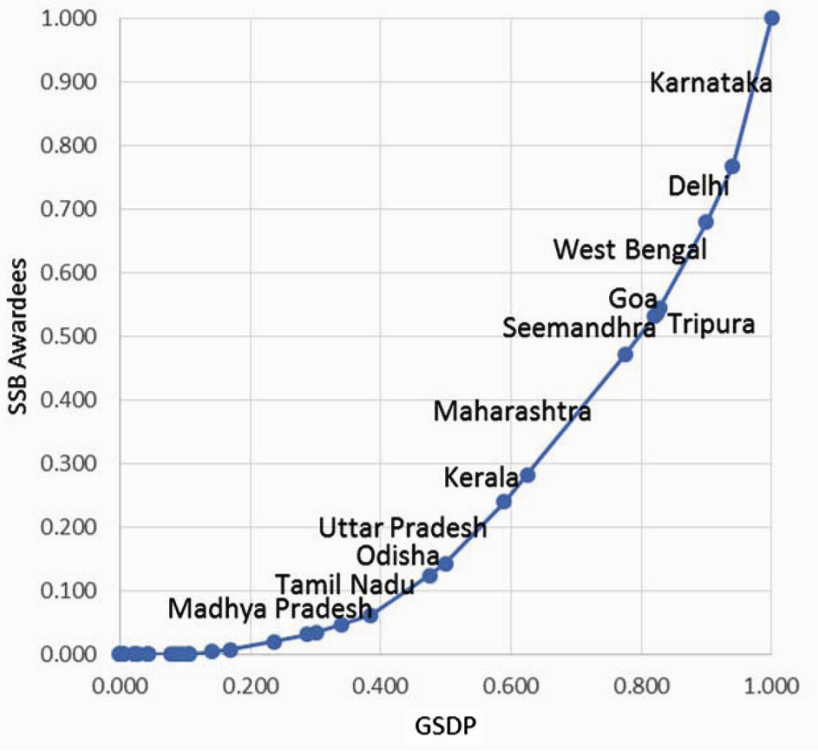

Figure 1. State-wise dispersion pattern across India during 1992–2016 shown using a cumulative Lorenz curve.

Awardees during the period 1992–2016. On a GSDP basis, it was West Bengal which headed the table in the 1958–1991 phase, while Tamil Nadu was prominent on a per capita basis[2]. As many as 18 States and Union Territories drew a blank during the period 1992–2016, while there were only 14 such states in the earlier 1958–1991 phase. Five states which found a place in the earlier phase are no longer represented. Some of the 'big' states, e.g. Haryana, Chhattisgarh and Jharkhand, are missing in the current phase. We see a growing concentration of awards in Karnataka (from 27 to 60) and Maharashtra (from 24 to 49). Tamil Nadu (from 37 to 16) and Uttar Pradesh (33 to 25) show significant decline in their share over these two phases. It is clear that a crucial role is played by the location of premier institutes in certain states – for example, the Indian Institute of Science, Bengaluru, Karnataka may top the list of institutes that have Awardees and thus Karnataka is on the top of the list.

Figure 1 shows graphically the state-wise dispersion pattern across India during the 1992–2016 phase using a cumulative Lorenz curve. It is important to note that underlying these patterns is the presence or absence of premier research institutions and universities in the States and Union Territories. A better dispersion of such units of assessment is needed.

1. *Bhatnagar Laureates (1958–91)*, Publications and Information Directorate, CSIR, New Delhi, 1992.
2. Prathap, G., *Curr. Sci.*, 1993, **65**(7), 575–576.
3. https://en.wikipedia.org/wiki/List_of_Shanti_Swarup_Bhatnagar_Prize_recipients
4. https://en.wikipedia.org/wiki/List_of_Indian_states_and_union_territories_by_GDP

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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 characteristics[1].

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 failure 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 reliability[2].

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 requirements[3]. It has proven to be a popular engineering

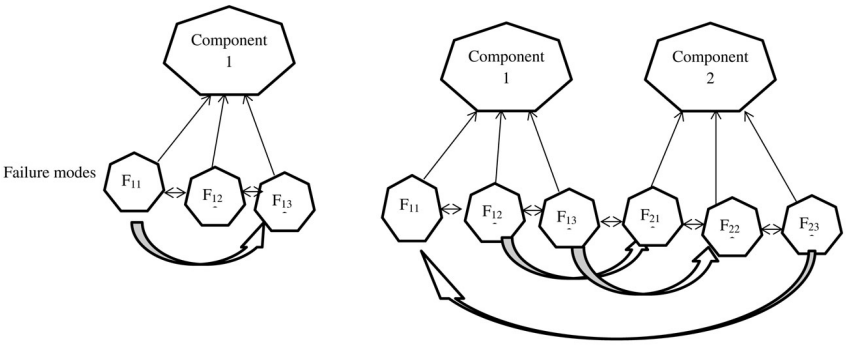

Figure 1. Internal failure causality relationships and external failure causality relationships (interaction between the failure modes).

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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Is the herbicide glyphosate really safe?

Glyphosate [*N*-(phosphonomethyl) glycine] is one of the most commonly used and largest selling herbicide worldwide. It is a non-selective (broad-spectrum), systemic and effective herbicide. Glyphosate was first registered by an US-based corporation in 1974. Since its introduction, the use of glyphosate has increased rapidly. Sharp rise in its use was also noticed with the introduction of genetically modified (GM) glyphosate-tolerant crops. It is registered for use in more than 130 countries. It controls annual and perennial weeds in various crops, orchards, plantations, pastures, lawns, gardens, forestry, roadsides and aquatic weeds. Glyphosate is rapidly translocated throughout the plant. The movement is mainly basipetal. It shows mobility through phloem, although mobility in xylem has also been reported. It tends to accumulate in plant regions with actively dividing cells. Glyphosate is soluble in water (12.0 g/litre). It inhibits the biosynthesis of aromatic amino acids, i.e. L-phenylalanine, L-tryptophan and L-tyrosine by inhibiting the shikimic acid pathway. This is done by competitively blocking the enzyme 5-enolpyruvylshikimate 3-phosphate synthase (EPSPS, E.C. 2.5.1.19), a key enzyme of the shikimic acid pathway. EPSPS is required in plants for synthesis of aromatic amino acids (L-tryptophan, L-phenylalanine and L-tyrosine) and other compounds, including vitamins, plant growth substance and lignin. These aromatic amino acids, besides being used for the synthesis of proteins, are also utilized as precursors of numerous natural products, such as pigments, alkaloids, hormones and cell-wall components in plants. Therefore inhibition of EPSPS (by glyphosate) can affect a number of physiological processes. Aspects like disease susceptibility and sprout suppression are also influenced by glyphosate treatment to the crop, depending on concentration and stage of growth[1]. Non-selective and systemic nature of this herbicide results in its residue in food and feed. Presently, maximum residue limit (MRL) for glyphosate ranges from 0.1 to 20 mg kg^{-1} (= 0.1 to 20 ppm) in different pulses, oil