Editorial

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Biographical notes: Agostino G. Bruzzone is Director of the MISS DIPTEM, Genoa. He teaches 'Theories and Techniques of Automatic Control', and since 1992 he has been a member of the industrial simulation work group at the ITIM University of Genoa; currently, he is Full Professor at DIPTEM. He uses simulation techniques in harbour terminals, maritime trading, industrial and business applications. He is involved in the scientific community and served as Director of the McLeod Institute of Simulation Science (MISS), Associate Vice-President and Member of the Board of the SCS (International Society for Modelling & Simulation), President of the Liophant Simulation, Vice-President of MIMOS (Movimento Italiano di Simulazione), and Italian Point of Contact for the ISAG (International Simulation Advisory Group) and Sim-Serv. He has written more than 150 scientific papers in addition to technical and professional reports in partnerships with major companies.

The world of Modelling and Simulation (M&S) is always strictly related to application fields; in fact, simulation is often the main tool to investigate systems where traditional thematic approaches are unable to deal with their complexity and high number of interacting phenomena or interoperable components (Bruzzone and Williams, 2006).

The origins of M&S are very articulated and it is possible to identify ancestors even during ancient times in Egypt, Greece and the Roman Empire (Carpenter Workshop, "Aristotelian Coreia, Circus Maximus", Bruzzone et al., 2004); however, in modern age, M&S activities grew quickly in term of computer simulation, strongly promoted by analogue and digital computer developments after World War II; in that period, the defence and airspace sectors represented major areas of investigation for M&S.

Therefore, M&S quickly became extensively applied in industry and logistics, providing opportunities for creating and extending new simulation paradigms and to demonstrate the potential in this framework (i.e., discrete event simulation). In fact, simulation allows artificial histories (simulation models) of real complex systems (Banks, 1998) to be created, to combine different aspects and to carry out virtual experimentations. Analytical approaches and models, as well as mathematical programming, often fall short of results applicability owing to the high number of restrictive assumptions that their application to real contexts requires, and so outcomes from such models hardly support the decision process in real world. In industry and logistics, it is critical to avoid models that recreate the reality to fit their a priori hypotheses; this approach represents often a theoretical solution unrelated to the real problem and without any effective capability to support industrial users; usually, simulationists' researches take the opposite direction by recreating complex models able to introduce all the critical real issues: this is the reason for the positive results achieved by M&S in this context.

Over half a century has passed since the first uses of M&S in industry, and the methodologies and approaches have evolved and recombined themselves to become more reliable and flexible. In parallel, the original simulation tools evolved in more effective solutions: major companies involved in M&S applications for industry and logistics have migrated over the years from different packages, hardware and software frameworks.

Looking back over this timeline, it is interesting to realise that the fundamental concepts still represent a cornerstone today as well as in the middle of last century: i.e., the criticality of verification and validation in M&S, the importance of solid conceptual modelling, efficient implementation solutions, object-driven model development, usability/fidelity ratio and proper planning of resources usage (Amico et al., 2000). From other point of view, it is also important to outline new issues and aspects related to 'Modelling and Applied Simulation in Industry and Industrial Logistics', the title of this Special Issue; therefore, today, it is possible to identify some major categories of innovation/change enabling M&S to be used as cutting-edge technology for industry:

- Techniques and Methodology Advances
- Innovative Technology for M&S Implementation and Use
- Innovative Technology for Process Solutions
- Innovative Management Solutions
- Scenario Evolution.

First of all, the methodologies and techniques are evolving quickly and they provide a very interesting opportunity for

Research and Development (R&D) in industrial applications. In fact, M&S applications often require the combination of different approaches to implement models capable of facing the challenging problems provided by real complex systems; so, it is common to integrate advanced artificial intelligence and intelligent agent techniques into simulation models to improve performance and to recreate the smart control of processes that usually requires the presence of the human factor (Bruzzone et al., 1999; Bruzzone and Signorile, 2001; Piera, 2009).

For instance, researches focused on optimisation algorithms, inspired by nature observation and evolved during recent years, have proven to be effective and robust solutions in industrial applications in strong liaison with M&S. Innovation in this field is related to the fact that it is possible to structure the problem as well as the methods, to improve their effectiveness. An interesting example is provided by ant colony optimisation, where constructive computational agents called 'ants' simulate real ants for achieving optimised results (Gambardella and Dorigo, 2000).

In addition, it is evident that the new technologies for M&S implementation provide different and innovative opportunities to combine, integrate, interoperate and use simulation solutions; currently, Information Technology (IT) provides a new generation of networking solutions that support the evolution from old distributed simulation to innovative web-based simulation and net-centric philosophy (Bruzzone et al., 1999; Bruzzone and Garassino, 2007).

In industry, and even more in logistics, considering their distributed nature in term of internal (i.e., warehouses, manufacturing) and external (i.e., supply chain) applications, the possibility to develop new distributed interoperable solutions combining online real situations with simulators (to generate scenarios for supporting decision-making processes and operative management) represents a strategic advantage. From this point of view, the innovations in Information and Communication Technology (ICT) simplify these developments, improve reliability and reduce drastically the related costs and times (Tiacci and Saetta, 2009).

These technologies are currently becoming more and more affordable and reliable, so they are promising further advances in terms of diffusion and interoperability of online simulation with the real world, introducing in the industrial sector the new concepts of net-centric management (Bruzzone, 2008).

Furthermore, the innovative concept of serious games introduces a revolution in education that it is quickly diffusing itself in training both for industry and for logistics; such simulation games, applied to industry and supply chains, have to be regarded as a powerful tool for presenting new concepts and for providing experience opportunities for improving decision-making skills (Muller-Malek, 1999; Simchi-Levi et al., 2003; Pecherska and Merkuryeva, 2004; Merkuryeva et al., 2004; Soshko et al., 2005). In addition, these solutions create massive experiments involving many users in many scenarios improving the understanding even of complex problems such as multi-echelon supply chain networks (Chopra and Meindl, 2007; Merkuryev et al., 2007; Graves, 1996). For instance, in this area of investigation, it is possible to develop new aspects in M&S, such as additional stochastic elements (i.e., lead times) in multi-echelon inventory models applied to retail networks connected with central warehouses (Lee and Wu, 2006). When models become mathematically intractable, it is clear that simulation studies become appropriate, so it becomes possible to identify new robust management policies by extensive simulation experiments, taking off from solutions of traditional deterministic models.

In addition to methodology evolution, it is important to consider the impact of current ICT developments. These affect strongly the industrial processes and it is evident that the consolidation in terms of software as well as in terms of hardware is very significant (i.e., ERP, CRM evolutions, mobile and wireless technology, RFID, etc.). These aspects support a leaner, distributed and quick supply chain organisation and provide new challenges to M&S in terms of modelling wide architectures and more articulated processes that dynamically switch between internal resources, outsourcing and different logistics network configurations.

The examples related to the new solutions for tracking provide an excellent demonstration that these technologies are strongly affecting warehouses as well as logistics nodes in the broad sense; for instance, port-automated vehicles are moving from being an edge solution involving high costs and risks to a much more easy implementation philosophy. In this context, M&S plays a critical role in refining the design solution in terms of automation requirements, new policy and procedures, etc. (Steenken et al., 2004).

Obviously, technology operates in industrial processes also as an enabler for new philosophies for management; opportunities that previously were not reliable or possible become convenient, and new policies need to be tested and validated on complex simulated scenarios (Klimov and Merkuryev, 2008).

For instance, the integrated production, inventory and maintenance problem is concerned with coordinating production, inventory and preventive maintenance operations to meet customers' demands with the aim of minimising costs; therefore, the production allocation and planning are strategic issues characterised by growing interest owing to their impact on competitiveness (Karen et al., 2003). Hence, the planning needs to evolve by combining not only manufacturing and scheduling decisions, but also the capability to proceed in decision-making in an environment affected by many different types of event, such as operations, failures, preventive maintenance and supplies, as well as customer demand fluctuations (Stahlbock and Voß, 2008). Most of these aspects are highly stochastic: they usually occur at the same time and it is evident that this results in a very promising arena for applying M&S.

Finally, in addition to the endogenous changes in the management strategies, it is evident that industry and

logistics are strongly affected by exogenous factors that produce scenario evolution. Traditionally, economic evolution and market demand are major drivers for logistics and industrial processes; in most of the simulators, they represent very influential independent variables for the model. In fact, demand forecasts in emerging markets are usually affected by a high level of uncertainties owing to variance in macroeconomic factors (Sull and Wang, 2005). The recent crisis emphasises the importance of these factors that could be subject to very high rate of change (i.e., social sustainability). In fact, today it has become necessary to introduce new elements to measure the performance of complex industrial and logistics systems vs. these new emerging challenges. Using simulation in this area allows the impact of different parameters to be identified and the degrees of freedom to be studied in terms of their impact on the Key Performance Indexes (KPIs). Indeed, logistics models represent in supply chains the critical element to protect the supply chain in terms of stability, robustness and respect of the newly introduced concept of supply chain resilience (Lee and Billington, 1993; Longo and Ören, 2008).

In addition, fast developing countries are main players in industry and logistics. They are not only production sites, but also very important markets for most Western companies (Woo, 2003). Originally, low labour costs and convenient import tariffs were the major motivations for moving production or constructing new facilities in these areas. Recently, new aspects have emerged in terms of a guarantee of a global approach (Jacob and Strube, 2008) and obviously these strategies require the capacity to define the proper supply chain.

So, to be effective in these new emerging markets, it is necessary to investigate many different scenarios (Laux, 1992; Moran, 2000; Humphrey and Memedovic, 2003) and to test different types of supply chain in terms of many different aspects: investments, sales levels and local content ratio, for example (Chung, 1998; Volpato, 2002).

In fact, there are many alternatives in identifying solutions from industrial and logistics point of view by tailoring the supply chain management. For instance, many different supply strategies have been developed to enter in developing markets (Tulder and Ruigrok, 1997), and often M&S represents the most effective approach for choosing the best one based on simulated experiment on different scenarios corresponding to articulated supply chain alternatives and market hypotheses (Bruzzone, 2002).

Owing to this sum of factors, the impact of M&S in industry and logistics is evident, and it is critical to provide high visibility to the promising R&D in M&S related to these applications that face the above-mentioned challenges and get benefits from the innovation opportunities. Usually, these initiatives are the result of multidisciplinary approaches combining M&S knowledge and industrial and logistics expertise. By this approach, it becomes possible to apply successfully new M&S techniques and methodologies to these challenging sectors (Longo and Mirabelli, 2008).

A good example of these combined factors is represented by the case of logistic nodes, where the evolving market demand requests a continuous growth, while new technologies provide the opportunities for a new level of automation; therefore, it becomes critical to define new layout solutions, new management strategies to be tested and evaluated by simulation before to being applied in the real world. In this case, innovative researches are currently focusing on combining simulation and optimisation techniques to investigate new strategies for redesign and extension of the infrastructures and for resource planning and management.

To establish an M&S reference in advance for industry and industrial logistics, it is necessary to consider the current situation in the M&S excellence networks and scientific activities. For this reason, a survey in major conferences has been conducted, including the 2008 European Modelling & Simulation Symposium (EMSS), the 2008 International Conference on Harbour, Logistics and Transportation Modelling & Simulation (HMS) and the 2008 International Conference on Modelling and Applied Simulation (MAS), under the umbrella of the 2008 International Mediterranean and Latin America Modelling Multiconference (I3M) (Bruzzone et al., 2008a, 2008b, 2008c).

Although it is challenging to select only a few contributions addressing all the critical issues for highlighting the potential of simulation applications in industry and logistics, in this instance the selection resulted from a multilevel process review concerned with the more interesting contributions from scientific and technical points of view as well as in terms of industrial impacts.

The papers presented in this Special Issue represent important contributions in M&S, for this reason I thank all the authors: their effort built up an ideal framework for sharing their advances, promoting the international relations among scientists and networking activity, with attention to possible further international research projects. Special thanks go to IJSPM Editor Nuno Melao, who has drawn together a selection of innovative scientists such as those in this Special Issue, and to the reviewers for their valuable contribution.

I am confident that readers will find new ideas in these contributions that demonstrate the potential of M&S technologies and applications. Such applications demonstrate achievement of the goal of every simulationist: overcome the challenge and increase M&S capacity.

References

Amico, V., Guha, R. and Bruzzone, A.G. (2000) 'Critical issues in simulation', *Proceedings of Summer Computer Simulation Conference*, Vancouver, July, Bruzzone.

Banks, J. (Ed.) (1998) 'Principles of simulation', *Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice*, Chapter 1, John Wiley & Sons, New York, pp.3–30.

Bruzzone, A. and Signorile, R. (2001) 'Container terminal planning by using simulation and genetic algorithms', *Singapore Maritime & Port Journal*, ISSN 0219-1555, pp.104–115.

Bruzzone, A.G. (2002) 'Supply chain management', *Simulation*, ISSN 0037-5497, Vol. 78, No. 5, May, pp.283–337.

Bruzzone, A.G. (2008) 'Net-centric supply chain management based', *Invited, Proceedings of AMS 2008*, Kuala Lumpur, 13–15 May, pp.20–28.

Bruzzone, A.G. and Garassino, G. (2007) *Interoperability in Supply Chain Management for Aerospace Industry*, Keynote Speech, Eurosiw 2007, Santa Margherita, June.

Bruzzone, A.G. and Williams, E. (2006) *Summer Computer Simulation Conference*, SCS International, ISBN 1-56555-307-1, p.504.

Bruzzone, A.G., Elfrey, P., Papoff, E., Massei, M. and Molnar, I. (2008a) *International Workshop on Modeling & Applied Simulation*, DIPTEM Press, Genoa, Italy, ISBN: 978-88-903724-1-4

Bruzzone, A.G., Frydman, C., Massei, M. and Piera, M.A. (2004) *International Mediterranean & Latin American Council of Simulation Manifesto*, SCS Technical Report, San Jose, CA.

Bruzzone, A.G., Giribone, P. and Vio, F. (1999) 'Genetic algorithms and simulation for supporting layout re-engineering of automotive component production facilities', *International Journal of Flexible Automation and Intelligent Manufacturing*, ISSN 1064-3645, Vol. 7, Nos. 3–4, pp.379–391.

Bruzzone, A.G., Longo, F., Merkuryev, Y., Mirabelli, G. and Piera, M.A. (2008b) *International Workshop on Harbor, Maritime & Multimodal Logistics Modelling and Simulation*, DIPTEM Press, Genoa, Italy, ISBN:978-88-903724-1-4.

Bruzzone, A.G., Longo, F., Piera, M.A., Aguilar, R.M. and Frydman, C. (2008c) *European Modelling Simulation Symposium*, DIPTEM Press, Genoa, Italy, ISBN: 978-88-903724-0-7

Bruzzone, A.G., Page, E. and Uhrmacher, A. (1999) *Web-based Modelling & Simulation*, SCS International, San Francisco, ISBN 1-56555-156-7

Chopra, S. and Meindl, P. (2007) *Supply Chain Management: Strategy, Planning, and Operation*, Prentice-Hall, New Jersey.

Chung, M.K. (1998) 'Globalization strategies of Korean motor vehicle industry: a case study of Hyundai', *Actes du GERPISA (Groupe d'Étude et de recherche Permanent sur l'Industrie et les Salariés de l'Automobile)*, Vol. 22.

Gambardella, L.M. and Dorigo, M. (2000) 'An ant colony system hybridized with a new local search for the sequential ordering problem', *INFORMS Journal on Computing*, Vol. 12, No. 3, pp.237–255.

Graves, S.C. (1996) 'A multiechelon inventory model with fixed replenishment intervals', *Management Science*, Vol. 42, No. 1, pp.1–18.

Humphrey, J. and Memedovic, O. (2003) *The Global Automotive Industry Value Chain: What Prospects for Upgrading by Developing Countries*, UNIDO (United Nations Industrial Development Organisation), Vienna.

Jacob, F. and Strube, G. (2008) *Why go Global? The Multinational Imperative*, Springer, Berlin and Heidelberg, Germany.

Karen, K.Y., Liu, H. and Yin, G.G. (2003) 'Stochastic models and numerical solutions for production planning with applications to the paper industry', *Computers and Chemical Engineering*, Vol. 27, pp.1693–1706.

Klimov, R. and Merkuryev, Y. (2008) 'Simulation model for supply chain reliability evaluation', *Technological and Economic Development of Economy, Baltic Journal of Sustainability*, Vol. 14, No. 3, pp.300–311.

Laux, J.M. (1992) *The European Automobile Industry*, Twayne Publishers, New York.

Lee, H. and Billington, C. (1993) 'Materials management in decentralized supply chain', *Operations Research*, Vol. 41, No. 5, pp.835–847.

Lee, H.T. and Wu, J.C. (2006) 'A study on inventory replenishment policies in a two-echelon supply chain system', *Computers & Industrial Engineering*, Vol. 51, pp.257–263.

Longo, F. and Mirabelli, G. (2008) 'An advanced supply chain management tool based on modeling & simulation', *Computers & Industrial Engineering*, ISSN: 0360-8352, doi: 10.1016/j.cie.2007.09.008, Vol. 54, No. 3, pp.570–588.

Longo, F. and Ören, T. (2008) 'Supply chain vulnerability and resilience: a state of the art overview', *Proceedings of the 20th European Modeling & Simulation Symposium*, 17–19 September, Campora S. Giovanni (CS), Italy.

Merkuryev, Y., Merkuryeva, G., Desmet, B. and Jacquet-Lagreze, E. (2007) 'Integrating analytical and simulation techniques in multi-echelon cyclic planning', in Al-Dabass, D., Zobel, R., Abraham, A. and Turner, S. (Eds.): *Proceedings First Asia International Conference on Modelling and Simulation, AMS 2007, Asia Modelling Symposium 2007*, Prince of Songkla University, IEEE, 2007, IEEE Computer Society, 27–30 March, Phuket, Thailand, pp.460–464.

Merkuryeva, G., Bikovska, J., Grubbström, R.W. and Weber, J. (2004) 'Development of learning scenarios for network-based logistics simulation game', *Scientific Proceedings of Riga Technical University. Ser. 5. Computer Science, Information Technology and Management Science*, RTU, Riga, Vol. 20, pp.148–156.

Moran, T.H. (2000) 'The product cycle model of foreign direct investment and developing country welfare', *Journal of International Management*, Vol. 6, pp.297–311.

Muller-Malek, H. (1999) 'Value assessment of a take-over bid for a competitor's logistics operations', in Mullerr-Malek, H., Merkuryev, Y., Silinevicha, I. and Zulch, G. (Eds.): *Cases in Industrial Logistics Management*, Shaker Verlag, Aachen, Germany.

Pecherska, J. and Merkuryeva, G. (2004) 'Experiences using simulation-based case-games in logistics management studies', *Scientific Proceedings of Riga Technical University. Ser. 5. Computer Science*, *Information Technology and Management Science,* RTU, Riga, Vol. 20, pp.122–129.

Piera, M.A. (2009) *Optimization through Simulation in the Logistic Field*, Keynote Speaker at ASM, Palma de Mallorca, Spain, September.

Simchi-Levi, D., Kaminski, P. and Simchi-Levi, E. (2003) *Designing & Managing the Supply Chain*, McGraw-Hill, New York.

Soshko, O., Merkuryev, Y., Merkuryeva, G. and Bikovska, J. (2005) 'Development of active training and educational methods in logistics', *Annual Proceedings of Vidzeme University College. ICTE in Regional Development*, Valmiera, pp.62–66.

Stahlbock, R. and Voß, S. (2008) 'Operations research at container terminals: a literature update', *OR Spectrum*, Vol. 30, pp.1–52.

Steenken, D., Vos, S. and Stahlbock, R. (2004) 'Container terminal operation and operations research', *OR Spectrum*, Vol. 26, pp.3–49.

Sull, D. and Wang, Y. (2005) *Made in China*, Harvard Business School Press, Boston, Massachusetts, USA.

Tiacci, L. and Saetta, S. (2009) 'An approach to evaluate the impact of interaction between demand forecasting method and stock control policy on the inventory system performances', *International Journal of Production Economics (0925-5273)*, 3/1/2009, Vol. 118, No. 1, pp.63–71.

Tulder, R.V. and Ruigrok, W. (1997) 'European cross-national production networks in the auto industry: Eastern Europe as the low end of European car complex', *Foreign Direct Investment and Trade in Eastern Europe: The Creation of a Unified European Economy*, 5–6 June, Vienna.

Volpato, G. (2002) *Carmakers Internationalisation Strategies: An Overview*, Lettre Du GERPISA – Groupe d'Etudes et de Recherches Permanent sur l'Industrie et les Salariés de l'Automobile, Février – Mars, No. 158, Ed.Université d'Evry-Val d'Essonne, France.

Woo, W.T. (2003) The Economic Impact Of China's Emergence as a Major Trading Nation, Statement at the Hearing of the U.S.-China Economic and Security Review Commission on *China's Growth as a Regional Economic Power: Impacts and Implications*, Washington DC, USA, 4 December.