An optimization model for the low-carbon scheduling of an assembly/disassembly production line

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1 Introduction

Sustainable manufacturing practices are gaining in importance as a mean to preserve the environment and create a business opportunity [1]. Remanufacturing represents an important and effective strategy to ensure that no longer useful products are returned to a manufacturing facility to be either remanufactured or dismantled into modules, components and materials suitable for reuse, or to be discarded altogether [5]. However, remanufacturing processes are often complicated and may be more challenging to implement and manage than upstream supply chains. That is especially the case when it comes to remanufacturing scheduling [4].

Disassembly is the main activity required to recover the parts and sub-assemblies of a product [2]. Initially, product disassembly was only done for maintenance or repair purposes, where defective or worn out components are substituted by new ones. Today, however, product disassembly has become a widespread and valuable practice in the industry and occurs once a product reaches the end of its useful life. Scheduling is an approach used to optimize manufacturing processes in order to enhance the performance of a given system or to get closer to its optimality in a short period of time (short-term schedule). Recently, many researchers have addressed the problem of shop floor scheduling with a focus on minimizing energy consumption, energy costs [3], and, of course, time-related challenges.

The focus of this study is a low-carbon scheduling problem model of a hybrid shop floor, where we consider a mixed production line that performs both assembly and disassembly jobs and investigate the best short-term operational decisions related to the scheduling of such jobs. A mathematical model is established with the objective of minimizing the sum of the energy consumption cost and the completion time cost.

2 Problem description

The configuration addressed in this study is the common assembly/disassembly line concept for remanufacturing, as presented in the accompanying figure. In other words, components derived from the disassembly of used products can be reused to repair other products or to build new ones. An example of such system would be the assembly of a product that is composed of three parts (part A, B, and C) in an assembly line for easier explanation of the system. This scenario can easily be expanded to include more assembly steps. The sequence of assembly is in the order of A-B-C. The disassembly sequence is assumed to be in the reverse order of the

assembly sequence, i.e., C-B-A. The problem is to schedule these two types of jobs, one with assembly tasks and the other with disassembly tasks. The jobs are executed on the same set of workstations and equipment. The objective is to minimize the sum of the energy consumption cost and the production cost.

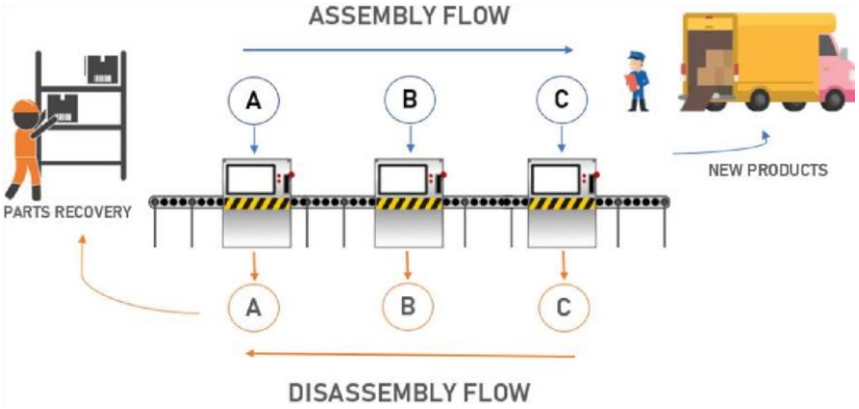

FIG. 1 – Hybrid production line for assembly and disassembly operations

Initially, we proposed a mixed integer programming (MIP) model for the scheduling of this hybrid production line while minimizing the sum of energy consumption cost and completion time cost. Then, its complexity was analyzed, and many tests on the proposed model were performed, using a solver in order to set its computational time limits. Overall, the present study deals with a quite promising problem, all the more so as it involves the consideration of reverse flows and closed-loop supply chains in the context of a sustainable development policy.

3 Conclusion and perspectives

We investigated the low-carbon scheduling problem of a hybrid production line, in which two workflows (assembly and disassembly tasks) are covered in opposite directions by the processing units. The results of the tests performed on small and medium-sized instances are very promising and there are several aspects to consider for possible future research.

References

[1] Mijoh A. Gbededo, Kapila Liyanage, and Jose Arturo Garza-Reyes. 2018. Towards a Life Cycle Sustainability Analysis: A systematic review of approaches to sustainable manufacturing. *Journal of Cleaner Production* 184, (2018).

[2] Muris Lage Junior and Moacir Godinho Filho. 2017. Master disassembly scheduling in a remanufacturing system with stochastic routings. *Central European Journal of Operations Research* 25, 1 (2017).

[3] Yi Lu and Tianhua Jiang. 2019. Bi-Population Based Discrete Bat Algorithm for the Low-Carbon Job Shop Scheduling Problem. *IEEE Access* 7, (2019).

[4] Shona D. Morgan and Roger J. Gagnon. 2013. A systematic literature review of remanufacturing scheduling. *International Journal of Production Research* 51, 16 (2013).

[5] Wenyuan Wang, Yue Wang, Daniel Mo, and Mitchell M. Tseng. 2017. Managing component reuse in remanufacturing under product diffusion dynamics. *International Journal of Production Economics* 183, (2017).