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Condition-based maintenance and age replacement in a system with two stochastically dependent components

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SUMMARY

The failure of some components in complex systems may affect the state of the rest this stochastic dependence should be considered when designing a maintenance model. In this paper we present a model for inspection and maintenance of a system with two components stochastically dependent. Component 1 may be in one of two states, good and failed. Component 2 can present one of three states: good, defective and failed. Thus, the time to failure of component 2 is modeled in two stages, from good to defective and from defective to failure (delay time, Christer [1]). Failures of component 1 and defective states of component 2 are unrevealed, that is, they are detected by inspection. Failures of component 2 can be considered as hard failures in the sense that the full system with the two components has to be replaced and a high cost is derived. In addition they are revealed at the very moment they take place. Aiming at detecting failures of component 1, it is inspected every T units of time. We propose a condition-based inspection for component 2 since component 2 is only inspected in case that component 1 is found to be failed. If it is in the defective state, the full system is replaced by a new one. If not, then only component 1 is replaced and the systems keeps on functioning until the following inspection, hard failure or preventive maintenance after M inspections, at MT, whichever comes first. We assume that failures of component 1 may affect the reliability of component 2. Thus, the baseline hazard rate $\lambda_0(t)$, corresponding to the delay-time in component 2, changes to $\lambda_1(t)$, with $\lambda_0(t) < \lambda_1(t)$, in case that component 1 fails while component 2 is defective. Hence, the stochastic dependence implies that component 1 degrades faster as a result of failures in component 1. The model leads to a cost function with two decision variables: the inspection interval, T, and the maximum number of inspections, M, before renewal. In order to check the advantages of this model for practical purposes, the optimum policy, $T^\star$ and $M^\star$, minimizing the cost function is compared with that derived from a model without age replacement ($M = \infty$).

Keywords: age replacement, condition-based maintenance, stochastic dependence

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