[[1]](#footnote-1)

Parallel Tabu Search Algorithm for the Permutation Flow Shop Problem with Criterion of Minimizing Sum of Job Completion Times

W. Bożejko, J. Pempera,   
Institute of Computer Engineering, Control and Robotics   
Wroclaw University of Technology  
Janiszewskiego 11-17, 50-372 Wroclaw, Poland  
email: wojciech.bozejko@pwr.wroc.pl, jaroslaw.pempera@pwr.wroc.pl

*Abstract* —This paper deals with an intelligent algorithm dedicated for the use in manufacturing systems. Particularly, it develops the fast parallel tabu search algorithm to minimize sum of job completion times in the flow shop scheduling problem. So called multimoves are used, that consist in performing several independent moves simultaneously, which allow one to guide very quickly the search process to promising areas of the solutions space, where good solutions can be found.

*Keywords* — intelligent manufacturing, flow-shop, parallel computing, tabu search, experimental evaluation.

# Introduction

T

HE flow-shop problem can be formulated as follows. There are a set of *n* jobs *J*={1,2,…,*n*} and a set of machines *M*={1,2,…,*m*}. Each of n jobs from the set *J* has to be processed on *m* machines 1,2,…,*m* in that order.

Thus job *j*, *j*∈*J* consists of a sequence of *m* operations; each of them corresponding to the processing of job *j* on machine *k* during an uninterrupted processing time *pjk*>0. A feasible schedule is defined by completion times *Cjk*, *j*∈*J*, *k*∈*M* of job *j* on machine *k*, such that the above constraints are satisfied. For the given processing order represented by permutation *π*=(*π*(1),…,*π*(*n*)) on set *J*, the feasible schedule (small as possible) can be found by using the following recursive formulae:

 (1)

calculated for where *π*(0)=0, *Cj,*0=0 *j*∈*J*, *C*0,*k* *k*∈*M*. Let Π denote the set of all permutations defined on the set *J*. We wish to find such permutation *π\**∈Π, that

 (2)

where  is the sum of the job completion times.

# Parallel tabu search method (TS)

Currently, tabu search approach, (see Glover [10] and [11]), is one of the most effective methods using local search techniques to find near-optimal solutions of many scheduling problems. This technique aims to guide the search by exploring the solution space of a problem beyond local optimality.

Table 1: Computational results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Group*** | ***PARALLEL*** | | | ***MULTIRUN*** | | |
| ***PRD*** | ***BCT*** | ***TCT*** | ***PRD*** | ***BCT*** | ***TCT*** |
| 20×5 | 0.000 | 0.2 | 3.4 | 0.007 | 0.2 | 3.4 |
| 20×10 | 0.000 | 0.6 | 7.0 | 0.004 | 0.6 | 6.9 |
| 20×20 | 0.000 | 2.3 | 13.6 | 0.000 | 0.9 | 13.3 |
| 50×5 | 0.372 | 34.1 | 50.6 | 0.339 | 30.9 | 50.0 |
| 50×10 | 0.600 | 75.7 | 105.5 | 0.497 | 67.2 | 104 |
| **Average** | 0.194 |  |  | 0.169 |  |  |

As we can see in Table 1 and 2 the best results (in average) were obtained by multirun version of the algorithm (for all 50 instances), but parallel version was better than multirun for first 30 instances (0.0% of PRD).

References

1. J. Grabowski, J. Pempera, “Sequencing of jobs in some production systems. *European Journal of Operational Research*, vol. 126, 2000, pp. 131-151.
2. M.T.M. Rodrigues, L. Gimeno, C.A.S Passos, T. Campos, “Reactive scheduling approach for multipurpose chemical batch plants, *Computers and Chemical Engineering*, vol. 20, 1996, pp. 1215-1220.
3. Y.D. Kim, H.G. Lim, M.W. Park, “Search heuristics for a flowshop scheduling problem in a printed board assembly process”, *European Journal of Operational Research*, vol. 91, 1996 pp. 124-143.
4. J. Grabowski, J. Pempera, “New block properties for the permutation flow-shop problem with application in TS”. *Journal of Operational Research Society* vol.52, 2001, pp. 210-220.
5. C. Wang, C. Chu, J. Proth, “Heuristic approaches for n/m/F/∑Ci scheduling problems”. *European Journal of Operational Research*, 1997, pp. 636-644.

1. [↑](#footnote-ref-1)