Industry 4.0 – A challenge for variation simulation tools for mechanical assemblies

Variation Analysis (VA) is used to simulate final product variation, taking into consideration part manufacturing and assembly variations. In VA, all the manufacturing and assembly processes are defined at the product design stage. Process Capability Data Bases (PCDB) provide information about measured variation from previous products and processes and allow the designer to apply this to the new product. A new challenge to this traditional approach is posed by the Industry 4.0 (I4.0) revolution, where Smart Manufacturing (SM) is applied. The manufacturing intelligence and adaptability characteristics of SM make present PCDBs obsolete. Current tolerance analysis methods, which are made for discrete assembly products, are also challenged. This paper discusses the differences expected in future factories relevant to VA, and the approaches required to meet this challenge. Current processes are mapped using I4.0 philosophy and gaps are analysed for potential approaches for tolerance analysis tools. Matching points of simulation capability and I4.0 intents are identified as opportunities. Applying conditional variations, incorporating levels of adjustability, and the unsuitability of present Monte Carlo simulation due to changed mass production characteristics, are considered as major challenges. Opportunities including predicting residual stresses in the final product and linking them to product deterioration, calculating non-dimensional performances and extending simulations for process manufactured products, such as drugs, food products etc. are additional winning aspects for next generation VA tools.

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