

International Conference
on Industrial Engineering and Systems Management
IESM 2009
May 13-15
MONTRÉAL - CANADA

Reliability Optimization of Series-Parallel Multi-State Systems Using Heuristic Search^{*}

Mohamed OUZINEB^a, Mustapha NOURELFATH^b,
Michel GENDREAU^a

^a*CIRRELT, Université de Montréal, Département d'informatique et de recherche opérationnelle Montréal (Qc.),
Canada*

^b*CIRRELT, Université Laval, Département de génie mécanique Québec (Qc.), Canada*

Abstract

This paper proposes an efficient heuristic to solve the redundancy allocation problem (RAP) of series-parallel multi-state systems (MSS). The objective is to determine the minimal-cost series-parallel system structure subject to the reliability constraints. The proposed heuristic method gives a new way to solve a difficult large-scale of RAP of non-homogenous series-parallel MSS where different elements can be used in parallel. A universal generating function technique is applied to evaluate MSS reliability. The optimal solutions obtained by the proposed algorithm for nine test instances are compared with the best-published results previously presented in the literature for homogeneous series-parallel MSS. The solutions found by our algorithm are all better than or in par with the well-known test solutions.

Key words: Redundancy optimization, Multi-state systems, Series-parallel systems, Tabu search, Genetic algorithm, Space partitioning

1 Introduction

The reliability optimization of series-parallel MSS is well known as the “Redundancy allocation problem (RAP) of series-parallel MSS”. The system is considered to have a range of performance levels from perfect functioning to complete failure and it is called a multi-state system (MSS). The MSS consists of several components connected in series. For each component there are different versions of elements, which are proposed by the suppliers on the market (for example, these elements can represent machines in manufacturing systems). These elements are characterized by their cost, performance and reliability according to their version. Each element may experience only two possible states: perfect functionality and complete failure. Failed elements are repaired and the elements reliabilities are known. The MSS is repairable and its reliability is defined as its ability to satisfy consumer demand which is represented as a piecewise cumulative load curve. The universal generating function (UGF) technique is used to calculate MSS reliability.

^{*} This paper was not presented at any other revue. Corresponding author Mustapha NOURELFATH. Tel.: 1-418-656-2131 (ext. 12355); fax.: 1-418-656-7415.

Email addresses: ouzineb@crt.umontreal.ca (Mohamed OUZINEB), Mustapha.Nourelfath@gmc.ulaval.ca (Mustapha NOURELFATH), michelg@crt.umontreal.ca (Michel GENDREAU).