Topics on Reliability Prediction Based on Different Types of Accelerated Testing Data

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Abstract: As modern products are made more and more reliable, product developers are faced with a big challenge of evaluating the reliability of such highly reliable products. Accelerated life testing (ALT) is a powerful tool for speeding up the development process. In this talk, a couple of new methods for modeling ALT data are introduced. In addition, as technology advances, engineers are able to use multiple sensors to monitor a system's physical characteristics or performance measures for health assessment. The sensor measurements or the data after signal processing can be modeled as degradation processes, and the system is failed when at least one of the degradation processes reaches its pre-determined threshold. In practice, it is quite common that the degradation processes are not independent and their parameters are unit-specific and often correlated due to the system's specific frailties. In the literature, copulas have been used to model multivariate degradation data, but these models are unable to identify the inherent mechanism of process correlation. Motivated by a tuner's accelerated degradation test (ADT), we propose a multivariate Wiener process model for analyzing multivariate degradation data involving random effects and process dependency. We develop a parameterized expectation-maximization algorithm for parameter estimation, establish large sample consistency of the estimators, and propose a two-stage goodness-of-fit test procedure for model selection. A comprehensive simulation study and a case study on the tuner's ADT data are presented to illustrate the capability of the proposed model and statistical methods. By making use of the proposed methods, the random effects and the inherent process dependency can be clearly identified for accurate reliability prediction.

Bio: Dr. Haitao Liao is a Professor, and John and Mary Lib White Endowed Systems Integration Chair in the Department of Industrial Engineering at University of Arkansas – Fayetteville. He received a Ph.D. degree in Industrial and Systems Engineering from Rutgers University in 2004. He also earned M.S. degrees in Industrial Engineering and Statistics from Rutgers University, and a B.S. degree in Electrical Engineering from Beijing Institute of Technology. His research interests include: (1) reliability models, (2) maintenance and service logistics, (3) prognostics, (4) probabilistic risk assessment, and (5) data analytics. His research has been sponsored by the U.S. National Science Foundation, Department of Energy, Nuclear Regulatory Commission, Oak Ridge National Laboratory, and industry. The research findings of his group have been published in *IISE Transactions*, *European Journal of Operational Research*, *Naval Research Logistics*, *IEEE Transactions on Reliability*, *IEEE Transactions on Cybernetics*, *The Engineering Economist*, *Reliability Engineering & System Safety*, etc. In 2014, he served as Chair of INFORMS Quality, Statistics and Reliability (QSR) Section, and President of IISE Quality Control and Reliability Engineering (QCRE) Division. He currently serves as an Associate Editor for *IISE Transactions on Quality and Reliability Engineering*. He received the U.S. National Science Foundation CAREER Award in 2010, a number of best paper awards, and the prestigious Alan O. Plait Award for Tutorial Excellence in 2018.