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Transdisciplinary Engineering for Complex Socio-technical Systems in Perspective of Real-life Application

Proceedings of the 27th ISTE International Conference on

Transdisciplinary Engineering, July 1 – July 10, 2020

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Preface

This book of proceedings contains papers that have been peer-reviewed and accepted for the 27th ISTE International Conference on Transdisciplinary Engineering, organized by Warsaw University of Technology, Poland, July 1 – 10, 2020. TE2020 has been the first conference in the series that was organized in a virtual manner due to the COVID-19 world-wide crisis. The papers published in this book of proceedings, as well as video presentations, were accessible during July 2020 in Webex Teams, while questions and answers were being exchanged.

This is the ninth issue of the series "Advances in Transdisciplinary Engineering", which publishes the proceedings of the TE (formerly: CE) conference series and accompanying events. The TE conference series is organized annually by the International Society of Transdisciplinary Engineering, in short ISTE (www.intsoctransde.org), formerly called International Society of Productivity Enhancement (ISPE, Inc.) and constitutes an important forum for international scientific exchange on transdisciplinary engineering. These international conferences attract a significant number of researchers, industry experts and students, as well as government representatives, who are interested in recent advances in transdisciplinary engineering research, advancements and applications.

The concept of Transdisciplinary Engineering includes Concurrent Engineering (CE), but also transcends it. The concept of CE, developed in the 80's, implies that different phases of a product life cycle are conducted concurrently and initiated as early as possible within the Product Creation Process (PCP), including the implications of this approach within the extended enterprise and networks. The main goal of CE is to increase the efficiency and effectiveness of the PCP and to reduce errors in the later phases, as well as to incorporate considerations for the full lifecycle, through-life operations, and environmental issues. In the past decades, CE has become the substantive basic methodology in many industries (e.g., automotive, aerospace, machinery, shipbuilding, consumer goods, process industry, environmental engineering) and is also adopted in the development of new services and service support. Collaboration between different disciplines is key to successful CE.

While for several decades CE proved its value in many industries and still continues to do so, many current engineering problems require a more encompassing approach. Many engineering problems have a large impact on society. For example, the development of self-driving cars requires taking into account changes in regulations for managing responsibilities, adaptation of road networks, political decisions, infrastructures for energy supply, etc. The impacted society may also be the business environment of networks of companies and supply chains. For example, the adoption and implementation of Industry 4.0 requires taking into account the changes to be expected in the business environment, the people, their jobs, the knowledge needed, technology, organizational rules and behaviours. These kind of engineering problems also require collaboration, but not only between technical disciplines. Disciplines from other scientific fields need to be incorporated in the engineering process, like disciplines from social sciences (governance, psychology, etc.), law, medicine, or other fields, relevant for the problem at hand.

The concept of transdisciplinary engineering transcends inter- and multi-disciplinary ways of working, like in CE. In particular, transdisciplinary processes are aimed at solving complex ill-defined problems or problems for which the solution is not obvious from the beginning. While such problems, including their solutions, have a large impact on society and the context in which the problems exist, it is important that people from society and practice collaborate with people from different relevant scientific communities. Neither one discipline nor one person can bring sufficient knowledge for solving such problems. Collaboration again is essential but has become even more demanding. Disciplines should be open to other disciplines to be able to share and exchange the knowledge necessary for solving the problem.

Any engineering problem can be put is a context in which the problem is to be solved or in which the solution for the problem is expected to be used. For researchers and engineers, it is important to take into account this context. This could be done, for example, by collaborating with researchers who can study user acceptance of the envisioned solution or with researchers who can apply suitable methods to acquire user preferences in the respective context and translate them into the necessary requirements for the solution to be developed. Validation of a proposed engineering solution will benefit also by incorporating people from other scientific fields

The conference is entitled: “Transdisciplinary Engineering for Complex Socio-technical Systems in perspective of Real-life Application”. The TE2020 Organizing Committee has identified 36 thematic areas grouped into nine themes within TE and launched a Call for Papers accordingly. More than 80 papers have been submitted from all continents of the world. The submissions as well as invited talks have been collated into nine themes.

The Proceedings contains 71 peer-reviewed papers presented at the conference by authors from 17 countries. These papers range from the theoretical, conceptual to strongly pragmatic addressing industrial best practice. The involvement of industry in many of the presented papers gives additional importance to this conference.

This book on “Transdisciplinary Engineering for Complex Socio-technical Systems in perspective of Real-life Application” is directed at three constituencies: researchers, design practitioners, and educators. Researchers will benefit from the latest research results and knowledge of product creation processes and related methodologies. Engineering professionals and practitioners will learn from the current state of the art in transdisciplinary engineering practice, new approaches, methods, tools and their applications. The educators in the TE community gather the latest advances and methodologies for dissemination in engineering curricula, to prepare students for transdisciplinary collaboration in complex engineering processes, while the community also encourages educators to bring new ideas into the field. With the annual contributions of many researchers and practitioners the book series will contribute to the further development of the concept of Transdisciplinary Engineering.

The proceedings are subdivided into several parts, reflecting the themes addressed in the conference programme:

Part 1 is entitled Transdisciplinary Engineering and contains seven papers that address the concept of TE. Some papers contain research into understanding the concept of TE, while others present work in which a transdisciplinary approach is or has been applied in developing a complex system.

Part 2 contains papers in the area of Transdisciplinary Engineering Education, an important field in our conferences. Empowering students with the knowledge to collaborate in complex project like TE

projects is very important. Four papers present different ways in which students learn to deal with different types of knowledge

Part 3, Industry 4.0, Methods and Tools, contains seven papers with subjects like bibliometric analysis for smart farming, information traceability to detect non-conformities in production, design languages for automatic generation of digital twins of CBSs, Enterprise Maturity Levels measurement, the use of IoT in industrial logistics, a design support tool for the development of CPSs, and reference architectures for Industry 4.0.

Part 4 contains eight papers in the theme Human-Centred Design addressing e.g., a transdisciplinary assessment matrix for human-machine interaction, innovative tools for designing ergonomic control dashboards, ergonomics in a university hospital, informal requirements analysis for a prosthetic device, radiographic bone age assessment, technology for the manufacturing of innovative orthopaedic corsets, evaluation of humanoid robot design base on global eye-tracking metrics, and transdisciplinary design of an air mobile stroke unit.

Part 5 is entitled Methods and Tools for Design and Production. It contains 14 papers focusing on engineering and logistic subjects like Berth allocation and quay crane assignment, control and coordination, tools for sheet metal forming, mass customization services through VR-enabled chatbot systems, green flatcar transportation scheduling in shipbuilding, FMEA with a multi-criteria approach, MCDM application in early stages of the PDP, context-sensitive evaluation of PSS solutions, change propagation in product realization, impact assessment of food safety news, automated generation of a digital twin of a manufacturing system, phenomena in safety systems made of hyper-elastic materials, verification of a method for building a very flexible wing generative model, and a thermomechanical model of a crank mechanism.

Part 6 contains nine contributions on Product and Process Development with various contributions like a design methodology for smart PSS development, digital collaboration techniques for interdisciplinary collaboration, energetic autonomy of UAV, a requirements management tool for specification and analysis of product lines, a multi-disciplinary optimisation framework for dual-mode launch vehicle concepts, factory planning by automated generation of a digital twin, design of injection moulding for LED lamp power supply, morphic arrangement of high flexibility and aspect ratio wing, and hierarchical models for vulnerability analysis of road networks.

Part 7 is entitled Knowledge and Data Modelling. It contains 13 papers with a focus on modelling, like a synthetic dataset for deep learning noise filtering, BIM maturity models, issues in semantic interoperability in integrated manufacturing, neural network for forecasting intermittent demand, semantic ontology for identification of trademark case precedents, integrated information for customized product development, reliability prediction for aircraft component behaviour by using textual elements, parametric modelling of steel connectors, knowledge-based assisting tools, agile engineering change management approach, cost modelling of recycling carbon fibre composites, modularity and configuration for IoT, and robust CAD modelling for industrial application.

Part 8 deals with Business Process and Supply Chain Management. This part contains seven contributions on identifying superfluous work in shop floor management digitalisation, conceptual model for process capability, practice-based learning for successful application of supply chain 4.0 technology, foreign direct investment and enterprise ownership, bibliometric analysis of production planning optimization, delivery demand peak levelling based on capability assessment of customer's acceptance, and an adaption of the internal quality auditing process.

Part 9 contains contributions on Sustainability addressing global transport challenges in reducing emission, and a CAD material skeleton approach for sustainable design.

We acknowledge the high-quality contributions of all authors to this book and the work of the members of the Scientific Committee who assisted with the blind peer-review of the original papers submitted and presented at the conference. Readers are sincerely invited to consider all of the contributions made by this year's participants through the presentation of TE2020 papers collated into this book of proceedings. We hope that they will be further inspired in their work for disseminating their ideas on transdisciplinary engineering within the ISTE community.

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