International Journal of Computer Integrated Manufacturing

ISSN: 0951-192X (Print) 1362-3052 (Online) Journal homepage: https://www.tandfonline.com/loi/tcim20

Smart Cyber-Physical System applications in production and logistics: special issue editorial

Elisabeth Ilie-Zudor, Davy Preuveneers, Anikó Ekárt & Eckhard Hohwieler

To cite this article: Elisabeth Ilie-Zudor, Davy Preuveneers, Anikó Ekárt & Eckhard Hohwieler (2019) Smart Cyber-Physical System applications in production and logistics: special issue editorial, International Journal of Computer Integrated Manufacturing, 32:4-5, 327-328, DOI: 10.1080/0951192X.2019.1616152

To link to this article: https://doi.org/10.1080/0951192X.2019.1616152

Published online: 12 Jun 2019.

INTERNATIONAL JOURNAL OF COMPUTER INTEGRATED MANUFACTURING
2019, VOL. 32, NOS. 4–5, 327–328
https://doi.org/10.1080/0951192X.2019.1616152

Taylor & Francis
Taylor & Francis Group

EDITORIAL

Smart Cyber-Physical System applications in production and logistics: special issue editorial

Current business environments, including production and logistics, are confronted with a great variety of emerging trends, such as growing collaboration of computational entities and networks of entities with the surrounding physical world (seen as Cyber-Physical Systems (Nahian Al Sunny, Liu, and Shahriar 2018; Khaitan and McCalley 2015)); creation and exploitation of large amounts of data/information (O'Donovan et al. 2015; Dubey et al. 2016; Preuveneers and Ilie-Zudor 2017; Zhong et al. 2017); open hardware and software engineering (Bosch 2016); societal and business practice shifts such as digital currency (Narayanan et al. 2016) (e.g.: Bitcoin, Namecoin, Litecoin); new human-machine interaction paired with advances in sensing and analytics (Wang et al. 2018; Varsaluoma et al. 2017); anarchic manufacturing (Ma, Nassehi, and Snider 2018) and many more. These trends and technologies separately as well as together are concurrently challenging and high potential, even to the level of disruptive innovation.

This special issue consists of 15 papers addressing a broad spectrum of aspects of cyber-physical system (CPS) applications in manufacturing and logistics. The first paper – *Design challenges for CPS-based service systems in industrial production and logistics* – presents a service systems perspective to processes, activities and resources. Based on related literature and industry interviews it identifies main challenges in the design of holistic cyber-physical systems.

The second article – *A novel fluid architecture for cyber-physical production systems*– addresses the concept and application of fluid computing in cyber-physical production systems, connecting the idea of computational sedimentation to a novel Fluid Manufacturing Architecture. The architecture encompasses the computing layers of cloud, fog, edge and mist, and extends them with a new layer representing the entry point where manufacturing legacy devices are converted into network-able, embedded components for the distributed production scenarios of Industry 4.0. A pilot factory application and preliminary results of an agent-based simulation case study for collaborative manufacturing services are also presented.

The third paper - *Representing adaptation options in experimentable digital twins of production systems*- introduces a new modelling concept combining Model-Based Systems Engineering and Variability Management to model different variants of production systems, and utilises capabilities of production equipment to make Digital Twins modular and reconfigurable.

The fourth paper – *An open source approach to the design and implementation of Digital Twins for Smart Manufacturing* – identifies main implementation requirements of smart cyber-physical systems and digital twins and presents components and technology building blocks such as management of data, models and services for the realisation of a digital twin. Furthermore, a high-level micro-services architecture has been derived from the conceptual model of a digital twin demonstrator and a case study infrastructure for the implementation of the demonstrator based on available open source technologies is being provided.

The fifth article – *Production Planning and Scheduling in Cyber-Physical Production Systems: a Review* – reflects on the relevance of computational tools in cyber-physical system environments, in particular different scheduling schemes. These are subsequently reviewed in the paper distinguishing between work on basic issues of scheduling and scheduling as part of higher level production planning activities.

The sixth article – *Multiobjective dynamic routing with predefined stops for automated vehicles* – highlights the importance of transportation to CPS applications due to the rapid development of highly automated or autonomous vehicles. A routing approach allowing automated vehicles to travel on different paths between given points, minimising the generalised cost of the route is elaborated in the paper. Although the method is introduced via the problem of traffic congestion on public transport paths, it can be generalised, for example to any transport system within factories or warehouses.

The seventh contribution – *Methodology on Developing an Assessment Tool for Intralogistics by considering Cyber-Physical Production Systems Enabling Technologies* – addresses intralogistics, as a key element of production systems. A method for developing an assessment tool for intralogistics is introduced, with attention to aspects such as key performance indicators of resource efficiency, evaluation issues. Its validation through a case study is presented as well.

The eight paper – *An IoT-enabled simulation approach for process planning and analysis: a case from engine remanufacturing industry* – proposes a novel rapid simulation approach which can serve as process planning and process analysis tool built on internet-of-things data, in terms of the historical records of sensors and radio frequency identifications.

The ninth article – *An Internet-of-Things based cyber manufacturing framework for the assembly of microdevices* – introduces a novel framework for the assembly of micron-sized parts and, among other things, proposes a unique information model-based approach to monitoring and tracking of cyber-physical interactions.

The tenth contribution – *From legacy-based factories to smart factories level 2 according to the Industry 4.0*– presents a transition procedure for transforming a factory based on a make-to-order manufacturing into a smart factory level 2 and its validation in a real case study leading to improved

operation efficiency and energy savings, respectively reduction in projected costs and human errors.

The eleventh article – *An online machine learning framework for early detection of product failures in an Industry 4.0 context* – presents an IoT machine learning and orchestration framework, applied to detection of failures of surface mount devices during production. The approach is evaluated by using a novel and realistic simulation of a production line for electronic devices by analysing various aspects such as software architecture, computational scalability, model accuracy, and production performance.

The twelfth paper – *Model-Free Condition Monitoring with Confidence* – addresses the issue of computational self-awareness as key to improving performance, robustness, and adaptivity of a system. It introduces 'confidence' as a quality metric of observation and leverages it to improve the correct identification of states of a system. Furthermore, experiments showing that 'confidence' not only improves the quality of system performance but also simplifies the system architecture and enhances its robustness are also presented.

The thirteenth paper – *PriMa: a prescriptive maintenance model for cyber-physical production systems* – analyses existing approaches and challenges towards rethinking maintenance in the context of Industry 4.0 and introduces a novel prescriptive maintenance model. Furthermore, the feasibility of the proposed model in real production systems is appraised through an industry-oriented proof-of-concept study by implementing a decision support solution and achieving a significant reduction of downtime.

The fourteenth article – *Smart CPS: vertical integration overview and user story with a cobot* – presents an overview and a demonstration for the vertical integration of manufacturing enterprise layers by implementing the manufacturing execution system. A use case involving a collaborative Baxter-type robot and state-of-the-art tools for MES implementation is described as well.

The fifteenth contribution – *Integrated application in intelligent production and logistics management: technical architectures concepts and business model analyses for the customised facial masks manufacturing* – elaborates an innovative intelligent production model of facial masks consisting of three modules: in-shop service, intelligent logistics, and smart manufacturing. The proposed solution can be extrapolated by any SME in the business and thus provides an innovative application of smart CPS in production coordination and logistics management.

Acknowledgments

The Guest Editors would like to warmly thank the IJCIM Editor-in-Chief, Prof. Stephen Newman and the Managing Editor, Dr Aydin Nassehi, for their effective coordination and guidance towards the completion of the special issue, as well as to all submitting authors and referees for their valuable contributions. Part of the work for the special issue was accomplished with the support of the European Commission through the Centre of Excellence in Production Informatics and Control, grant No. 739592.

References

Bosch, J. 2016. "Speed, Data, and Ecosystems: The Future of Software Engineering." *IEEE Software* 33 (1): 82–88. doi:10.1109/MS.2016.14.

Dubey, R., A. Gunasekaran, S. J. Childe, S. F. Wamba, and T. Papadopoulos. 2016. "The Impact of Big Data on World-Class Sustainable Manufacturing." *The International Journal of Advanced Manufacturing Technology* 84 (1–4): 631–645. doi:10.1007/s00170-015-7674-1.

Khaitan, S. K., and J. D. McCalley. 2015. "Design Techniques and Applications of Cyberphysical Systems: A Survey." *IEEE Systems Journal* 9 (2): 350–365. doi:10.1109/JSYST.2014.2322503.

Ma, A., A. Nassehi, and C. Snider. 2018. "Anarchic Manufacturing." *International Journal of Production Research*. doi:10.1080/00207543.2018.1521534.

Nahian Al Sunny, S. M., X. F. Liu, and M. R. Shahriar. 2018. "Communication Method for Manufacturing Services in a Cyber–Physical Manufacturing Cloud." *International Journal of Computer Integrated Manufacturing* 31 (7): 636–652. doi:10.1080/0951192X.2017.1407446.

Narayanan, A., J. Bonneau, E. Felten, A. Miller, and S. Goldfeder. 2016. *Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction*. Princeton: Princeton University Press.

O'Donovan, P., K. Leahy, K. Bruton, and D. T. O'Sullivan. 2015. "Big Data in Manufacturing: A Systematic Mapping Study." *Journal of Big Data* 2 (1): 20. doi:10.1186/s40537-015-0028-x.

Preuveneers, D., and E. Ilie-Zudor. 2017. "The Intelligent Industry of the Future: A Survey on Emerging Trends, Research Challenges and Opportunities in Industry 4.0." *Journal of Ambient Intelligence and Smart Environments* 9 (3): 287–298. doi:10.3233/AIS-170432.

Varsaluoma, J., H. Väätäjä, T. Heimonen, K. Tiitinen, J. Hakulinen, M. Turunen, and H. Nieminen. 2017, July. "Usage Data Analytics for Human-Machine Interactions with Flexible Manufacturing Systems: Opportunities and Challenges." In *21st International Conference on Information Visualisation (IV)*, 427–434. London, UK: IEEE.

Wang, J., Y. Ma, L. Zhang, R. X. Gao, and D. Wu. 2018. "Deep Learning for Smart Manufacturing: Methods and Applications." *Journal of Manufacturing Systems* 48: 144–156. doi:10.1016/j.jmsy.2018.01.003.

Zhong, R. Y., X. Xu, E. Klotz, and S. T. Newman. 2017. "Intelligent Manufacturing in the Context of Industry 4.0: A Review." *Engineering* 3 (5): 616–630. doi:10.1016/J.ENG.2017.05.015.

Elisabeth Ilie-Zudor
MTA SZTAKI, Budapest, Hungary
elisabeth.zudor@sztaki.mta.hu

Davy Preuveneers
imec-DistriNet-KU Leuven, Belgium

Anikó Ekárt
Aston University, Birmingham, UK

Eckhard Hohwieler
Fraunhofer IPK, Berlin, Germany