# Editorial


## Margherita Peruzzini*

Department of Engineering 'Enzo Ferrari',
University of Modena and Reggio Emilia,
Via Vivarelli 10, 41125 Modena, Italy
Email: margherita.peruzzini@unimore.it
*Corresponding author

## Nel Wognum

Section Air Transport and Operations,
Technical University of Delft,
P.O. Box 5058, 2600 GB Delft, The Netherlands
Email: p.m.wognum@tudelft.nl

**Biographical notes:** Margherita Peruzzini is an Associate Professor at the Department of Engineering 'Enzo Ferrari', University of Modena and Reggio Emilia, and works in the research groups of Methods and Tools for Industrial Engineering. She co-founded the X-in-the-Loop Simulation (XiLab) (http://www.xilab.unimore.it) and she is a part of the inter-department Lab INTERMECH MO.RE working on advanced mechanics for industrial applications. Her research topics are virtual prototyping, human-centred design, human-computer interaction and human-machine interfaces, collaborative virtual environments, co-design, and product-service systems. She is part of the Board and Conference Coordinator of International Society of Transdisciplinary Engineering (ISTE, https://intsoctransde.org). She is an author of more than 130 publications.

Nel Wognum is a guest researcher at the Technical University of Delft. She graduated in Medical Informatics and obtained her PhD in Knowledge Systems. Since 1996, she has been involved in research in concurrent engineering and cross-organisation collaboration in the Technical University of Twente. From 2007 till 2012, she has worked on supply chain management and collaboration in the Wageningen University, The Netherlands. She is the General Secretary of the International Society of Transdisciplinary Engineering (ISTE, https://intsoctransde.org).


Transdisciplinary engineering (TE) is an emerging field that extends and evolves the initial basic concepts known as concurrent engineering (CE). While CE concentrates on enterprise collaboration, from integrating people and processes to very specific complete multi/inter/transdisciplinary solutions, TE combines 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 or services will be implemented and are experienced by users (Borsato et al., 2016).

TE is aimed at solving ill-defined and socially-relevant problems. Many researchers have studied transdisciplinary processes and have tried to understand the essentials of transdisciplinarity. Many engineering problems can be characterised as ill-defined and socially relevant, too. Although TE cannot widely be found in the literature yet, a transdisciplinary approach is deemed relevant for many engineering problems. In this direction, Wognum et al. (2019) present an overview of the literature on research into transdisciplinary processes and investigate the relevance of a transdisciplinary approach in engineering domains.

Transdisciplinarity has been subject of discourse in the ‘70s of the previous century, when interdisciplinarity seemed to be only possible between neighbouring disciplines, like physics and chemistry (Scholz and Steiner, 2015). Mode 1 transdisciplinarity, including general systems theory, emerged in search of a meta-structure for integration of disciplines and a unity of knowledge. However, natural sciences have been dominant in this approach. Moreover, in the ‘90s of the previous century, it was realised that societal needs should shape research and education. Klein (2004) argues that the problems of society are increasingly complex and interdependent. Not one single sector or discipline can tackle such problems. Each problem is multidimensional. Tackling complex problems requires mode 2 knowledge creation, which overcomes the reductionist view of science (Scholz and Steiner, 2015). In mode 2 knowledge creation, older hierarchical and homogenous modes are replaced by new forms characterised by complexity, hybridity, nonlinearity, reflexivity, heterogeneity and transdisciplinarity (Klein, 2004). Mode 2 transdisciplinarity is not merely aimed at integrating disciplines, but at relating disciplines. In 2012, the European Commission also emphasised that solving the complex and ill-defined problems of current societies requires collaboration not only across various disciplines, but also with incorporation of the innovative and creative capabilities in society itself. In summary, a transdisciplinary approach is highly problem-oriented, and aims at solving ill-defined, society-relevant problems by encompassing both technical (e.g., disciplinary or inter or multidisciplinary) and social science goals (e.g., encompassing business management, human resources, consumer studies, or team composition and culture).

In the context of modern industrial systems, agile and TE methods can be successfully applied to solve complex problems. In particular, special attention should be paid to transdisciplinary knowledge management (KM) including intelligent data management, advanced process sustainability, energy-efficiency strategies, collaborative practices, and attention to human factors.

This issue incorporates examples and applications of transdisciplinary KM including intelligent data management, advanced process sustainability, energy-efficiency strategies, collaborative practices, and attention to human factors. The context of TE is emphasised by paying attention to collaboration between different disciplines needed for the subject of the paper or for the intended implementation of the envisioned result. It includes invited papers selected from contributions to the 25th International Conference on Transdisciplinary Engineering held in Modena, Italy, on 3–6 July 2018 (Peruzzini et al., 2018).

The authors come from traditional industrial countries, such as Germany, Italy and Sweden in Europe, as well as Japan, and new emerging countries, such as Slovenia and Malaysia, to demonstrate how the attention to TE is widespread and represents a new topic of discussion shared among industry and academia. All works present novel approaches to deal with complex industrial processed by adopting transdisciplinary pillars, from different perspectives. All works emphasise the search for a balance between technical issues, economic aspects and social sciences.

Raudberget et al. describe the results of an explorative study on platforms and modularisation at five product developing and manufacturing companies, including how they work with their product concept before a development project is started, the character of requirements, and the adoption of product platforms. The main contribution of this work is the identification of a list of criteria and new platform elements termed 'design assets' to enable a proper knowledge exchange and collaboration. These are introduced as a means to make diverse types of resources to be reused in a company and a pragmatic way to bridge the gap between the physical products and the knowledge, tools and methods needed to realise these.

Bettinger at al. propose a new variability management methodology and a specific variant management tool (that implements key parts of the proposed methodology) to support even inexperienced users to meet the challenges of a complex product development process, by adopting a transdisciplinary perspective. User interaction paradigms and high-performing transformation and analysis procedures are combined with state-of-the-art technology to allow the user to inspect, edit or analyse variability information on all popular platforms and at any time.

Tavčar et al. propose a five-step KM model integrated into the engineering change process, using failure modes and effects analysis (FMEA) and design history files to manage the knowledge related to a specific product. According to the new approach, a product design history file should contain explanations of decisions that have been made, and special attention should be put on the transfer of tacit knowledge that can be stimulated by mixed teams of senior and up-coming engineers.

Mandolini et al. present a holistic 'should-costing' approach able to foster collaboration on cost-oriented solutions among company's departments, focusing on the opportunities to reduce costs, from the conceptual design stage through the overall production stages. In addition, the paper presents also a related tool to enable a systematic review of cost evolution, and a requirements list for efficient implementation of a should-cost tool considering enterprise software solutions already available in manufacturing companies. Quantitative and qualitative evaluations of the deployment process are presented as results by two industrial cases.

Finally, two papers focus on human factors in industry. Ceccacci et al. propose a pragmatic approach to apply ergonomic risk management in practice, thanks to a multipath methodology to investigate human factors impacting on workers' safety by considering the specific workspace, the adopted tools, the overall production environment and the workers' activity. An industrial case study is described to illustrate the methodology application and demonstrate the benefits for companies. Ito and Kamat present a prototype of an ergonomic work monitoring system to evaluate work posture in a manufacturing work environment, integrating environmental measurements and body posture measurement. The study starts with the importance of ergonomic consideration on workers in manufacturing, which attracts much attention by industries both in Malaysia and Japan. The proposed tool allows reviewing the experimental results at a welding assembly section. The study finally discusses the feasibility of applying the proposed approach to prevent ergonomic issues in all manufacturing industries.

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