Modeling and optimization of tool replacements on parallel machines

T.F.H. van Diessen

Supervisors: Dr. Ir. T.G. Martagan, Prof. Dr. Ir. I.J.B.F. Adan, Dr. Ir. Q.V. Dang, K. Herps

Problem definition

This project solves the Identical Parallel Machines with Tooling Constraints (IPMTC) problem [2] for a set of parallel machines in a high-mix, low-volume production environment. Figure 1 defines the breakdown of the IPMTC into three sub-problems as defined by Ahmadi et al. [1] and Tang and Denardo [3].

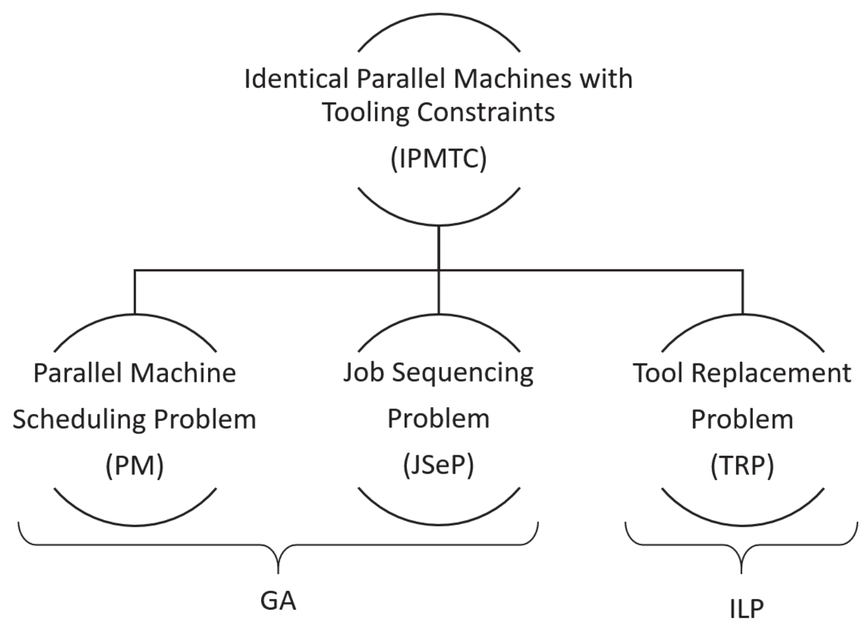

Figure 1: Breakdown of the IPMTC.

The goal of the project is to answer the following question: *How can the tool setup time and tardiness be minimized in the milling department of KMWE by a new scheduling method ?*

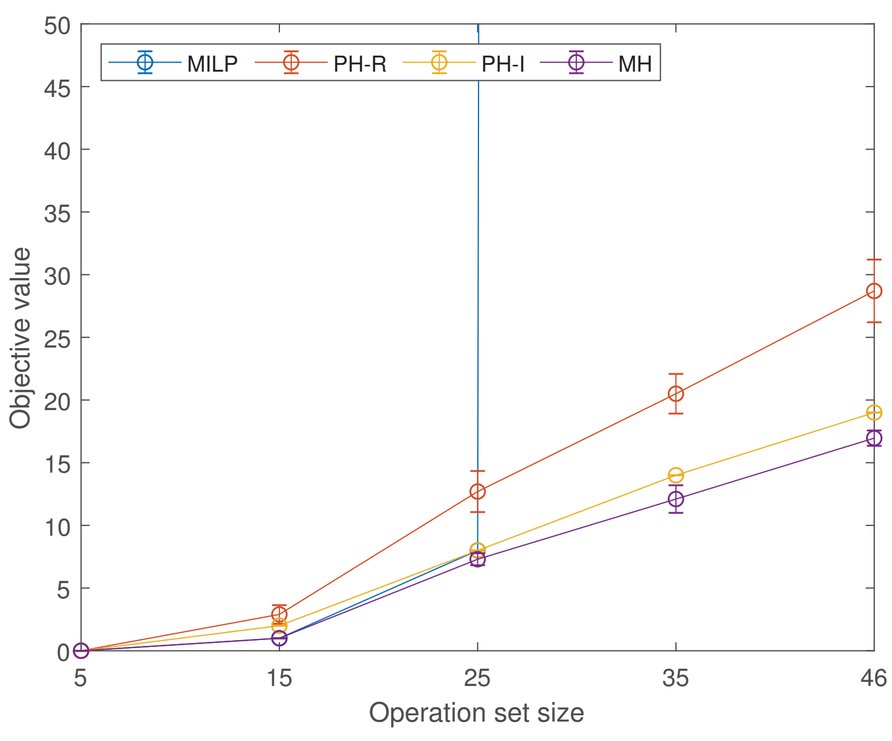

Figure 2: Computational results for two machines.

Solution method

A matheuristic (MP) has been constructed which consists of a Genetic Algorithm (GA) and a Integer Linear Programming (ILP) formulation. The application of the GA and the ILP is indicated in Figure 1. In addition, a Mixed Integer Linear Programming (MILP) formulation has been devised based on the work of Beezão et al. [2].

For bench-marking purposes, the *Practitioner Heuristic Random* (PH-R) is formulated to capture the current way of scheduling. In addition, the ILP formulation is combined with the PH-R to obtain the *Practitioner Heuristic Improved* (PH-I) method.

Computational results

Figure 2 and Figure 3 show the performance comparison for varying machines and operation set sizes. The MILP is, for both cases, able to solve small problem sizes but deviates from the other found average objective values as the problem size increases. In addition, the MH outperforms both PH methods by obtaining an equally good, or better, average objective value. For two machines and 46 operations, the average objective value reduction equals 10.74 % while an reduction of 10.59 % is obtained for six machines and 163 operations when comparing the average objective value of the MH with the second best method.

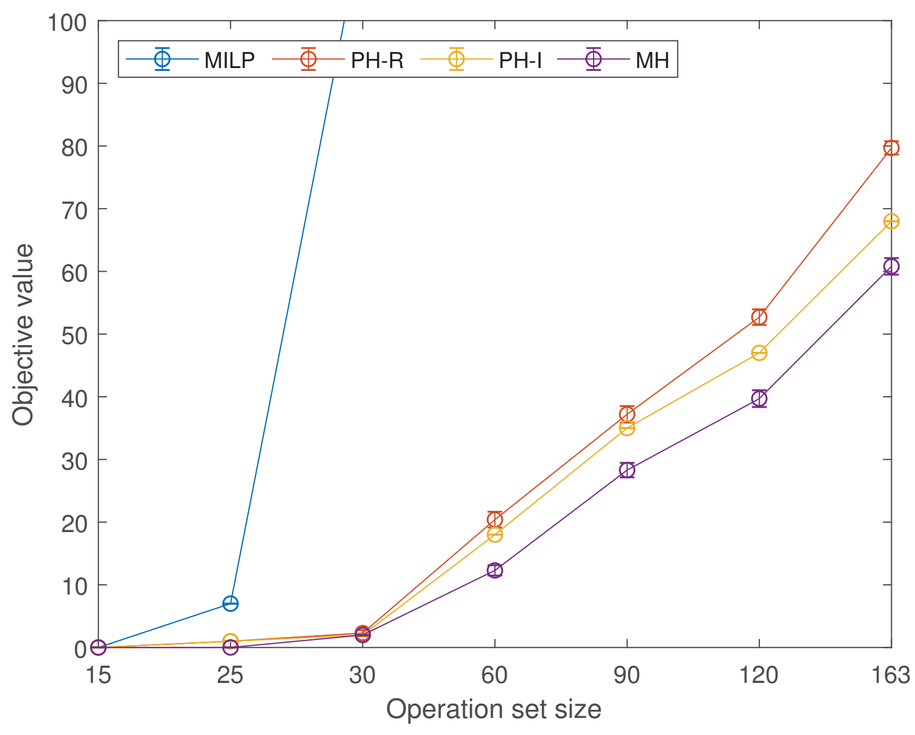

Figure 3: Computational results for six machines

References

[1] Ahmadi, E., Goldengorin, B., Süer, G. A., and Mosadegh, H. (2018). A hybrid method of 2-TSP and novel learning-based GA for job sequencing and tool switching problem. *Applied Soft Computing*, 65:214 – 229.

[2] Beezão, A. C., Cordeau, J.-F., Laporte, G., and Yanasse, H. H. (2017). Scheduling identical parallel machines with tooling constraints. *European Journal of Operational Research*, 257(3):834 – 844.

[3] Tang, C. S. and Denardo, E. V. (1988). Models Arising from a Flexible Manufacturing Machine, Part I: Minimization of the Number of Tool Switches. *Operations Research*, 36(5):767 – 777.

Department of Industrial Engineering and Innovation Sciences