Simulation

Special Issue Editorial

Simulation: Transactions of the Society for Modeling and Simulation International
2024, Vol. 100(6) 527–528

DOI: 10.1177/00375497241252172
journals.sagepub.com/home/sim
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Commemorating SIMULATION's 100th volume: selected articles by Editorial Board members

As discussed in the preceding Editorial, these special issues are one of the events planned to commemorate the 100th volume of our journal. These articles have been authored by members of our esteemed Editorial Board, a meticulously revamped team built during Prof. Gabriel Wainer's tenure as Editor in Chief, comprised of a diverse group chosen based on their varied expertise and perspectives. This variety can be seen in this interesting Special Issue, where many of our Associate Editors have provided insightful commentary and analysis on their own areas of interest, aiming to spark meaningful conversations and drive positive change within our community. Dr Giabbanelli organized and oversaw the peer review of the articles, using the journal standards for Special Issues, and ensuring the quality of the overall process. We are thankful for his hard work and the excellent results he obtained in putting together these materials.

Some of the various themes in these special issues are familiar to readers in the Modeling & Simulation (M&S) community. For example, Verification and Validation, essential tasks to ensure quality of the results obtained. Historically, M&S faced a scarcity of data for these tasks, thus it was necessary at times to assume the value of simulation parameters or to perform validation in a qualitative manner. The situation is different today, as we face a data deluge. To adapt to this environment, simulation experts need to efficiently integrate data into their work. The assimilation of data into simulation models can be arduous when data is being continuously recorded, e.g., through the many sensors that compose the Internet of Things (IoT). Hu and Yan provide practical solutions for this timely issue by showing how *real-time data* can be integrated into simulations. Likewise, machine learning and artificial intelligence (ML/AI) are now powerful tools to improve verification and validation, as shown by Liang et al.,[2] which discusses how a traditional task such as verification can be revisited through the lens of ML/AI. The use of ML/AI also features prominently in other articles of these special issues, for instance, in Honhaga and Szabo's[3] article, which shows the use of reinforcement learning for large-scale operations in dynamic environments. Another important methodological innovation discussed in these issues is virtual reality, a technique with increased sophistication and growing availability. Fu et al.[4] show an elegant integration of virtual reality and simulation through the use of fire simulation in buildings.

M&S has long been a driving force in science and engineering. In particular, practical problems emerging from the industry have fueled the development of new models, paving the way for technical innovations whose applicability was often broader than the original problem of interest. In these special issues, Zhang et al.[5] exemplify the tight connection between M&S and industrial needs by proposing a simplified generator system along with numerical simulations. This system is important for energy transmission, which is a key part of the power system. The use of differential equations to represent continuous signals is also examined by Barros,[6] who discusses a formalism and its use in generating signals, as illustrated by a resistor-capacitor circuit (Defining hybrid hierarchical models in πHyFlow). The benefits of sound formalisms to build systems are further exemplified by Castro et al.,[7] who build on discrete event system specifications (DEVS) to examine a family of numerical integration algorithms. Another extension of DEVS is shown by Fard and Sarjoughian[8] in the context of water and energy systems.

The rich applications of M&S to engineering are also demonstrated by Moreira and Marques[9] in the context of surface treatments, which can be used in automotive systems. The use of M&S in science and engineering is far from being limited to providing analytical tools for physical systems. Indeed, simulation has also been used for decades to support engineering education by developing different categories of competencies (e.g., personal openness and reflection capability, socio-communicative aspects of teamwork and leadership). Negahban[10] provides a thought-provoking examination of current opportunities such as virtual labs and immersive learning environments, along with several open problems.

These special issues have identified research gaps, as further demonstrated by Tolk,[11] who builds on his leadership in simulation interoperability to summarize three decades of achievements and propose concrete actions for the future. Achieving a shared understanding among systems that have been developed independently continues to be a highly relevant task. This is a challenging task, due to the intricacies of conceptual alignment among models and their semantics. To address this issue, Frydenlund et al.[12] discuss how to use large language models (LLMs) for M&S, turning text-based descriptions of a phenomenon into a model in a variety of paradigms. This emphasis is also apparent when it comes to Digital Twins and Cyber-Physical Systems. Via a thought-provoking perspective on

evolution or revolution by Ali et al.[13], leaders in this research area invite the broader community of modelers and simulationists to move beyond buzzwords and reflect on some of the fundamental shifts of our time, such as the ongoing (digital) industrial revolution.

We hope you enjoy these thought-provoking and engaging articles. We trust these special issues of SIMULATION will capture your interest. Thank you for choosing our publication. We look forward to sharing the next 100 volumes with you.

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