Editorial: Special Issue ‘Scheduling in Manufacturing Systems: New Trends and Perspectives’

Ali Allahverdi

Department of Industrial and Management Systems, Kuwait University, P.O. Box 5969, Safat, Kuwait

ali.allahverdi@ku.edu.kw

Erwin Pesch

Department of Management Information Systems, University of Siegen, Hölderlinstraße 3, D-57068 Siegen, Germany and HHL Leipzig Graduate School of Management, Center for Advanced Studies in Management (CASiM), Jahnallee 59, 04109 Leipzig, Germany

erwin.pesch@uni-siegen.de

Michael Pinedo

Department of Information, Operations and Management Sciences, Stern School of Business, New York University, 44 West 4th Street, New York, NY 10012-1126, USA

mpinedo@stern.nyu.edu

Frank Werner

Faculty of Mathematics, Otto-von-Guericke-University, P.O. Box 4120, D-39016 Magdeburg, Germany

frank.werner@mathematik.uni-magdeburg.de
This special issue is dedicated to the celebration of the 55th anniversary of International Journal of Production Research and its relevancy in scheduling. The idea was to present the state-of-the-art in scheduling with respect to theoretical advances as well as practical relevancy in modern manufacturing and resource planning. Thus, the aim of this issue was to attract high-quality papers on most recent developments in modelling and solving scheduling problems in manufacturing systems which include parallel as well as multi-stage facilities, the wide area of logistics, supply chains or new applications. Potential authors were encouraged to submit their best recent research particularly in new and challenging scheduling areas leading to advanced perspectives in scheduling.

As possible current research topics, we suggested for instance grouping and sequencing operations in multi-stage systems, new scheduling approaches for flexible shops, new developments for scheduling with precedence constraints, batching and further technological constraints, assembly flow shop scheduling, scheduling with setup times/cost, just-in-time scheduling, new types of scheduling heuristics and approximation algorithms, scheduling under resource constraints, connections between scheduling and logistics, scheduling problems related to energy management, game theoretic aspects in scheduling, scheduling in segments of a supply chain, scheduling under uncertainty, online scheduling, or new scheduling applications in logistics, traffic, health care, mechanical and industrial engineering, human computer interaction.

We have received 56 submissions. After a careful refereeing, 12 papers have been selected for inclusion into this special issue. The first four papers deal with generalizations of classical single and multi-machine shop scheduling problems. Lai et al. [6] address the single machine problem of minimizing total weighted completion times with interval processing times. The authors introduce the optimality box as a stability measure of an optimal schedule and derive a linear time algorithm for calculating the optimality box for a given job sequence. Properties of an optimality box and a dynamic programming algorithm for constructing a job sequence
with the largest optimality box are presented. Computational results for finding a permutation
with the largest perimeter of the optimality box are given for instances with up to 10,000 jobs.
Valledor et al. [12] consider a multi-objective rescheduling problem in a dynamic permutation
flow shop environment with three types of disruption, namely arrival of new jobs, machine
breakdowns and variations in the processing times of the jobs. A rescheduling architecture
based on a predictive-reactive strategy and a new method for calculating the reactive schedule
in each rescheduling period are suggested. In addition, a methodology with the use of multi-
objective performance metrics is used to evaluate dispatching rules. The results demonstrate
that the random rule provides a better behaviour than the other rules tested and also a lower
ratio of non-dominated solutions in comparison with the apparent tardiness cost and first-in-
first-out rules.
Meng et al. [8] investigate a two-stage machining and welding scheduling problem with
minimizing the sum of the makespan values of the parts, denoted as total makespan. At stage
one, several parts are processed as in a job shop scheduling problem and are then grouped into
a single construction component at the subsequent welding stage. After presenting a
mathematical model, the authors suggest an improved harmony search algorithm including a
local search. It turned out that the new hybrid algorithm outperforms several conventional
algorithms.
Bozek and Werner [1] study a flexible job shop scheduling problem with the additional
inclusion of lot streaming and subplot size optimization. The authors suggest a two-stage
algorithm, which first minimizes the makespan for the smallest sublots. Then the sublots are
maximized in the second stage without increasing the makespan. In the second stage, two
optimization criteria are used: the maximization of the sum of the subplot sizes of all
operations and the maximisation of the number of operations that do not need to be split. For
solving the problem, mixed integer linear programming, constraint programming and graph-
based methods are used. The two developed optimisation approaches are compared for each
stage and objective, where benchmark instances with up to 20 jobs and 20 machines are considered.

The next two papers deal with particular manufacturing systems, inspired by real production systems. De Matta [3] considers a manufacturing process appearing in a drug packaging company. The problem requires to assign resources to production lines during the set-up to satisfy certain product specifications. For this problem, two mixed integer programming models and a Lagrangian heuristic are given. The algorithm has been tested on real and randomly generated data. The results demonstrate that the suggested solution approach is both effective and efficient in finding good feasible solutions.

Prasad and Jayswal [10] study a reconfigurable manufacturing system which can change its capacity and functionality whenever required. For an Automotive Components company, a modified reconfigurable layout has been proposed for an assembly line, and scheduling is considered under the criteria reconfiguration effort, profit over cost and due date. Scheduling of the products is done using an integrated approach of the Shannon entropy and the Reference Ideal Method. In addition, a sensitivity analysis has been performed for this problem.

Foumani et al. [4] address a robotic automated storage and retrieval system, where a Cartesian robot picks and palletises items onto a mixed pallet for any order. The decisions to be made include finding an optimal sequence of the orders and also an optimal sequence of the items inside each order such that the total travel times are minimised. In the first phase, an avoidance strategy for the robot is developed which detects the occurrence of collision causing an unsafe handling of hazardous items and delivers a collision-free robot movement sequence. In the second phase, a cross-entropy method is applied which has been tested and compared with the solutions obtained by CPLEX. It turned out that CPLEX was only able to solve small instances, and for larger instances the author tested their algorithm against the
nearest neighbour heuristic. Some model extensions and future research directions are also
discussed.
The next three papers deal with scheduling problems related to supply chains. Ivanov et al. [5]
extend existing studies of supply chain scheduling and resilience analysis by an explicit
integration of the recovery policy of an optimal schedule and supply chain resilience. The
authors suggest a scheduling model that considers the coordination of recovery actions in the
supply chain and also a resilience index by means of the concept of attainable sets which are a
known tool in control theory. The computational algorithms presented are based on the
presentation of an optimal control problem as a two-point boundary problem using the
maximum principle and the necessary conditions of optimal control. Some managerial
insights of the developed method are also given.
Liu et al. [7] present an integrated model for the multi-resource constrained production
planning and truck scheduling problem in a manufacturing supply chain, where production
units can produce different types of products and coordinate with a resource manager. After
formulating a mixed integer programming model and presenting some analytical properties, a
heuristic based on Lagrangian relaxation is derived which uses several enhancements. The
computational results for 720 instances demonstrate that their heuristic has a better
performance than CPLEX, both with respect to the objective function value and the CPU
time.
Motivated by a real production problem, Chen et al. [2] investigate the problem of
coordinating the supplier selection and project scheduling, more precisely they consider a
project network consisting of several concurrent projects which are independent in operation
but subject to shared suppliers and a final quality inspection. For this problem, a mixed
integer linear programming model and a heuristic based on mathematical programming are
suggested. It decomposes the problem into sub-problems which are solved in an iterative way.
The authors demonstrate the computational effectiveness of their algorithm by numerical examples with up to 25 projects, each of them consisting of up to 11 activities.

Nasiri et al. [9] deal with the incorporation of supplier selection and order allocation into the vehicle routing and multi-cross-dock scheduling problem. The authors present a mixed integer linear programming model for the problem of minimizing total costs, and the sensitivity of the model on the key parameters of the objective function is investigated. The authors suggest a two-stage solution algorithm and compare the results on small instances with the exact solution. They also consider a real-world case of urban freight transport in Tehran city.

Qu et al. [11] propose a single cumulative sum scheme for simultaneously detecting the size and time interval of an event. The authors compare their new scheme against three other schemes. It turns out that the new chart is rather powerful, and it can be applied in industries and also non-industrial fields.

We hope that the readers of this special issue can find new inspirations for their current research which may lead to innovative approaches for classical and new scheduling problems and applications in the future. The guest editors wish to thank all authors for submitting their papers, whether accepted or not accepted for publication, to our special issue. The guest editors also wish to thank the referees for their support in the preparation of this special issue. We are also grateful to Taylor & Francis, the editorial staff of the journal and in particular Prof. Alexandre Dolgui for the pleasant cooperation.

References


