Considering the Prediction Variance in the Dual Response Approach to Robust Parameter Design.

Guillermo Miró-Quesada and Enrique del Castillo

ABSTRACT

The prediction properties of models used in the dual response approach to robust parameter design are studied and two procedures that improve the performance of the approach are proposed. The first procedure scales the noise variables appropriately to reduce the expected mean squared error of the variance model, based on the intuition that the range of the noise variables used in the experimental design should contain most of their distribution. The second procedure combines the variance due to the noise factors with the variance due to the prediction error of the fitted model (i.e., it looks at the variance of the predictions), thus considering all sources of variability present in the problem. An unbiased estimator of this combined variance is developed. Two examples are given for each procedure. The second proposed method is compared with the dual response approach recommended in the literature by means of the prediction intervals of the responses, as recently discussed by Myers et al. (1997). It is found in the examples that the new procedure gives narrower intervals (50\% and 12\% percent smaller) where the degree of improvement depends, as expected, on the goodness of fit of the response surface model. The resulting solutions thus obtained are robust to both noise factor {\em and} parameter estimation uncertainty. Negative variance values, possible in the usual dual response approach in the literature, are avoided in the new formulation.