Mis-specification Analysis of Linear Degradation Models

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Abstract

Nowadays, degradation models are widely used to assess the lifetime information of highly reliable products if there exists quality characteristics (QC) whose degradation over time can be related to reliability. The performance of a degradation model, obviously, depends strongly on the appropriateness of the modeling of a product's degradation path. In this paper, motivated by a laser data, we propose a general linear degradation path in which the unit-to-unit variation of all test units and the time-dependent structure in degradation paths can be considered simultaneously. Based on the proposed degradation model, we first derive an implicit expression of a product's lifetime distribution and its corresponding mean-time-to-failure (MTTF). By using the profile likelihood approach, MLEs of parameters, a product's MTTF, and their confidence intervals can be obtained easily. In addition, a laser degradation data is used to illustrate the proposed procedure. Furthermore, we also address the effects of model mis-specification on the prediction of the product's MTTF. It shows that the effect of the model mis-specification on the predictions of a product's MTTF is not critical under the case of large samples. However, when the sample size and the termination time are not large enough, a simulation study shows that these effects are not negligible.