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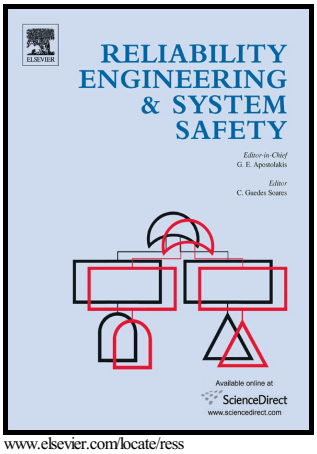

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Development of a Bayesian multi-state degradation model for up-to-date reliability estimations of working industrial components

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Abstract

We consider a three-state continuous-time semi-Markov process with Weibull-distributed transition times to model the degradation mechanism of an industrial equipment. To build this model, an original combination of techniques is proposed for building a semi-Markov degradation model based on expert knowledge and few field data within the Bayesian statistical framework. The issues addressed are: i) the prior elicitation of the model parameters values from experts, avoiding possible information commitment; ii) the development of a Markov-Chain Monte Carlo algorithm for sampling from the posterior distribution; iii) the posterior inference of the model parameters values and, on this basis, the estimation of the time-dependent state probabilities and the prediction of the equipment remaining useful life. The developed Bayesian model offers the possibility of updating the system reliability estimation every time a new evidence is gathered. The application of the modeling framework is illustrated by way of a real industrial case study concerning the degradation of diaphragms installed in a production line of a biopharmaceutical industry.

Keywords: Multi-state degradation modelling, Weibull distribution, Remaining useful life, Maintenance, Bayesian inference, MCMC algorithms

Acronyms

A-MCMC: Adaptive MCMC algorithm

CDF: Cumulative Distribution Function

EPDM: Ethylene Propylene Diene Monomer

i.i.d: independent and identically distributed

MCMC: Markov Chain Monte Carlo