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A Gauge Repeatability and Reproducibility Study for Multivariate Measurement Systems

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Abstract : Measurement system analysis (MSA) plays an important role in helping organizations to improve their product quality. Generally speaking, the gauge repeatability and reproducibility (GRR) study is performed according to the MSA handbook stated in QS9000 standards. Usually, GRR study for assessing the adequacy of gauge variation needs to be conducted prior to the process capability analysis. Traditional MSA only considers a single quality characteristic. With the advent of modern technology, industrial products have become very sophisticated with more than one quality characteristic. Thus, it becomes necessary to perform multivariate GRR analysis for a measurement system when collecting data with multiple responses. In this paper, we take the correlation coefficients among tolerances into account to revise the multivariate precision-to-tolerance (P/T) ratio as proposed by Majeske (2008). We then compare the performance of our revised P/T ratio with that of the existing ratios. The simulation results show that our revised P/T ratio outperforms others in terms of robustness and proximity to the actual value. Moreover, the optimal allocation of several parameters such as the number of quality characteristics (v), sample size of parts (p), number of operators (o) and replicate measurements (r) is discussed using the confidence interval of the revised P/T ratio. Finally, a standard operating procedure (S.O.P.) to perform the GRR study for multivariate measurement systems is proposed based on the research results. Hopefully, it can be served as a useful reference for quality practitioners when conducting such study in industries. Measurement system analysis (MSA) plays an important role in helping organizations to improve their product quality. Generally speaking, the gauge repeatability and reproducibility (GRR) study is performed according to the MSA handbook stated in QS9000 standards. Usually, GRR study for assessing the adequacy of gauge variation needs to be conducted prior to the process capability analysis. Traditional MSA only considers a single quality characteristic. With the advent of modern technology, industrial products have become very sophisticated with more than one quality characteristic. Thus, it becomes necessary to perform multivariate GRR analysis for a measurement system when collecting data with multiple responses. In this paper, we take the correlation coefficients among tolerances into account to revise the multivariate precision-to-tolerance (P/T) ratio as proposed by Majeske (2008). We then compare the performance of our revised P/T ratio with that of the existing ratios. The simulation results show that our revised P/T ratio outperforms others in terms of robustness and proximity to the actual value. Moreover, the optimal allocation of several parameters such as the number of quality characteristics (v), sample size of parts (p), number of operators (o) and replicate measurements (r) is discussed using the confidence interval of the revised P/T ratio. Finally, a standard operating procedure (S.O.P.) to perform the GRR study for multivariate measurement systems is proposed based on the research results. Hopefully, it can be served as a useful reference for quality practitioners when conducting such study in industries.

Keywords : gauge repeatability and reproducibility, multivariate measurement system analysis, precision-to-tolerance ratio, Gauge repeatability
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