

Modeling Strategies for Failure Amplification Method

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Abstract

Designed experiments are widely used for reducing failure or defect rate in manufacturing processes. When the probability of failures is small, it can happen that very few failures occur in the experiment. With such an outcome, it is difficult or even impossible to build an adequate model and obtain optimum process settings. To overcome this difficulty, Joseph and Wu (2004) proposed a novel experimentation strategy known as failure amplification method (FAMe). In FAMe, an amplification factor is selected based on the physical knowledge of the process and is used to amplify the failures. The experiment is then performed at the amplified conditions to ensure that an adequate number of failures are observed, which will provide sufficient information for modeling, analysis, and optimization.

In this article we propose new modeling strategies and provide a general framework for the analysis of experiments using FAMe. Since the experiment is performed at the amplified conditions, we need to extrapolate to the normal conditions for optimization. Because of this, carefully selected models should be used for the analysis. The performance of these models at the tails, i.e., regions with low failure rate, is critical for obtaining accurate results during extrapolation. Generalized linear models (GLMs) are suitable for the analysis of failure data (see McCullagh and Nelder (1989), Hamada and Nelder (1997)). Our proposed strategies build appropriate nonlinear models but avoid the complexity of using generalized nonlinear models by utilizing the availability of GLMs in standard software. It is illustrated with the analysis of two real experiments on printed circuit boards.