Special issue on 'new transdisciplinary practices for intelligent manufacturing for industry 4.0'

Peruzzini, Margherita; Wognum, Nel; Verhagen, Wim

DOI
10.1080/0951192X.2022.2028369

Publication date
2022

Document Version
Final published version

Published in
International Journal of Computer Integrated Manufacturing

International Journal of Computer Integrated Manufacturing

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tcim20

Special issue on 'new transdisciplinary practices for intelligent manufacturing for industry 4.0'

Margherita Peruzzini, Nel Wognum & Wim Verhagen

To cite this article: Margherita Peruzzini, Nel Wognum & Wim Verhagen (2022) Special issue on 'new transdisciplinary practices for intelligent manufacturing for industry 4.0', International Journal of Computer Integrated Manufacturing, 35:1, 1-3, DOI: 10.1080/0951192X.2022.2028369

To link to this article: https://doi.org/10.1080/0951192X.2022.2028369

Published online: 01 Feb 2022.

INTERNATIONAL JOURNAL OF COMPUTER INTEGRATED MANUFACTURING
2022, VOL. 35, NO. 1, 1–3
https://doi.org/10.1080/0951192X.2022.2028369

Taylor & Francis
Taylor & Francis Group

EDITORIAL

Special issue on 'new transdisciplinary practices for intelligent manufacturing for industry 4.0'

Transdisciplinary Engineering (TE) is an emerging area of research able to evolve traditional engineering approaches by transcending the technical disciplines. It can be successfully applied in different fields, by combining natural sciences, applied sciences, social sciences, and humanities to achieve a higher level of comprehension and awareness of the context in which industrial products, processes, systems, and services will be implemented and experienced by users (Borsato et al. 2016). Research in TE also incorporates social science methodologies to acquire knowledge about users and context, and solve ill-defined, socially relevant problems. Based on recent evidence, it can be stated that numerous engineering problems can be characterised as ill-defined and socially relevant, too (Wognum et al. 2019).

Industry 4.0 is today a well-known paradigm that pushes the vision of a smart factory based on intelligent manufacturing. The intelligence of machines is mainly enabled by networking production systems and real-time process control via cyber-physical systems (CPSs) and Internet-of-Things (IoT) to have greater productivity through resource efficiency. However, a lot of aspects need to be included to fully achieve this challenging objective, from selection of sensors and smart components to efficient and feasible data collection, proper information system architecture to reliable data analysis, to knowledge representation and data requirements definition, until production line management, also including the need for people with the right type of knowledge and interaction with humans. Indeed, intelligent manufacturing is not just about machines, as we can think in a general way, but also about people and product-process knowledge management, merging the physical and digital worlds (Zhong et al. 2017). As a matter of fact, creating a smart factory is a complex problem. To support a fully sustainable development, based on resource-efficient production systems, promoting safety, innovation, and economy, smart factories need to exploit digital trends as well as users' active participatory and collaborative processes (Peruzzini et al. 2020). A vertical networking of smart production systems is required as well as a horizontal networking of smart logistics, production, marketing and smart services, able to generate global value-creation networks, including integration of business partners and customers, and new business and cooperation models across companies and countries.

In smart factories, machines are becoming more and more digitised and technologically advanced. In this context, new approaches and methodologies are required to bridge the gaps between technical and social sciences. TE approaches can help to bring the intelligence into the shop floor to provide factories with flexible and adaptive behaviours (e.g. self-steering or continuous improvement teams). Moreover, social sciences are necessary to include people from practice and relate their needs and the system features at different levels (considering the users, the context, the machine, and the interface). Next to different methodologies, novel technologies like virtual tools are necessary to anticipate critical conditions and to envisage possible solutions. In addition, proper training is needed for people to understand the new processes and to be able to work in the new environment and collaborate with others. The new mindset needs to be incorporated on all levels in the organisation, from top management to the work floor.

This special issue is aligned with these developments and challenges. It includes invited papers selected from contributions to the 27th International Conference on Transdisciplinary Engineering held online from 1st to 10 July 2020, hosted by the Warsaw University of technology, Poland (Pokojski et al. 2020) and supported by the International Society for Transdisciplinary Engineering (ISTE). The authors come from traditional industrial countries, such as Italy, Germany and Poland in Europe, and more recently industrialized countries

like Brazil in South America, and Australia. The geographical distribution demonstrates how attention to TE approaches is widespread all over the world and represents a new topic of discussion shared among Industry and Academia.

In this issue five papers are included, each of them focusing on a specific issue related to the design of modern factories and the implementation of successful TE practices.

The first paper entitled 'A Multi-Criteria Decision Tool for FMEA in the Context of Product Development and Industry 4.0' by Leite et al. deals with data analysis and real-time processing in Industry 4.0, which are both important to create an efficient, highly connected smart factory. In particular, the paper addresses Failure Mode & Effect Analysis (FMEA) and proposes a dedicated tool to contribute to decision-making by processing data to improve design, manufacturing, and maintainability of products. This consequently improves accuracy and reduces bias in the evaluation process of FMEA in different organisations. The findings show how a transdisciplinary approach can help in using different evaluators, taken from traditional methods, supporting strategic decision making.

The second paper entitled 'Concept of a Design Activity Supporting Tool in the Design and Development Process of CPS' by Knap et al. is about the design of CPS in order to satisfy the needs of multi-disciplinary project teams and proposes a dedicated software tools which enable easy access to the acquired and accumulated knowledge. Such a tool provides support for designers with a high level of search automation, and contemporarily quick and easy definition of all relevant instances of activity, related contextual information, related instances of activity, and their resources, gained by designers' experience and examples of use in specific previous projects.

The third paper entitled 'Creation of a UX index to design human tasks and workstations' by Grandi et al. focuses on human-related issues in Industry 4.0 and proposes the definition of a User eXperience Index (UXI) to assess the quality of human-system interaction during job tasks and, consequently, evaluate the design of both process and workstation. The proposed approach can be applied to improve the design of human tasks in the smart factory, using a virtual simulated world to anticipate and objectify the workers' experience to improve the factory overall design, according to a transdisciplinary perspective.

Finally, the fourth paper entitled 'Transdisciplinary System of Systems Development in the Trend to X4.0 for Intelligent Manufacturing' by Mo et al. examines, from a high-level system of systems perspective, how transdisciplinary engineering can create a model of evolutionary X4.0 and how intelligent manufacturing can be developed towards X4.0 within the transdisciplinary modelling framework. The paper aims at generalising the strategy of migrating into X4.0, where 'X' is a notion of specificity of an industry sector and identifying the most important ingredients that smart manufacturing companies need to develop or acquire in the X4.0 system development process.

We would like to thank all the reviewers who gave their significant comments and suggestions for improving the published papers in this special issue, and the contributors to make the publication of this special issue. A special thank is given to Prof. Stephen T. Newman, editor-in-chief of the International Journal of Computer Integrated Manufacturing, and Dr. Aydin Nassehi, managing editor, who gave their great support.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

Borsato, M., N. Wognum, M. Peruzzini, J. Stjepandić, and W. J. C. Verhagen. 2016. "Transdisciplinary Engineering: Crossing Boundaries." *Advances in Transdisciplinary Engineering* Vol. 4. (The Netherlands: IOS Press).

Peruzzini, M., N. Wognum, B. Cees, and J. Stjepandic. 2020. "Special Issue on "Transdisciplinary Approaches to Digital Manufacturing for Industry 4.0". *International Journal of Computer Integrated Manufacturing* 33 (4): 321–324. doi:10.1080/0951192X.2020.1752071.

Pokojski, J., M. Gil, L. Newnes, J. Stjepandić, and N. Wognum. 2020. "Transdisciplinary Engineering for Complex Socio-technical Systems – Real-life Applications." *Advances in Transdisciplinary Engineering* Vol. 12. (The Netherlands: IOS Press).

Wognum, N., C. Bil, F. Elgh, M. Peruzzini, J. Stjepandić, and W. J. C. Verhagen. 2019. "Transdisciplinary Systems Engineering: Implications, Challenges and Research Agenda." *International Journal of Agile Systems and Management* 12 (1): 58–89. doi:10.1504/IJASM.2019.098728.

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.

Margherita Peruzzini
University of Modena and Reggio Emilia, Modena, Italy
margherita.peruzzini@unimore.it http://orcid.org/0000-0003-2260-0392

Nel Wognum
Technical University of Delft, Delft, The Netherlands

Wim Verhagen
Royal Melbourne Institute of Technology Melbourne, Australia