

Need for reliability assessment of parent product before redesigning a new product

As companies increasingly invest on the development of new products, and in the redesigning of existing ones in order to meet the ever emerging and rapidly changing customer demands, they continue to face an extremely competitive and cost-cutting war. Since today's product design works are mainly focused on the redesigning of existing products, most especially for complex products and systems, their properties are expected to be of higher technical content, reliability requirements as well as design characteristics¹.

Redesigning of existing products which has become one of the most critical topics in the development of new products, is aimed at the creation of products that meet both the customer requirements as well as the product reliability index by adjusting, replacing or making changes to the existing predecessor designs until all the new requirements are met. To improve product reliability and quality during the product redesigning phase, and to create novel product(s) for the customers, deliberate efforts must be made to identify and analyse the fail-

ure information of the existing or parent product, and the result converted into appropriate design knowledge. Identification of the failed product component is most critical to achieve improved product quality and reliability².

Failure mode and effect analysis (FMEA) is the method most commonly used for identifying and analysing failures. This was introduced by the United States aerospace industry as a structured and systematic method with apparent reliability and safety requirements³. It has proven to be a popular engineering

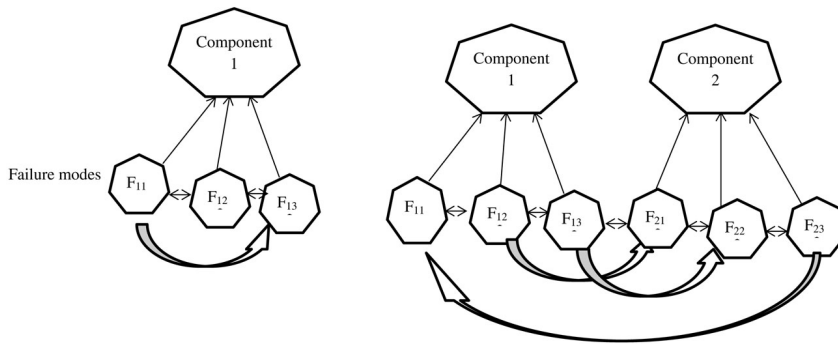


Figure 1. Internal failure causality relationships and external failure causality relationships (interaction between the failure modes).

technique for identifying, ranking and evaluating potential failures in new and existing products as well as in the improvement of product quality.

However, the FMEA method is limited when it comes to quantifying the failure causality relationships (FCRs) of the product components. Hence, applying the FMEA method in failure identification will produce incomplete analysis result of design risk for making a design decision, since one failure mode may exacerbate or result in another failure mode. Extensive literature of the failure analysis of parent product during redesigning of new product^{4,5}, shows that although the design risk of each failure mode of the product has been studied, no work has considered quantifying the FCRs of

the product. Also, although some authors^{6,7} have developed failure causality tools for machine maintenance, these tools were merely used for quantifying the internal failure causality relationships (IFCRs) within the components, without considering the external failure causality relationships (EFCRs) between components. Figure 1 shows the causality relationship (interaction of failure modes) of product components.

Thus, to build adequate design knowledge for the to-be-improved or redesigned product, the historical failure information of the parent or similar product should properly be analysed and the result converted into appropriate design knowledge. This can be achieved by simultaneous consideration of the root

cause of failure, IFCR and EFCR between product components.

1. Kwapień, J. and Drożdż, S., *Phys. Rep.*, 2012, **515**(3–4), 115–226; doi:10.1016/j.physrep.2012.01.007.
2. He, Y.-H., Wang, L.-B., He, Z.-Z. and Xie, M., *Eng. Appl. Artif. Intell.*, 2015, **47**, 1–13; doi:10.1016/j.engappai.2015.06.002.
3. Bowles, J. B. and Pelaez, C. E., *Reliab. Eng. Syst. Saf.*, 1995, **50**(2), 203–213; doi:10.1016/0951-8320(95)00068-D.
4. Zhao, H., You, J.-X. and Liu, H.-C., *Soft Comput.*, 2016; doi:10.1007/s00500-016-2118-x.
5. Vahdani, B., Salimi, M. and Charkhchian, M., *Int. J. Adv. Manuf. Technol.*, 2015, **77**(1–4), 357–368; doi:10.1007/s00170-014-6466-3.
6. Venkata Rao, R. and Gandhi, O. P., *Int. J. Mach. Tools Manuf.*, 2002, **42**(4), 521–528; doi:10.1016/S0890-6955(01)00135-3.
7. Jangra, K., Grover, S., Chan, F. T. S. and Aggarwal, A., *Int. J. Adv. Manuf. Technol.*, 2011, **56**(9–12), 959–974; doi:10.1007/s00170-011-3234-5.

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