Maintenance policies for heterogeneous multi-component systems with stochastic dependence

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In the last few years, since manufacturing and service systems become more and more complex and consist in many inter-dependent equipments, the maintenance and decision making models designed for single component systems are no longer capable of representing the complexity of real situations. Therefore, maintenance modeling for multi-component systems with dependence between components receives increasing attention from researchers as well as industrial practitioners. A literature review on maintenance modeling for multi-component systems considering three types of dependence (economic, stochastic and structural dependence) between components is given in [8]. Among these types of dependence, stochastic dependence is identified as of particular importance in modern technical systems.

Existing deterioration models taking into account stochastic dependence between components are based on either continuous degradation process (see [11], [6], [3], [10]) or lifetime distributions (see [2], [5], [7], [9]) are used. Nevertheless, technical systems are often made of non-similar components which play different roles and thus, are not subject to the same type of failure. In such a situation, it is more realistic to combine e.g. degradation processes and lifetime distributions to describe the health condition of different components within the system. Although this combination may be useful to model various deteriorating systems in practice, it is not exploited in the literature.

The objective of this work is to address the problem of maintenance modeling of multi-component systems composed of a gradually deteriorating component and a set of components subject to sudden failures e.g. due to shocks. Stochastic dependences between components are considered. The dependence between components is modeled by assuming that the lifetime parameters of the component subject to sudden failures are influenced by the gradually deteriorating component in such a way that the components subject to shocks operate in two different modes: a normal and a stressed mode. Moreover when the set of components subject to shocks suffers a given number of failures a sudden random increment occurs for the gradually deteriorating component. Maintenance policies taking account of the available information about the components subject to shocks to adapt the monitoring of the gradually deteriorating component as well as the replacement period when the stressed mode is observed are proposed. A performance analysis is made using a long-run expected cost per unit of time. Monte Carlo simulation technique, which is widely used when treating complex maintenance systems (see [1]), is implemented to evaluate and optimize the proposed maintenance strategies. The advantages and weaknesses of the considered policies are discussed.

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