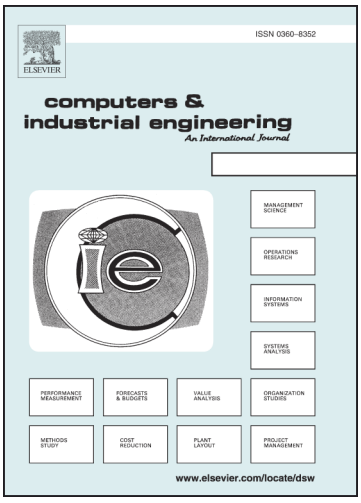

Balancing Mixed-model Assembly Systems in the Footwear Industry With a Variable Neighbourhood Descent Method

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Abstract

This paper addresses new Mixed-model Assembly Line Balancing Problems (MALBP) in a real industrial context, the stitching systems of a footwear company. The work is part of large ongoing projects with this industry, and the main purposes are minimising the number of required workstations and smoothing the operators' workload.

The company has invested in new flexible automated assembly systems, which accommodate dozens of workstations and many moving boxes. Footwear components are inside boxes (with various quantities) which can move from the warehouses to a convenient workstation or between any workstations (in any order). This is a significant and distinct feature of the MALBP, together with the fact that the assignment of different skilled operators and machines is achieved simultaneously.

An optimisation model is developed, in part to facilitate the understanding of the situation and to solve small-size instances. Due to the complexity of the problems, we had to devise an approximate method, based on the Variable Neighbourhood Descent (VND) metaheuristic and integrating an adaptation of the Ranked Positional Weighted (RPW) method. The adapted RPW method is used to create initial feasible solutions, while preassigning special operators and machines. After choosing good initial solutions, VND is applied to improve their quality.

The new contributed method, named as RPW-VNDbal, is tested with medium and large instances, in two distinct stitching systems. A Lower Bound of the objective function and Simulation contribute to evaluate the solutions and their practicability. The results implemented by the project team, show that the RPW-VNDbal method is fast enough and offers better solutions than those implemented by the experienced operation managers of the company.

Keywords:
Mixed-model assembly line balancing, Footwear industry, Variable neighbourhood descent, Ranked positional weighted method, Simulation

1. Introduction

The footwear industry has been remarkably improving over the last years. The high variety and quality of the products and the international competitiveness are an impressive reality. Creative design, technological leadership in the type of materials and productive equipment, the progress in management solutions and skilled labour, among other aspects, have been crucial for such improved performance. While, in the past, a few models were produced in large numbers, the circumstances changed when the industry started relying on fashion. This lead to production flexibility, both in volume and variety, and fast response times for a company to succeed. The obvious consequence is that the factories need to transform or adapt themselves to face the new production paradigm and simultaneously handle a variety of mixed models.

That is the case of the large footwear company considered in this work, Kyaia in Portugal, whose production is almost entirely for worldwide export. The company has invested in completely new flexible automated assembly lines (and participated in their design), which transport boxes with the components of different models, from and to warehouses, that can reach any workstation with specialised operators, in any order. These flexible assembly lines offer many possibilities but certainly