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## Editorial

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It is with great pleasure that we share this special issue of the *International Journal of Simulation Process Modelling* (IJSPM) with its focus on 'Modelling and Simulation Education'. As we know, *IJSPM* strives to disseminate high-quality research about the theory and the practice of simulation and process modelling. Modelling and Simulation (M&S) Education is key to explaining the *theory behind M&S* via coursework and study of the ever-expanding body of knowledge, and the *practice of M&S* through the application of those academic principles.

Those of us engaging the discipline of M&S recognise its useful attributes:

- it allows for precise abstraction of reality
- it hosts a methodology to master complexity
- it requires techniques and tools
- it is validated by solid mathematical foundations.

At the core of the discipline are three basic precepts: the fundamental notion that 'models' are approximations for the real-world; a well-developed model can then be followed by 'simulation', which allows for the repeated observation of the model; and that 'analysis' facilitates drawing conclusions, verification and validation (V&V), and recommendations based on various iterations/simulations of the model. These three principles coupled with 'visualisation', the ability to represent data as a way to interface with the model, make M&S a problem-based discipline that allows for repeated testing of a hypothesis.

Teaching these precepts and providing research and development opportunities are core to M&S education and research. This special issue comprises five essays specific

to curriculum development, teaching, and new venues for learning.

#### *Curriculum development*

As M&S application domains expand, the user community will expand. To meet the needs of that community education programs throughout the world are introducing new programs of study in the discipline. M&S's long-standing relationship within the sciences and engineering fields is now expanding to include students in health sciences, business, social sciences, and education disciplines. This special issue includes two essays that discuss program development: one from a multidisciplinary approach and one that suggests incorporating aspects of M&S studies into an existing curriculum.

In 'A model for multidisciplinary graduate education in modelling and simulation' Roland R. Mielke, Mark W. Scerbo, Kurt Taylor Gaubatz and Ginger S. Watson (Old Dominion University, Virginia) detail two different approaches to M&S graduate education, one path for users of M&S and another path for developers of M&S. This is premised by the fact that M&S is an increasingly important aspect of scientific investigation in numerous disciplines. The authors suggest that universities can no longer adhere to the traditional departmental approach, the one-size-fits-all approach, with regard to M&S education. They proffer a new multidisciplinary approach to M&S graduate education that encourages the development of a number of M&S programs or tracks, coordinated by university-level oversight, in which all academic colleges participate.

The paper 'Embedding simulation education into the engineering management body of knowledge'

by Andreas Tolk (Old Dominion University), Gaith Rabadi (Old Dominion University), and Donald N. Merino (Stevens Institute of Technology) acknowledge that simulation is of growing interest to engineers in general and to engineering managers in particular. Specifically, simulation is part of the M&S a body of knowledge established by the American Society for Engineering Management. Its basis comprises established and accredited curricula and additional input from practitioners of the field. The authors suggest embedding aspects of simulation education within the basic topics and core competences of the Engineering Management body of knowledge as well as application specific domain knowledge.

#### *Teaching: simulation as art*

M&S has the necessary theory and substance to be taught as a discipline, and many think it should be taught as a discipline in itself. M&S is an infrastructure discipline necessary to support integration of the partial knowledge of other disciplines needed in applications. As a discipline, M&S has a robust theory based on dynamic systems, computer science, and an ontology of the domain. It is the theory and ontology that characterise M&S as distinct in relation to other disciplines; these serve as necessary components of a body of knowledge needed to professionally practice M&S in any of its aspects. Some M&S professionals suggest simulation is more of an art than science in that the various stages of simulation development engage artistic characteristics.

‘Simulation – Art or science? How to teach it?’ by Istvan Molnar (Bloomsberg University of Pennsylvania), Alfredo O. Moscardini (University of Sunderland) and Reiner Breyer (University of Applied Sciences Ostfriesland) examines the underlying philosophy of simulation education to include different phases of modelling and simulation and different scientific or artistic characteristics that are predominant. Certain skills are required of the user to develop simulations as well as understanding simulation methodologies and employing software tools. The research presented by Molnar et al., proposes that simulation is more of an art than a science and that this viewpoint has major consequences for its pedagogy.

#### *Teaching: simulation and epidemiology*

M&S is unique as a discipline, set apart by its ability to progress from hypothesis – to simulation – to test; its ability to allow for precise abstraction that can master complexity; its ability to apply robust theory and ontology; and, its ability to cross-cut ideas of modelling methods and theories of simulation. This cross-cutting is truly significant

as there is now much interest using computational modelling and simulation tools to address problems considered too complex for standard statistical analyses.

‘Learning to build network-oriented epidemic simulation models in epidemiology education’ by Ji-Lung Hsieh (National ChiaoTung University), Chung-Yuan Huang (Chang Gung University), Chuen-Tsai Sun (National ChiaoTung University), Yu-Shiuan Tsai (National Chiao Tung University), and Gloria Yi-Ming Kao (National Chiao Tung University) offers insight into the use of computational modelling and simulation software to teach epidemiology concepts. The authors proffer that integrating domain-specific knowledge and building network-oriented simulation models are proving to be difficult tasks in terms of teacher preparation and learner evaluation. The authors introduce an architecture based on demographic and geographic data for building network-oriented epidemic simulation model of the transmission dynamics of three infectious diseases. Their research illustrates the challenge of creating network-oriented models in epidemiology education.

#### *New venues: teaching online*

Information technologies offer new ways to teach and learn. This is driving the growth of distance learning opportunities while simultaneously facilitating a shift to an emergent educational paradigm which considers students as active and central actors in their learning process. The final essay from a group of scholars in Spain serves as a case study in online education.

‘Learning Operations Research online: benefits, challenges, and experiences’ by Javier Faulin and Angel A. Juan (University of Lleida), Pau Fonseca and Lluís M. Pla (Open University of Catalonia), and Sara V. Rodriguez (Public University of Navarre) provides a discussion on the benefits and challenges related to the teaching and learning of operations research in online environments. Use of computer software and collaborative e-learning as methodological policies to increase students’ motivation for operations research are also discussed in this paper.

There is no question that a need exists for young professionals to serve as future teachers, developers, and users of M&S. Within the pages of this special issue of *IJSPM*, ‘Modelling and Simulation Education’, you will be introduced to new approaches for curriculum development, unusual perspectives on teaching simulation, and experiences in working with new venues of learning.

We hope you enjoy the contributions made by this distinguished body of educators.