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Guest Editorial

This special issue, devoted to "*Performance evaluation models of manufacturing systems*", is a selection of papers presented during the 9th IFAC Workshop on Intelligent Manufacturing Systems (IMS 2008) that took place in Szczecin, Poland in October 2008. The IMS workshop has established itself as an important event for scientists and practitioners who are involved in the broad field of advanced, intelligent manufacturing.

Modeling for performance evaluation takes a variety of forms and uses different methods and techniques. Theoretical advances in operational research, stochastic processes, computer simulation and artificial intelligence provide versatile conceptual models for the design and operation of manufacturing systems. The application of the models is usually limited to some aspects of the operation of an enterprise. Depending on the requirements imposed on the solution of particular tasks, which can be uncertain or deterministic, dynamic or static, etc., different modeling methods may need to be applied to the same problem. No models, however, can guarantee an efficient solution, adequate for all problems occurring in both technical and organizational aspects of a production system. In other words, the problems arising in manufacturing are as diverse as the techniques and tools used for solving them. Some problems can be solved with simple heuristics; other may require more sophisticated optimization approaches, or artificial intelligence tools. Therefore, in order to achieve successful management of either traditionally organized or extended enterprises, the methods applied should take into account the interconnections existing among a variety of energy, personnel, material, money and data flows, as well as the requirements imposed on a reliable, cheap and on-line decision making process with regard to, for example, task allocation and scheduling or workflow planning. This means that the selection of the appropriate conceptual model aimed at the development of the model-based design and evaluation method is of primary importance.

In this context, the present special issue covers various aspects of manufacturing management, while providing the state-of-the-art in modern computer science-based management engineering, particularly in such domains as discrete event theory, scheduling, neural networks, computer simulation, multi-agent and artificial intelligence theory. The papers fall into four groups according to the kind of fundamental methods and techniques for manufacturing systems modeling, ranging from a general modeling and design framework to specific issues related to implementation of information technology and concepts of production flow planning.

The first three papers deal with specific **machine level** issues concerning the milling strategy development, machine fault diagnosis and tool selection for manufacturing operation, all within an artificial neural network modeling framework. The prediction of milling tool-path strategy using a neural network is considered by *Klancnik, Balic and Cus*. In particular, the design and implementation of a system for selecting milling strategies is discussed as an attractive alternative to the standards implemented in commercially available CAD/CAM systems that require the recognition of the free surface as a conglomerate of building blocks. A new method for surface feature extraction from a 3D CAD model, and classification using a self-organizing neural network is proposed. *Van Tung Tran and Bo-Suk Yang* present an approach to machine fault diagnosis and condition prognosis based on classification and regression tress and neuro-fuzzy inference models. In case of diagnosis, a feature selection tool to select pertinent features from the data set and a neuro-fuzzy inference system is used as the classifier. The crisp rules obtained from classification and regression trees are then converted to fuzzy if-then rules that are employed to identify the structure of the neuro-fuzzy inference system classifier. In case of prognosis, both of these models, in association with direct prediction strategy for long-term prediction of time series, are utilized for the forecasting of future values of machine operating condition. Next paper, by *Rojek*, deals with the problem of tool selection for manufacturing operations including turning, milling and grinding. Three types of neural networks are used as classification models, namely a linear network, a multi-layer network with error back-propagation and a radial basis function network.

Production flow planning at the **shop level,** employing different methods, ranging from constraint programming techniques through computer simulation to the queuing network theory, is addressed in the second group of three papers. The concept of constraint programming (CP) considered as appropriate framework for development of decision making software, supporting a multi-robot scheduling system in a multi-product job shop is discussed by *Bach, Bocewicz, Banaszak and Muszyński*. The authors deal with a multi-resource problem, in which more than one shared renewable and non-renewable resource type may be required by a manufacturing operation and the availability of each type is time-window limited. The aim is to present a knowledge based and CP-driven approach to multi-robot task allocation, providing a prompt service to a set of routine queries stated both in terms of the direct and inverse problem. *Korytkowski, Wiśniewski and Zaikin* study multi-product production manufacturing systems with in-line quality control. The quality control is carried out at inspection stations located within a production line and having an impact on system performance. Production lines are modeled as a multi-product Open Jackson Network, where the stochastic character of routing is a result of quality control operations. The possibility of applying modeling and simulation techniques in designing a logistic chain in production enterprises is addressed in the paper by *Matuszek and Moczała*. The main contribution of the paper is a new approach,

based on simulation techniques together with a utility function, to partnership selection in cooperative production, i.e., a new class of computer aided systems for production cooperation.

The third set of four papers deals with selected issues of the **supply chain management level,** ranging from multilevel serial systems through flexible supply networks to data flow control in distributed control systems. A supply planning problem for multilevel serial production systems under lead time uncertainties is examined by *Hnaien, Dolgui and Louly.* The problem concerns the development of an exact performance evaluation technique for calculating total cost as a function of the planned lead times when the actual lead times are random discrete variables. The sum of the average component holding and tardiness costs at each level, plus the average finished product backlogging cost is considered. The next paper, written by *Nawarecki and Koźlak*, deals with formal principles for the construction of a multi-agent environment, geared to the simulation analysis of a given class of supply chains and production activities. An abstract structure of the multi-agent system compound of dedicated agents representing distinguished activities of the production process is proposed. *Smirnov, Levashova, Shilov and Kashevnik* study ontologies that specify the interoperability between flexible supply network members. It is shown that the usage and competence profiles of the supply network members facilitate knowledge sharing and simplify partner selection while formalizing and sharing the member knowledge and competencies. Since constraints are used for knowledge description, the usage of constraint solvers for solution search is proposed. The interaction between the controller and the plant as well as the data processing inside the controller are discussed by *Gerber, Ivanova-Vasileva and Hanisch*. The execution model and the relevant transformation rules to automatically generate formal models from IEC 61499 Basic Function Blocks are proposed. Net Condition/Event modules and structures are used as formal models. Analysis of the resulting closed-loop behaviour is presented using a small but realistic manufacturing system.

The last group of four papers relates to the **knowledge management level**, focusing at issues concerning pattern recognition, artificial intelligence, control and knowledge modeling. The changing face of Intelligent Manufacturing Systems - from the perspective of the pattern recognition domain - is discussed in depth by *Zaremba*. Design criteria for techniques that facilitate the implementation of manufacturing systems exhibiting adaptive and intelligent operation are presented. It is shown through examples how incorporating pattern recognition capabilities can help in building more intelligence and self-organization into manufacturing systems of the future. Two specific aspects of organizational knowledge modelling: capturing organizational knowledge for supporting product development with so called task patterns, and evaluating task pattern use with the focus on economic effects are explored by *Sandkuhl*. The concept of task patterns and the method used for the evaluation of task patterns used in product development employing a balanced scorecard approach is dis-

cussed. *Baglee and Knowles* study the barriers to the implementation of Total Productive Maintenance within small and medium sized enterprises. A new maintenance methodology for the Advanced Integrated Maintenance Management System (AIMMS) is proposed. The AIMMS, developed with use of the methodology, supports strategic maintenance decisions, and helps increasing equipment effectiveness through prioritizing equipment criticality and focusing on specific resources that maximize gains based upon the return on investment. The next paper, written by *Bakhtadze, Yadikin, Kulba, Lototsky and Maximov*, deals with intelligent control techniques for power generation. A technology for estimating the dynamics of power grid generating facilities participation in overall primary frequency regulation in contingences is developed using frequency and generating capacity time series analysis.

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