Statistical Engineering Division Seminar

Tuesday, November 7, 1995, 11:00 a.m.
Room B111, Technology Building
NIST
Gaithersburg, MD

Utilizing a Statistical Method in Measurement Uncertainty Estimation for the Rockwell Hardness Test

Masayoshi Koike

National Research Laboratory of Metrology

The ISO guide for the expression of measurement uncertainty was published in 1993 and is widely utilized in the measurement community. In this guide, estimations of uncertainty are categorized in two types, type A and type B. Statistical methods are used for estimating the type A component, but the statistical methods used in the guide and its examples are rather simple ones. We applied the tolerance design method that is part of Taguchi Methods. We used an orthogonal array to estimate the uncertainty components and thereby evaluated the uncertainty of Rockwell hardness standard blocks. In the estimation of measurement uncertainty, estimations of standard uncertainty of input quantities and their partial derivatives (sensitivity coefficients) are essential for determining the combined standard uncertainty. When the mathematical model for measured value is clear, the method can be applied straight forward. However, in the case when the relationship between the measurand Y and the input quantities X_i is not mathematically expressed, the sensitivity coefficients should be determined experimentally. We determined them using an experimental design method called "tolerance design". Rockwell hardness is defined by the indentation depth under a certain test condition. Theoretically, the hardness can be determined when the test condition is satisfied. However, there are some imperfections in actualization of the test condition and a tester. Sources of error are categorized in three parts; imperfections of tester, measurement conditions, and blocks. In the tolerance design experiment, we picked six factors as error sources: reference load, test load, indenter's form, holding time, blocks and the placement. We assigned them in an orthogonal array for reducing the number of runs in the experiment. Three sensitivity coefficients for reference load, test load and holding time and the variability of other factors were determined in an experiment with only 18 runs. We emphasize the utilization of statistical methods such as tolerance design in the estimation of measurement uncertainty.

Masayoshi Koike heads the Instrumentation Mathematics Section of the Measurement System Department at the National Research Laboratory of Metrology, Tsukuba, Japan. He was a guest researcher at NIST during 1983 and 1984. He is a graduate of the University of Tokyo.

[NIST contact: Walter Liggett, 301-975-2851]