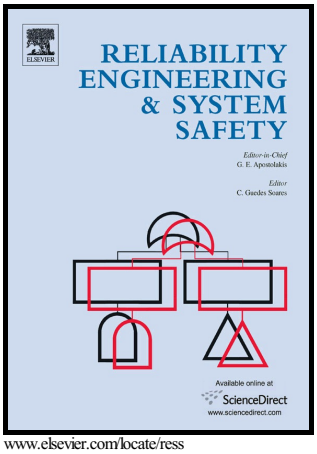

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Multi-Objective Redundancy Allocation Problem for a System with Repairable Components Considering Instantaneous Availability and Strategy Selection

Farjam Kayedpour[a,*], Maghsoud Amiri[a], Mahmoud Rafizadeh[a], Arash Shahryai nia[a]

[a]*Department of Industrial Management, Management and Accounting Faculty, Allameh Tabatabai University, Tehran, Iran*

Abstract

Many Studies have been conducted on Redundancy Allocation Problem (RAP), but only a few of them have considered designing systems which operate for a certain period of time. Such temporary systems are not meant to operate for a long period of time (e.g. a manufacturing cell designed to produce a unique product with a small window of opportunity). Due to this fact, the investigation of the reliability at an infinite time will not be helpful; instead designing a system which perform optimally in a short period of time is of importance. additionally RAP's are inherently complex and classified as NP-Hard, as a result most proposed approaches, consider a set of simplified assumptions. Among these assumptions are the calculation of availability in the steady state (a time in which a system becomes completely stable), the use of non-repairable components, and setting predetermined configuration strategy (parallel, cold or warm standby subsystems). Unfortunately, these simplified assumptions do not conform to the real world conditions. Therefore, this article intends to develop an integrated algorithm to solve the reliability design problem considering instantaneous availability, repairable components, and the selection of configuration strategies based on the Markov processes and NSGA-II algorithm.

Keywords: Redundamcy Allocation Problem, Instantaneous Availability, Warm Standby, Repairable Components, Markov Process, NSGA-II

1. Introduction

Reliability and availability concepts are correlated in designing the reliable systems. Although reliability is a fundamental attribute, availability is more meaningful regarding the repairable systems since it contains both reliability and maintainability (Chiang and Chen, 2007).

The word *repairable* refers to a system that can be repaired in case of failure to operate normally. In order to have a highly reliable system, it is better to have more than one component in parallel with different subsystems working in series to ensure that the system would not fail due to a component failure. However, increasing the number of components has some consequences like increasing the cost, weight, volume etc (Kuo, 2001).Hence, system designers normally work on number of redundant components and structure of the system to minimize the system costs while satisfying the system availability constraints.

A well-known type of reliability optimization problems is called Redundancy Allocation Problem (RAP) in which the system is consisted of series-connected sub-systems, as shown in Fig.1. In each sub-system an optimal level of redundancy must be determined to satisfy all of the design relevant constraints (Chern, 1992). The RAP has been investigated in various system configuration such as parallel (active)(Fyffe et al., 1968; Soylu and Kapan Ulusoy, 2011; Elegbede and Adjallah, 2003; Chen and You, 2005; Yalaoui et al.,

*Corresponding author

Email addresses: Kayedpour921@atu.ac.ir (Farjam Kayedpour), Amiri@atu.ac.ir (Maghsoud Amiri), Rafizadeh921@atu.ac.ir (Mahmoud Rafizadeh), Shahryarinia921@atu.ac.ir (Arash Shahryai nia)