Editorial

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1 Introduction

Modelling and simulation are two prominent methods and tools increasingly used in enterprise engineering and organisational modelling. Modelling and simulation yield invaluable benefit for modern enterprises in addressing a variety of challenges they are facing when designing new processes or systems, redesigning existing processes, or seeking improvements for which different options need to be compared both quantitatively and qualitatively.

In today's business environment, at least two challenges dominate the host of expectations a modern enterprise should satisfy in order to stay competitive in the frequently changing business environment. These challenges are *complexity* (dynamics) and *flexibility* (agility) – both are ideal situations for the application of modelling and simulation methods and tools.

Business processes in enterprises not only span a single enterprise, but they are spread across a network of organisations. Analysing and changing these business processes become quite challenging in many aspects. Management and monitoring of the processes require a complicated distributed structure. More importantly, design, redesign, and constant improvement of these processes require rigorous tools, methods, and methodologies.

An average enterprise could be a network of hundreds of interwoven business processes. For example, SAP – the widely used enterprise resource planning system – consists of 604 Event-driven Process Chains that models the enterprise underlying business processes supported by the R/3 system (Curran and Keller, 1997). It is not hard to gauge the challenge that business analysts and designer face every time a large enterprise is embarked on redesigning part of its business processes. Each change in a process may have extensive organisational impacts and an arbitrary chain of cause-effect relationships across the supply chain. An example of such dependencies and relationships can be seen even in a simple "product ordering and delivering process". Typically, a product order and delivery comprises the *order placing process*, *billing process*, *shipping and delivery process*. Many companies may have their shipping process even outsourced, which further complicates the interaction and interrelation of the processes. Every time that an organisation attempts to redesign its ordering process, it will certainly impact other processes as well, let alone that a change has its social impact on the users. All this manifests the *complexity* dimension of enterprise and organisational processes.

Analogous to complexity, flexibility is a defining feature that an enterprise should possess in order to swiftly react to external changes. Dietz and Hoogervorst (2008) state that due to globalisation, removal of trade barriers, and deregulation, future enterprises will have to operate in an ever-more dynamic and global environment, which requires enterprises to be more agile, adaptive and transparent. Furthermore, the paper states that enterprises

are purposefully designed (socio-technical) systems, which need new skill to design, redesign, and implement an enterprise in a comprehensive and consistent way. This implies adherence to *flexibility* of modern enterprise.

The challenges of complexity and flexibility are further twisted by the fact that in this digital economy era, modern enterprises are supported and enabled by complex Information Communication Technologies (ICT). Therefore, in the complex web of interrelated enterprise processes, information system design, ICT use, business processes, and organisational structures in enterprises can no longer be regarded in an isolated manner as they are highly correlated in networks, and becoming increasingly complex and dynamic. According to Brandt et al. (1999), enterprises, their organisation, business processes and supporting ICT must be understood as socio-technical systems that consist of human actors, technical subsystems and their complicated relationships with each other. In designing, redesigning and improving such systems, modelling and simulation methods are necessary, highly relevant tools (Brandt et al., 1999).

Thus, in a more extended sense, enterprise modelling and simulation is about business processes, information systems, organisational change, IT impact, business IT alignment, business strategy, workflow modelling, etc. Furthermore, in a broader perspective, it extends to collaboration engineering, designing the flow of disruptive interactions and message overload in networked enterprises, and the patterns of collaboration between workers in different parts of the complex value network.

Simulation has evolved into a mature discipline in the traditional fields of engineering, such as manufacturing, military, and transport (traffic and control). Simulation techniques have been benefiting many of the traditional engineering fields in helping to mitigate design flaws, learning about system behaviour, providing training and becoming a standard practice for building complex systems. However, in the context of the enterprise, its organisation, and its underlying business processes, which collectively constitute a complex socio-technical system, the application of modelling and simulation is still in its infancy.

Following the analogies of traditional domains, application of simulation in the context of socio-technical environment (enterprise, organisation, business process) has attracted a huge interest among researchers from diverse perspectives (Gladwin and Tumay, 1994; Harrison, 2002; Hlupic and Robinson, 1998; Paul and Seranno, 2003; Vreede et al., 2003; Seila, 2005; Barjis, 2008). The practice of modelling and simulation is opening a promising research field as the potential and full capacity of enterprise modelling and simulation have yet to be fully revealed. But the popularity and widespread use of simulation among practitioners is rather at a moderate or slow pace as surveyed in Melão and Pidd (2003). This survey reveals the need for more active research in the field and more real-life applications to demonstrate the value and potential of modelling and simulation within the enterprise and organisational contexts.

Therefore, in order to elevate and highlight the role of modelling and simulation in the enterprise and organisational contexts, this special issue solicited the latest research findings tackling different but interrelated aspects to show the multifaceted use of enterprise and organisational modelling and simulation. The papers included into this special issue originate from the *4th International Workshop on Enterprise and Organisational Modelling and Simulation* (EOMAS: http://www.EOMAS.org/), established with the aim to become a major forum to foster discussion and exchange on theoretical and practical aspects, serve as an outlet for publication of new knowledge and experience, and a meeting for networking among researchers, practitioners, and educators interested in the application of modelling and simulation pertaining to various aspects of enterprise, organisation, business processes, information systems, enterprise information systems. EOMAS is a flagship international activity of the Association for Information Systems' *Special Interest Group on Modelling And Simulation* (http://www.AIS-SIGMAS.org/).

2 Synopsis of the papers in this special issue

As stated, this special issue demonstrates the multifaceted application of simulation modelling in the enterprise and organisational contexts. Although the scope of the papers varies somewhat, business process modelling, simulation, and formalisation and verification approaches are the main targets of the papers. Furthermore, the papers demonstrate an increasing popularity of Petri nets in business process modelling and automatic analysis of processes and interactions as Petri nets are based on formal semantics and models using Petri nets lend to automated analysis and simulation (Barjis, 2008).

The paper 'Automatic verification of business process integrity', by Manuel I. Capel-Tuñón, Luis E. Mendoza-Morales and Kawtar Benghazi-Akhlaki, draws on the fact that the current research underestimates the importance of verifiable task modelling. Methods and tools for transformation of task models into a verifiable design of a system that supports the tasks and consequently the whole business process are needed. This paper proposes a method and an approach to describe the process that a task is carrying out and to model the interactions that take place during the execution of a task. The proposed method is based on formal specification and definition using process algebra and UML modelling elements (activity and sequence diagrams). In order to achieve automatic verification of the task models, the proposed method is integrated with model checking techniques.

The paper 'Formal modelling and discrete-time analysis of BPEL web services', by Radu Mateescu and Sylvain Rampacek, presents another formalisation approach using a translation procedure. The focus of the paper is on web services as a useful basis for implementing business processes that can be achieved either by wrapping existing

software components or by developing new functionalities comprised of simpler functions. The paper proposes a methodology based on formal modelling and analysis of web services and abstract business processes described in the BPEL language. Web services are regarded as complex distributed systems and therefore the paper argues that design methodologies for web services should be supported by formal modelling and analysis techniques for which reason BPEL is adapted and further supported by tools.

The paper 'Formalisation and verification of interaction protocols for business process integration: a Petri net approach', by Djamel Benmerzoug, Fabrice Kordon and Mahmoud Boufaida, is motivated by developing approaches that formalise and automatically verify interaction protocols as the centerpiece of web-based applications and services. The authors present a new approach for designing business process integration with an emphasis on the interaction protocols within web applications. The proposed approach facilitates integration and collaboration among autonomous and distributed business process modules. The authors use a three step modelling approach for the formalisation and verification of interaction protocols using Agent UML (AUML) for representing interaction protocols, BPEL4WS for specifying and publishing them on the web and Coloured Petri Nets (CPN) for formalisation and automatic detection of flaws and errors.

The paper 'Modelling and simulation of complex workflow processes using multi-level Petri nets', by Marina Flores-Badillo, Ernesto López-Mellado and Mayra Padilla-Duarte, presents a modelling and simulation method for complex workflow processes. This paper also takes advantage of formal modelling by using Petri net based multilevel formalism representing an organisation in separate modules (levels) such as the process level, the resource management level, and user interaction level. The proposed modelling and simulation method is illustrated using a case study describing insurance claim processing activities. In turn, the paper discusses simulation as a tool for validating complex processes (models) in the absence of analytical procedures for verifying the correct behaviour of the models.

The paper 'Dynamic simulation modelling using descriptive information in natural language', by Yutaka Takahashi, argues that many benefits of dynamic simulation of business process have not been realised due to the gap between the descriptive nature of information conveyed by business people and formal handling of information by software tools such as systems dynamics. The hindering fact is that business people do not understand the intricacy of dynamic simulation while dynamic simulation uses either numerical or other formal input for processing. To fill in this gap, the author proposes an intermediary (or middle) language that conveniently bridges statements in natural language with dynamic simulation models through a translation step. The paper demonstrates the translation of natural language to a system dynamics model using an example case.

The paper 'Developing a software process simulation model using SPEM and analytical models', by Seunghun Park, Hyeonjeong Kim, Dongwon Kang and Doo-Hwan Bae, discusses the high cost and difficulty of developing simulation models. As a solution, the paper introduces an approach that gives the benefits of using predefined models in order to build simulation models. The argument of the authors is to decrease the simulation modelling costs by using maximum automatic approaches vs. manual model design and analysis. The paper discusses four key aspects of simulation modelling that have direct affect on cost and difficulty of simulation. By paying attention to building simulation models on conceptual or behavioural models (e.g., UML activity diagrams) modellers can take advantage of shortcutting many efforts (and costs). Also by this approach, the paper solves several complexity issues, through the use of hierarchical modelling.

The paper 'SIMONE: a Simulator for Interruptions and Message Overload in Network Environments', by Ashish Gupta and Ramesh Sharda addresses yet another use of simulation within the enterprise context. Namely, this paper proposes a simulation model to study an aspect of information exchange related to the disruptive nature of continual e-mail arrival within a network of knowledge workers. The paper findings yield interesting suggestions such as the scheduling of e-mail processing times across an organisation, which can reduce interruptions and improve overall productivity of organisation by helping knowledge workers change poor e-mail processing practices. The paper also suggests the effectiveness of simulation combined with analytical approaches in situations that require prolonged monitoring of the processes such as e-mail arrival and response patterns spanned over a long period of time.

The paper 'Challenges in collaborative modelling: a literature review and research agenda', by Michiel Renger, Gwendolyn L. Kolfschoten and Gert-Jan de Vreede, studies the importance of participative and collaborative modelling and the underlying challenges. This paper provides an elaborated account of literature supporting that modelling plays an enormous role in shared understanding of complex phenomena such as enterprise systems. Through an extensive literature review, the paper argues that the wider participation of end users and interested stakeholders, the higher is the quality of models designed for complex systems. The paper further discusses that a broad base participation itself could be a daunting task, which in part can be overcome by use of proper collaborative modelling techniques and methods.

3 Conclusion

The aim of this special issue is to explain and discuss the relevance of the notions of enterprise, its organisation and business processes, and the role of modelling and simulation as two prominent and complementary methods and tools

in the study of these phenomena. The papers of this special issue try to put these notions in a meaningful relation to each other and emphasise the importance of modelling and simulation for analysing, designing and redesigning enterprises as complex socio-technical systems.

It is hoped that this special issue successfully echoes the importance and awareness of enterprise modelling and simulation with the aim to become an inspiration for more follow up research.

Acknowledgements

For this special issue to see print, much effort and collaboration preceded its almost 18 months marathon. First of all, the continuous support and encouragement, *from idea to product*, of the Editor-in-Chief of IJSPM, Dr. Nuno Melão, is highly appreciated and acknowledged. To ensure high quality, relevance and consistency among the papers, a team of 30 reviewers put their expertise together to scrupulously review the papers in two rounds, suggested improvements and selected the most suitable papers for this issue. Therefore, special thanks go to the reviewers. Finally, but most importantly, the diligent and tireless work of the authors is highly commended as each paper went through two rounds of revisions and rewriting that involved many back and forth interactions and dedication.

References

Barjis, J. (2008) 'The importance of business process modelling in software systems design', *Science of Computer Programming*, Vol. 71, No. 1, pp.73–87.

Brandt, D., Hartmann, E., Sander, C. and Strina, G. (1999) 'Designing and simulating sociotechnical systems: concepts and strategies', *Human Factors and Ergonomics in Manufacturing*, Vol. 9, No. 3, pp.245–252.

Curran, T. and Keller, G. (1997) *SAP R/3 Business Blueprint: Understanding the Business Process Reference Model*, Prentice-Hall, New Jersey, USA

Dietz, J.L.G. and Hoogervorst, J.A.P. (2008) 'Enterprise engineering – a manifesto', in Dietz, J.L.G., Albani, A. and Barjis, J. (Eds.): *Advances in Enterprise Engineering*, Lecture Notes in Business Information Processing, Springer, pp.vii–ix.

Gladwin, B. and Tumay, K. (1994) 'Modelling business processes with simulation tools', in Tew, J., Mannivannan, M., Sadowski, D. and Seila, A. (Eds.): *Proceedings of the 1994 Winter Simulation Conference*, IEEE, Piscataway, NJ, pp.114–121.

Harrison, J.R. (2002) 'Organisational processes', *Simulation Modelling Practice and Theory*, Vol. 10, Nos. 5–7, pp.249–251.

Hlupic, V. and Robinson, S. (1998) 'Business process modelling and analysis using discrete-event simulation', in Medeiros, D.J., Watson, E.F., Carson, J.S. and Manivannan, M.S. (Eds.): *Proceedings of the 1998 Winter Simulation Conference*, IEEE, Piscataway, NJ, pp.1363–1369.

Melão, N. and Pidd, M. (2003) 'Use of business process simulation: a survey of practitioners', *Journal of the Operational Research Society*, Vol. 54, No. 1, pp.2–10.

Paul, R.J. and Seranno, A. (2003) 'Simulation for business processes and information systems design', in Chick, S., Sánchez, P.J., Ferrin, D. and Morrice, D.J. (Eds.): *Proceedings of the 2003 Winter Simulation Conference*, IEEE, Piscataway, NJ, pp.1787–1796.

Seila, A.F. (2005) 'The case for a standard model description for process simulation', *International Journal of Simulation and Process Modelling*, Vol. 1, Nos. 1–2, pp.26–34.

Vreede, G.J., de Verbraeck, A. and van Eijck, D.T.T. (2003) 'An arena simulation library for business process modelling', *Simulation*, Vol. 79, No. 1, pp.35–42.