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## Editorial

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**Biographical note:** Agostino G. Bruzzone is Full Professor at DIME (formerly DIPTEM) University of Genoa, Director of M&S Net (International Network involving 34 Centres), Director of the McLeod Institute of Simulation Science – Genoa Center (over 28 Centres distributed worldwide), founder member and president of the Liophant Simulation, member of the Board of MIMOS (Movimento Italiano di Simulazione) and member of the NATO MSG. He works on innovative modelling, AI techniques, application of neural networks, GAs and fuzzy logic to industrial plant problems using simulation and chaos theory. He is a member of several International Technical and Organization Committees (i.e. AI Application of IASTED, AI Conference, ESS, ESM, AMS) and General Chair of many international conferences (e.g. General Chair of SCSC and I3M). He teaches ‘M&S’, ‘M&S for Biomedical Systems’, ‘VV&A’ for the PhD Program DIMS (Doctorship in Integrated Mathematical M&S). He is Director of the Master Program in Industrial Plants for the University of Genoa.

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Over the years, Modelling & Simulation (M&S) has proved to be one of the most effective and successful methodologies (and technologies) to investigate and study complex systems belonging to various sectors/areas. Continuous hardware and innovations and software advances have certainly contributed in making M&S a cutting-edge methodology by enlarging its scope of applicability and potential advantages. The United States House Resolution 487 recognizes the strategic importance of M&S: “Recognizing the contribution of Modelling and Simulation technology to the security and prosperity of the United States and recognizing Modelling and Simulation as a National Critical technology”.

A simple overview of the scientific literature over the last 50 years clearly reveals the continuous growth of the simulation community from the ‘formative years’, where simulations were carried out mostly in the military and industry sectors, to the recent developments in the fields of simulation-based serious games used for high-level training and education in a number of different areas. M&S can be used as part of multidisciplinary approaches (where multiple disciplines are concurrently used to pursue well-defined objectives) and as strength for evaluating and exploring different options, diagnosing problems, finding out optimal solutions, training managers and operators and transferring knowledge and results into the real systems (Banks, 1998). Nowadays, M&S is widely and successfully applied in many application domains, ranging from industry to social sciences, from logistics to military, from energy to health-care; in this sense M&S provides a multidisciplinary perspective where theory and data from different fields can be used to build models and simulations that provide insights in to the system considered (Del Rio Vilas et al, 2012).

Apart from the number and types of disciplines involved in the development of a simulation model, M&S continues to receive research attention mainly because it can be used

for a wide range of purposes, namely decision making (at strategic, tactic and operative levels), optimization (when combined with artificial intelligence techniques) education and training, from education in universities to training in real complex systems, including cooperative and multidisciplinary training (Bruzzone et al. 2007; Bruzzone and Longo, 2013). The success of the so-called simulation-based optimization relies on the concrete possibility to detect a variety of alternative solutions and test them under different constraints and objectives. In this regard, Fu and Glover (2005) present a classification of the most important simulation-based optimization approaches proposed in the literature; additional information and classifications can be found in Azadivar (1992), Fogel (1994), Merkurjev and Visipkov (1994), Alander (1997), Carson and Maria (1997), Andradóttir (1998), Andradóttir (2006), Fulcher (2008), Prudius and Andradóttir (2012) and many others.

The spread of M&S based training tools, instead, has been encouraged by the great variety of situations and contexts where training of inexperienced people in the real system may well be dangerous and/or expensive. In this case, the main advantages of the simulation-based training rely on the possibility for the operators to be immediately aware about the consequences of their actions in a visual manner while experiencing a variety of possible scenarios that cannot be recreated in the real system and avoiding the potential dangers that may occur when real tools and equipment are used. Further advantages include the strong reduction of the training costs (both direct and indirect costs) and the possibility to collect and store data for after-action review and monitoring of the trainees’ performance evolution (Wilson et al. 1998; Bruzzone and Longo, 2010; Bruzzone et al. 2010). These advantages have encouraged the development of advanced training tools based on M&S in many sectors, as clearly proved by the variety and number of the published research works:

- Menendez and Bernard (2000), Chin-Teng et al. (2001), Koglbauer et al. (2011) and de Winter et al. (2012) report examples of flight simulators,
- Lee et al. (1998) Freund et al. (2001), Park et al. (2001), Roenker et al. (2003) and Dunn and Williamson (2012) report examples of driving simulators,
- Zeltzer et al. (1995), Sotomayor (2010) and Bruzzone (2011) report examples of military training,
- Cramer et al. (2000), Anon (2000), Forssén and Haho (2001) and Manca et al. (2013) report examples of simulation based training in industry.

Finally training in virtual environments has been successfully applied in marine ports and container terminals for operators training (Seron et al., 1999; Kim, 2005; Wilson et al., 1998; Huang, 2003; Daqaq, 2003; Rouvinen et al., 2005, Longo 2010).

Furthermore, it is worth mentioning that during recent years both the healthcare and the sustainable development (for energy and environment) sectors have become important application areas for M&S. Innovative simulations for healthcare can be found in diagnostic and therapy, cellular and molecular models in medicine, biosciences and bioinformatics, surgery, administration of anaesthesia, laparoscopy, endoscopy and intensive care. Specific references in this area are Gaba and DeAnda (1988), Suwa(1992), Swank and Jahr (1992), Lussi et al. (1999), Morris et al. (2006), Semeraro et al (2008), Yoshida et al (2009) Sun et al. (2010) and Murray (2011). Interesting simulation applications in the sustainable development for energy and environment regards, among others, climate change, conservation, renewable energy, environmental health and degradation, genetic engineering and nanotechnology, nuclear issues, pollution and resources depletion. Examples of research work can be found in Kutzbach and Guetter (1986), Nobre et al. (2005), Bernal-Agustin and Dufo-Lopez (2009), Chauliac et al. (2011), Teutschbein and Seibert (2012).

The objective of this special issue is to provide the reader with some of the latest advances in complex systems design and management based on M&S; the selection of the papers in this special issue has been made according to a multidisciplinary perspective, therefore including different application areas (industry, logistics, environment, healthcare, energy) and different focuses (methodology and tools development). The issue includes the extensions of the best papers of the I3M 2011 (International Multidisciplinary Modeling & Simulation Multiconference 2011) which are the results of more than a year's effort that was carried out with the invaluable support of the authors and reviewers, who have strongly contributed to increase the scientific and academic relevance of the papers. It is worth saying that the special issue includes two papers in the industry and logistics area (simulation is used to support the decision making in a manufacturing system, by Longo; simulation is used as training tool in marine ports ), two papers in the healthcare area (simulation is used for diagnostic and

therapy, by Winkler et al. and simulation is used for dynamic healthcare practices by Santos et al.), two papers in the sustainable development for energy and environment area (simulation is used for environmental assessment and products design) and two papers in the simulation methodologies area (where different simulation networks problems are investigated). A summary of the papers is reported below.

- In the paper 'On the short period production planning in industrial plants: a real case study', by Francesco Longo, the author proposes a simulation-based tool for the short period production planning in industrial plants. The tool has been specifically developed for a real manufacturing system that produces high pressure hoses in the south of Italy. During the developmental phase an advanced simulation approach, based on programming code and tables for information storage, has been adopted. As a result the proposed modelling architecture ensures flexibility and high computational efficiency and allows comparing the system performances under different production planning scenarios obtained by applying dispatching rules, genetic algorithms and ant colony optimization algorithms. The suitability of the simulation outputs is ensured by the verification and validation activities carried out in the developmental phase; furthermore, specific subroutines allow the full integration of the simulation model with the company ERP system.
- In the paper 'HLA-based real time distributed simulation of a terminal port for training purpose', by Marina Massei, Alberto Tremori, Simonluca Poggi and Letizia Nicoletti, the authors propose a real-time distributed simulation environment called ST-VP (Simulation Team Virtual Port Simulator), for training purposes in marine ports able also to take into account safety and operative efficiency. The simulators, installed on low-cost training workstations, cooperate and share the same virtual environment based on the High Level Architecture standard for distributed simulation (HLA) and they can be effectively used for cooperative training.
- In the paper 'On the use of estimated tumour marker classifications in tumour diagnosis prediction: a case study for breast cancer', by Stephan Winkler, Michael Affenzeller, Gabriel Kronberger, Michael Kommenda, Stefan Wagner, Viktoria Dorfer, Witold Jacak and Herbert Stekel, the authors describe the use of tumour marker estimation models in the prediction of tumour diagnoses. In previous work we have identified classification models that can be used for estimating tumour marker values on the basis of standard blood parameters. These virtual tumour markers are used in combination with blood parameters for learning classifiers that are used for predicting tumour diagnoses. Several data-based modelling approaches implemented in HeuristicLab have been applied for identifying estimators for selected tumour markers and

cancer diagnoses: linear regression, k-nearest neighbour learning, artificial neural networks and support vector machines (all optimized using evolutionary algorithms) as well as genetic programming. We have applied these modelling approaches for identifying models for breast cancer diagnoses; in the results section we summarize classification accuracies for breast cancer and we compare classification results achieved by models that use measured marker values as well as models that use virtual tumour markers.

- In the paper ‘Modelling and simulating dynamic healthcare practices’, by Eugene Santos, Keum Joo Kim, Fei Yu, Deqing Li and Joseph Rosen, the authors present an advanced methodology to model and simulate more dynamic situations over longer periods of time in real-life healthcare practices. Through the simulation and gap analysis, the authors are able to show that collective decisions are expected to improve both the training of the operators and the quality of care significantly.
- In the paper ‘Multicriteria approach for process modelling in strategic environmental management planning’, by Antonella Petrillo and Fabio De Felice, the authors test a multicriteria methodological approach based on the Analytic Network Process methodology (ANP) in order to examine the scope and feasibility of a process modelling integrated with public participation for environmental assessment. In fact, environmental challenges decisions are often characterised by complexity, irreversibility and uncertainty. Much of the complexity arises from the multiple-use nature of goods and services, difficulty in monetary valuation of ecological services and the involvement of numerous stakeholders. From this point of view, multicriteria techniques and process modelling are considered as a promising framework to take into account conflictual, multidimensional, incommensurable and uncertain effects of decisions explicitly. In particular, the integration of ANP with tools for public participation and process modelling poses certain methodological challenges, but provides an innovative approach to designing the scope of the environmental assessment and defining and assessing alternatives.
- In the paper ‘Modelling of aerodynamic flutter on a NACA 4412 airfoil wind blade’, by Drishtysingh Ramdenee, Adrian Ilinca, Ion Sorin Minea and Hussein Ibrahim, the authors assert that study of aero elastic phenomena on wind turbines (WT) has become a very important issue when it comes to safety and economic considerations as WT tend towards gigantism and flexibility. At the Wind Energy Research Laboratory (WERL), several studies and papers have been conducted and published, all focusing on Computational Fluid Dynamics (CFD) approaches to model and simulate different aero elastic phenomena. Despite very interesting obtained results, CFD is very costly and difficult to be directly used for control

purposes owing to consequent computational time. This paper describes a complementary lumped system approach to CFD to model flutter phenomena. This model is based on a described Matlab-Simulink model that integrates turbulence characteristics as well as characteristic aerodynamic physics. From this model, we elaborate on flutter eigen-modes and eigen-values in an aim to apply control strategies and relate ANSYS-based CFD modelling to the lumped system.

- In the paper ‘Petri nets with exclusive entities for decision making’, by Juan Ignacio Latorre and Emilio Jimenez, the design of discrete event systems (DES) can be seen as a sequence of decisions leading to a final product that complies with a set of specifications and operates with efficiency. These decisions usually include the choice among a set of alternative structural configurations for the DES. This paper discusses the formalization of a decision problem based on a DES into an optimisation problem, stressing and making explicit the exclusiveness between alternative structural configurations. This approach broadens and improves the classical methodology for solving the mentioned problems with new ideas and techniques. A significant advantage achieved consists of increasing the efficiency of the solving techniques by removing redundant information in the Petri net model of the DES and by unifying the solution space.
- In the paper ‘Measuring degree-dependent failure in scale-free networks of bipartite structure’, by Yilun Shang, the author studies degree-dependent failure in networks consisting of two types of node with edges running only between nodes of unlike type. Both types of node are assumed to have scale-free degree distributions. These networks are called as scale-free bipartite graphs, which appear in many real-life networks. In the paper, the author measure the network robustness and fragility based on a recently proposed spectral measure, natural connectivity, which is an average eigenvalue obtained from the graph spectrum.

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