Estimation of the lifetime distribution of mechatronic systems in the presence of covariates: A comparison of parametric, semiparametric and nonparametric models.

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Currently, for a variety of mechatronic systems and components, sufficient failure behaviour data are not available. Endurance tests at customer-specific operating conditions provide manufacturers with specific failure time data. However, they are time-consuming and expensive. Findings gained through experiments are valid only for the applied test conditions and loads. Often, modified components using the same technology basis are applied with other load profiles. One can try to derive sufficiently precise predictions for newly developed components or new application environments from a variety of existing data sets from endurance tests of similar components and other load cases.

In an exemplary manner three regression models were considered, i.e. a parametric, a semiparametric and a non-parametric approach. First, the parameter of the Weibull-distribution were modelled as linear functions of the covariates. Second, the well-known regression models of the survival analysis, the Cox proportional hazards model, was applied. Finally, a kernel estimator was used to interpolate between empirical distribution functions.

After introducing three models, we need to decide which model fits the data best. We propose a goodness of fit measure (GoF), which can be applied to all three types of regression models. Using this GoF measure we discuss a model selection procedure.

To illustrate this method of reliability prediction, the three classes of regression models are applied to real test data of motor experiments. Further the performance of the approaches is investigated by Monte Carlo simulations.