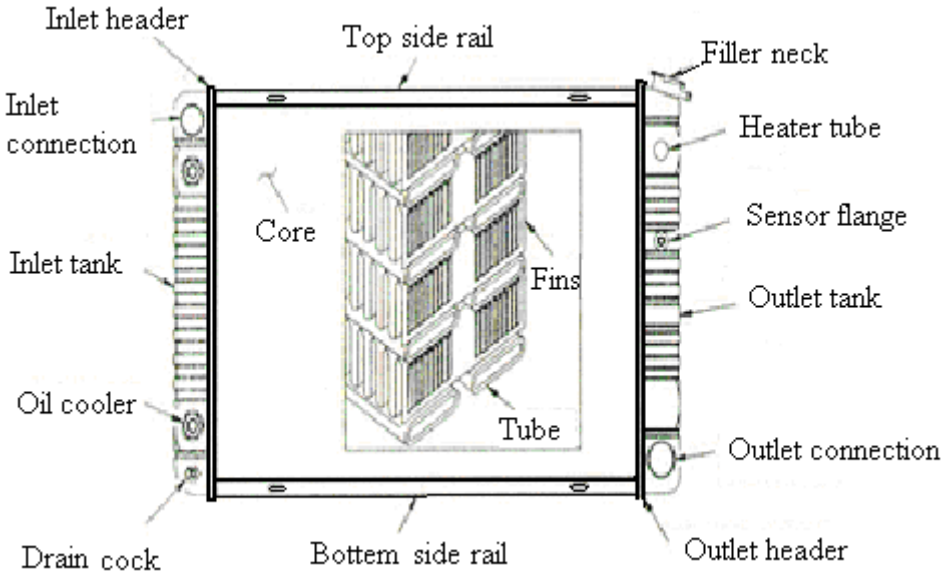
FMEA PROCESS





Radiator assembly

The engine produces a tremendous amount of heat when in operation. The vehicle is equipped with a cooling system to prevent vehicle from becoming too hot. Radiator is a device normally required to remove heat from an internal combustion engine as shown in the Figure 2.1. For most applications, the power required to turn the fan that moves air through the radiator has been obtained through some mechanical, hydraulic or belt driven connection to the engine crank shaft. A radiator includes an intake tank, a core made-up of a plurality of finned tubes, and an exit tank connected by hoses. The radiator may be filled with a coolant to radiate superfluous heat from the engine into the air by means of conduction and convection. Fan which may be powered by the vehicle engine or electrically powered; propel ambient air nearer the surface of the road through the radiator core to accelerate the cooling process.



1 Severity guideline for FMEA (1-10 qualitative scale)

Effect	**Rank**	**Criteria**	**Resolution**
No	1	No effect.	If the numerical value falls between two numbers always select the higher number. If the team has a disagreement in the ranking value the following may help. 1. If the disagreement is an adjacent category, average out the difference. For example, if one member says 5 and someone else says 6, the ranking in this case should be 6 (5 and 6 are adjacent categories. Therefore 5 + 6 = 11, 11/2 = 5.5) 2. If the disagreement jumps one category, then consensus must be reached. Even with one person holding out total consensus must be reached. No average, no majority. Everyone in that team must have ownership of the ranking. They may not.
Very slight	2	Customer not annoyed. Very slight effect on product or system performance.	
Slight	3	Customer slightly annoyed. Slight effect on product or system performance.	
Minor	4	Customer experiences minor nuisance. Minor effect on product or system performance.	
Moderate	5	Customer experiences some dissatisfaction. Moderate effect on product or system performance.	

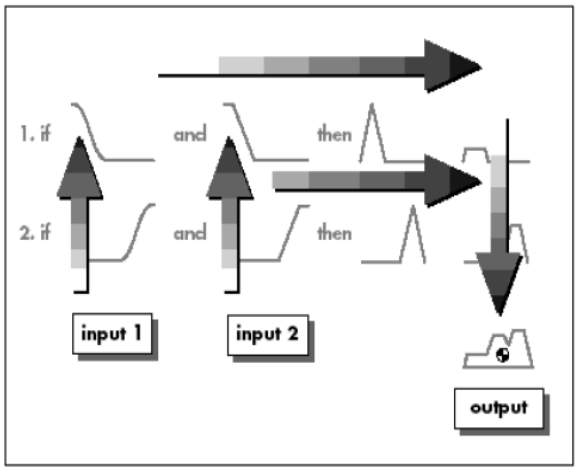
LIMITATIONS OF CONVENTIONAL FMEA

- RPN evaluation does not fulfill the usual measurement requirements.
- There is no precise algebraic rule to assign a score to the frequency index "O" and detection index "D", as traditional scoring based on the probability of occurrence of failures and the probabilities of non-detection.
- Different scores for the "O", "D" and "S" indexes could give the same RPN result, yet the risk involved would be completely different.

The RPN does not cater for a possible weighting of the importance of "D", "O" and "S" indexes.

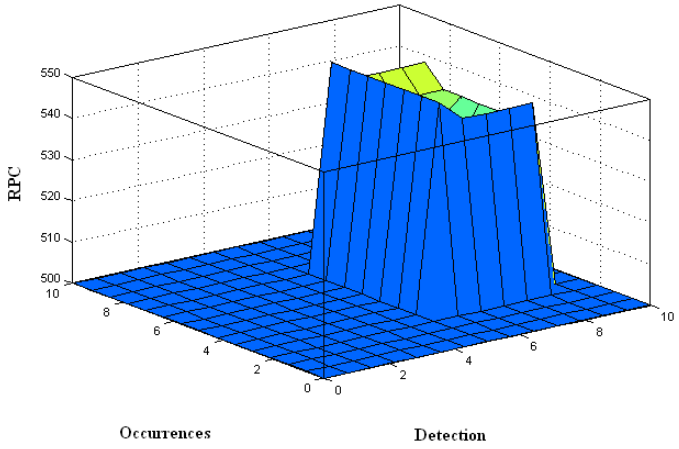
Defuzzification

The input for the defuzzification process is a fuzzy set (the aggregate output fuzzy set) and the output is a single number. As much as fuzziness helps the rule evaluation during the intermediate steps, the final desired output for each variable is generally a single number. However, the aggregate of a fuzzy set encompasses a range of output values, and so must be defuzzified in order to resolve a single output value from the set. Perhaps the most popular defuzzification method is the centroid calculation, which returns the center of area under the curve. There are five built-in methods supported: centroid, bisector, middle of maximum (the average of the maximum value of the output set), largest of maximum, and smallest of maximum.



Fuzzy Control surface

The fuzzycontroller performs a mapping of inputs severity, occurrence and detection to the output FRPN through the linguistic If-then rules adopted in this study is represented using a control surface plots. The plots help to examine the consistency of the rules framed in fuzzy inference system (FIS). The surface displays the dependency of the output as a function of the inputs that is; it illustrates the entire span of the output set based on the entire span of the input(s) set. These three-dimensional plots represent very well a two-input and one-output system. Since in the radiator assembly study three inputs, i.e. severity (S), occurrence(S) and detection (D) are used. The surface plot can be represented with a group of surfaces keeping one of the input variables stable.



CONCLUSION

Fuzzy logic based decision supporting system is one of the method by which few drawbacks of conventional FMEA can be rectified.From the literature, it has been found that few researchers [Pillay and Wang (2003), Guimaraes and Lapa (2004), Zafiropoulos and Dialynas (2005)] have used fuzzy logic system to overcome the drawbacks of traditional FMEA.

REFERENCES

1. Arunachalam.V.P and Jegadheesan.C., (2006), Modified Failure Mode and Effect Analysis: A reliabilitu and cost based approach, The ICFAI Journal of Operation and Management, Vol. V, No.1, 7-20.

2. Ben-Daya.M and Raouf.A., (1996), A revised failure mode and effects analysis model, International journal of Quality and Reliability Management, 13, No.1, 43-47.

3.Breiing.A.J and Kunz.A.M., (2002), Critical consideration and improvement of the FMEA, Proceedings of the TMCE 2002**,** 519-530.

4. Chang.C-L, Liu.P-H and Wei.L-C., (2001), "Failure mode and effects analysis using grey theory", Integrated Manufacturing systems, Vol.12, No.3, PP.211-216.

5.Devadasan.S.R, Muthu.S, Neil Samson.R and Sankaran.R.A., (2003), Design of total failure mode and effects analysis programme, International Journal of Quality and Reliability Management, Vol. 20, No 5, 551–568.