Guest Editorial: Simulation for Training: Foundations and Techniques

Simulation is generally used for three purposes: problem solving, training, and education. *TOMACS* has published papers only on simulation for problem solving. We are pleased to present, for the first time, this issue on Simulation for Training: Foundations and Techniques. Our objective is to broaden the coverage of *TOMACS* and initiate the publication of training-related simulation papers.

During the last decade we have seen a significant increase in the use of modeling and computer simulation for training purposes. This usage is expected to increase even more in the future in military, industry, and education. For the Department of Defense (DoD), simulation remains to be the most cost-effective technique for training military personnel. The Defense Modeling and Simulation Office (<http://www.dmsomil>) was established to strengthen the use of simulation within the DoD and to promote cooperation among DoD components, to maximize efficiency and effectiveness in the use of simulation for training purposes. As stated in the U.S. Army Modernization Plan (Vol. 2, Annex P, Jan. 1993), "The training vision for the year 2000 and beyond is to produce a seamless simulation environment which allows actual combat systems, manned simulations, and other simulations to exercise on a virtual battlefield."

The ever-increasing use of simulations and simulators for training users and operators of complex systems has far exceeded the capabilities of the current technology. The challenges require not only extensions and advances in current methodologies, but the discovery or creation of innovative approaches and techniques to deal with the rapidly expanding expectations. This issue contains four papers addressing some of the challenges we face today.

The first paper, "Performance and Reliability Analysis of Relevance Filtering for Scalable Distributed Interactive Simulation" by **Bassiouni et al.**, deals with one of the major challenges facing the design and implementation of large-scale distributed interactive simulation (DIS) training exercises: meeting the bandwidth and communication requirements. After describing the DIS scalability problem, the authors present five bandwidth reduction techniques: dead-reckoning, relevance filtering, packet bundling, data compression, and quiescent entities. The distributed relevance filtering algorithms are analyzed, performance results are given, implementation considerations are presented, and migration to high-level architecture is discussed.

The paper, "Terrain Database Interoperability Issues in Training with Distributed Interactive Simulation" by **Schiavone et al.**, deals with another major challenge facing the design and implementation of DIS training exercises: terrain database correlation problem. DIS terrain database

elements (terrain, culture, 3D models) and generation methods are described and constraints on terrain database processing systems in DIS are presented. Several statistical techniques are presented for correlation testing of terrain elevation and culture-feature classification accuracy. Correlation metrics are formulated for terrain elevations and features. Image consistency and comparisons for interoperability are addressed. A set of software tools to aid interoperability investigations and visualization is presented.

The paper, "Consistency Maintenance in Multi-Resolution Simulations" by **Reynolds et al.**, deals with another major challenge: the problem of consistently linking simulations at different levels of resolution. The consistency problem arises when low-resolution entities, e.g., corps, interact with high resolution entities, e.g., tanks. The authors introduce cross-resolution modeling and describe different types of consistency problems: temporal inconsistency, mapping inconsistency, chain disaggregation, transition latency, thrashing, and network flooding. The notion of simulation fidelity in a training exercise is discussed. Four fundamental observations are given regarding the consistency problem: appropriate level of resolution, consistent combining, dependent concurrent interactions, and time-step differential. Based on these observations, the authors present a unified approach for cross-resolution modeling.

The paper, "A Case Study of Verification, Validation and Accreditation for Advanced Distributed Simulation" by **Page et al.**, deals with another major challenge: credibility assessment of DIS training exercises. The authors present a case study in which verification and validation activities are illustrated and evaluated throughout the development lifecycle of the Joint Training Confederation.

Many people have contributed for the creation of this issue. Special thanks are due to Richard E. Nance for suggesting the topic and motivating me to edit this special issue. Thanks to Philip Heidelberger, Editor-in-Chief, for his encouragement and patience. Thirteen papers were submitted. Five papers were rejected at the end of first round of refereeing. Remaining papers were revised and resubmitted. Only four were accepted after second round of refereeing. We very much thank the thirty referees, who will be listed in a future issue, for their excellent refereeing work.

OSMAN BALCI
Blacksburg, VA