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The two-stage assembly flowshop scheduling problem with buffers

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Keywords: Assembly flowshop; limited buffer; scheduling; complete enumeration

1 Introduction

The two-stage assembly scheduling problem is a well-known problem from the literature with a lot of practical applications. It consists of a system with two stages where a set of n jobs must be processed in a given sequence. First stage is composed of m machines, each one produces a component to be assembled in one single machine at the second stage. Since the seminal paper of Johnson (1954) an extensive amount of papers has been published related with scheduling problem. One typical assumption is the absence of buffer limitations between both stages but this is too unrealistic from a practical point of view as it can be seen in the recent survey of Andres and Maheut (2018).
Simultaneously, other kind of scheduling problems called assembly flowshop has attracted the interest of the researchers. Lee et al. (1993) probed this problem is NP-hard even for two machines at the first stage. The best approach up to now to solve the problem with makespan was proposed by Hariri and Potts (1997) using Branch and Bound techniques. Regarding total completion time minimization in assembly flow shops, Framinan and Perez-Gonzalez (2017) proposed a constructive heuristic and a metaheuristic that outperform all the previous heuristics.

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2 Objectives

Under Lean Manufacturing paradigm, it is interesting to minimize the time that all jobs wait in all the buffers and total machine blocking time. However, there are no previous research about two-stage assembly flowshop with buffering and blocking time as objective function. We present a complete enumeration study to show relationship between buffer size and objective function for small size problems.

3 Methods

In order to show the effect of buffer size over makespan for small instances (up to nine jobs), a test based in complete enumeration has been carried out considering that there is an identical buffer of size b between each component machine and the assembly one. We used some instances from Taillard (1993) where first machine was used to represent processing time in assembly machine and the rest represents processing time in component manufacturing machines. All the 9! sequences for the each instance have been computed for buffer size between 0 and 4.

4 Results

Empirical distributions of blocking plus buffering times show interesting differences between each solution space depending on buffer size. More precisely, when buffer size increases is more difficult to find a good solution randomly. For example, for zero buffer size all solutions are under 50% from optimal value but for buffer size equal to 3, there are only 2,3% of solutions.

5 Conclusion

The conclusion of the research is that it is “easier” to find a good solution randomly in blocking assembly shops but the difficulty arises when buffer size is taken into account. Our aim is to develop competitive heuristic procedures to solve realistic instances and get more insights about the relationship between buffer size and assembly flowshop performance under finite storage conditions.

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