Analysis on Accuracy of Bias, Linearity and Stability of Measurement System in Ballscrew Processes by Simulation

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ABSTRACT
To consistently produce high quality products, a quality management system, such as the ISO9001, 2000 or TS 16949 must be practically implemented. One core instrument of the TS16949 MSA (Measurement System Analysis) is to rank the capability of a measurement system and ensure the quality characteristics of the product would likely be transformed through the whole manufacturing process. It is important to reduce the risk of Type I errors (acceptable goods are misjudged as defective parts) and Type II errors (defective parts are misjudged as good parts). An ideal measuring system would have the statistical characteristic of zero error, but such a system could hardly exist. Hence, to maintain better control of the variance that might occur in the manufacturing process, MSA is necessary for better quality control. Ball screws, which are a key component in precision machines, have significant attributes with respect to positioning and transmitting. Failures of lead accuracy and axial-gap of a ball screw can cause negative and expensive effects in machine positioning accuracy. Consequently, a functional measurement system can incur great savings by detecting Type I and Type II errors. If the measurement system fails with respect to specification of the product, it will likely misjudge Type I and Type II errors. Inspectors normally follow the MSA regulations for accuracy measurement, but the choice of measuring system does not merely depend on some simple indices. In this paper, we examine the stability of a measuring system by using a Monte Carlo simulation to establish bias, linearity variance of the normal distribution, and the probability density function. Further, we forecast the possible area distribution in the real case. After the simulation, the measurement capability will be improved, which helps the user classify the measurement system and establish measurement regulations for better performance and monitoring of the precision of the ball screw.

Keywords: measurement system analysis; Monte Carlo simulation; bias; linearity; stability

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