Editorial for Recent Advances in Unified Modeling and Simulation Approaches

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In recent years, the application of Modeling and Simulation has moved from traditional fields to a new wide range of real systems, each requiring a unified modeling and simulation approach. For instance, currently advanced simulation approaches in systems biology deal with elucidation of the design principles controlling gene expression. The simulation of semiconductor devices requires the prototyping of multi-layer circuits, ranging from low-level physics to higher levels of abstraction. Applications in environmental sciences must integrate multiple sources of data (i.e. meteorological, chemical, traffic). Simulation in training applications has become a source for studying human behavior and operator efficiency.

Dealing with the current level of complexity requires advanced research efforts in the methodologies applied, focusing on the integration of the multiple components in a seamless fashion with a unifying modeling view. This includes the use of formal methodologies (for instance, DEVS – Discrete-Event Systems Specifications – or Colored Petri Nets), novel algorithms (including scalable parallel simulation, distributed Modeling and Simulation), composition of multiple techniques (from physics to human behavior, including agent-based solutions) and solid output analysis techniques (including stability and high performance).

With this goal, the 2007 edition of the Summer Computer Simulation Conference was devoted to techniques and applications using unified modeling approaches. After receiving 229 technical articles and doing over 700 reviews, we selected the top 20 papers. After a new round of reviews, the top 10 were invited to be submitted to this special issue (the first of two volumes). In this volume, the reader can find extended versions of the top conference papers, together with other papers submitted especially for this issue.

The four articles in this volume cover varied topics, ranging from Advanced applications to modeling methodologies.

The article by Peer-Olaf Siebers, Uwe Aickelin, Helen Celia and Chris W. Clegg, *Simulating Customer Experience and Word-Of-Mouth in Retail – A Case Study*, covers the use of agent-based simulation models used to model management and retail activities, including multidisciplinary research in psychology and computer simulation. Their agent-based models were used to simulate training and empowerment, including new methods for human interaction simulation. They model customer satisfaction and include a comparative analysis of different strategies to understand model customer evolution.

Bounding the Dynamic Behavior of an Uncertain System via Polynomial Chaos-based Simulation, by Anton H. C. Smith, Ferdinanda Ponci, and Antonello Monti focuses on a different kind of model. They study parametric uncertainty in closed-loop operation of control systems. In these systems it is impossible to express the behavior of the system using deterministic modeling, thus they present a method based on polynomial chaos theory. They show how this method one can formally include uncertainty in the model and how this method can be applied to analyze robust stability of closed-loop systems.

The third article, *Identifying Multi-Level Emergent Behaviors in Agent-Directed Simulations using Complex Event Type Specifications*, by Chih-Chun Chen, Christopher D. Clack and Sylvia B. Nagl, presents a multidisci-

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plinary view to study advanced model behaviour based on agent-directed simulations. They show how the individual behaviour of simple agents can lead to complex emergent higher level behaviors spontaneously. They define a formalism for specifying these emergent behaviours and a method to identify them in dynamically executing agent-based simulations. This permits to formulate hypotheses about how these behaviors relate to each other.

Finally, *A Real-time Interface Simulator for Operator Training: A Proposed Architecture* by Maria F. Q. Vieira, José A. N. Neto, Alexandre Scaico, Charles Santoni and Jean-Marc Mercantini, presents an architecture to build operator training systems. They are interested in safety-critical situations in supervisory control systems (in particular, they show how to apply the method in the case of an electricity distribution substation). They present a method to develop a real-time operator simulator and the immersive environment for the operator. The model is formally specified and then built as a set of interconnected formal models. The goal is to reduce the occurrence of human errors during such industrial systems operation by removing the sources of those error.

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