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Introduction to Special Issue of *Journal of Defense Modeling and Simulation*: Novel Approaches to Defense and Military Modeling and Simulation

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SPECIAL ISSUE: Novel Approaches to Defense and Military Modeling and Simulation

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Developing solutions to complex problems in government and industry is a daunting task that often requires tremendous investment in time and resources to solve. Modeling and simulation (M&S) has incredible potential to streamline development and cut costs by conducting virtual experiments that give insight into performance under various test conditions. As many program managers in the federal acquisition process can attest, realistic testing of live equipment in an operational environment can be some of the most expensive parts of a development program. M&S can provide insight into mission success of yet-to-be-designed systems without the need to actually build and test the system in the real world. Similarly, M&S tools can evaluate human effectiveness under various scenarios while only risking the virtual lives of avatars. When properly applied, M&S capabilities provide critical insight that allows leaders to make smart decisions about how to accomplish the mission and increase human performance more quickly and at lower cost and risk than reliance on real-world testing.

Throughout this special issue, we examine a variety of novel M&S concepts that promise to deliver simulation results to the defense and military community that positively impact system-level mission studies and human effectiveness research. These M&S tools not only affect the defense and military community, but can also have application to a wide variety of government and industry users with needs to solve similar problem sets. Whether the end goal is cost savings, operational analysis or refinement of sub-components, the M&S concepts described in this special issue testify to the power that these tools can provide to help decision makers efficiently allocate scarce resources and provide improved performance of humans and the systems that they operate in the long run.

In the first article in this issue, Oerter et al. explore the use of M&S to provide a virtual environment for architects and planners to collaborate with clients to optimize space planning and operational capability within the space. “A system architecture and simulation environment for building information modeling in virtual worlds” describes a simulation architecture that allows information to be exchanged between industry-standard architectural tools, such as Revit and 3DS Max and a three-dimensional (3D) visualization engine, Unity. The effectiveness of this process was demonstrated in a design exploration of a reconfigurable space in a collaborative effort with United States Strategic Command.

The next article, “Performance effects of imperfect multi-modal sensory cueing in a target detection simulation,” showed how human performance was affected by various sensory inputs. Mercado et al. examined how tactile, auditory or a combination of tactile and auditory cueing could be used to increase the effectiveness of an operator’s search for simulated targets when the operator is confronted with imperfect information from the system. From this research, results indicate that multi-modal cues permitted stronger learning and increased performance over that of uni-modal stimulus under the conditions of imperfect information.

For the third article, Ball and Runge discuss the obstacles that the engineering community faces as it moves forward where there is a significant reliance on M&S to define requirements and develop products. The “Producing Reusable Engineered Systems Through Ontology (PRESTO)” concept discussed in this article outlines an M&S system that facilitates concurrent engineering, a critical feature to development in a rapid engineering environment. The output of this concept is the capability to organize and manage information across many disciplines and users that could eventually allow a 10-fold reduction in product development time.

Taylor and Love take on the challenge of optimizing deployment of renewable energy-generation systems to combat zones in their article, "Simple multi-attribute rating technique for renewable energy deployment decisions (SMART REDD)." As the US experience in Afghanistan and Iraq proved, supplying the energy needs of deployed troops is costly in the long run in monetary terms and casualties. Using the SMART REDD model, field commanders could optimize the deployment of renewable resources to take into account mobility requirements, maintenance capabilities and other factors that would affect performance of the energy-generation systems.

The next article, "System architecture for functional characterization of devices to mitigate hearing impairment," examines use of an M&S tool that assesses how treatments for hearing loss impact intelligibility, without the expense of human listener studies. Byrne, Sarkani and Mazzuchi developed a physics-based simulator, the Cochlear Laser Transduction Model and the Optical Cochlear Implant Simulator, that can potentially shorten the development time for a new optical cochlear implant. This capability has the potential to positively improve the quality of life of many warfighters affected by combat-related hearing loss.

In their article, "Nuclear enterprise performance measurement," Hackleman, Johnson and Ahner describe their concept that would allow commanders responsible for the nuclear enterprise more insight into its overall status. The model developed for this effort creates a performance measurement system connecting strategic goals of the organization with metrics used to evaluate success. This provides the decision maker with actionable information that can be applied directly to decisions being made at every level of the organization.

Morris, O'Neal and Deckro discuss an M&S tool designed to generate random social networks that could be analyzed using the numerous Social Network Analysis (SNA) tools now being developed. In "A random graph generation algorithm for the analysis of social

networks," the authors describe how the development of the Prescribed Node Degree, Connected Graph (PNDCG). The PNDCG can be adjusted to generate weakly connected social networks that do not contain a high number of hubs. This capability can be used to test algorithms designed to map clandestine organizations that attempt to evade detection through use of isolated cell organizational structures.

Coalition Battle Management Language (C-BML) is a developmental programming language that hopes to allow coalition forces to operate seamlessly with US counterparts in simulations. Unal and Topcu, in their article, "Modeling unmanned surface vehicle patrol mission with Coalition Battle Management Language (C-BML)," show how this language can be used to simulate a surveillance and reconnaissance mission for patrol boats. This simulation allowed the interaction between command and control nodes and simulated entities to test operational concepts during all stages of the mission.

In their article, "Parametric analysis for water ricochet studies of ogive nose-shaped projectiles," Murali and Naik describe the challenges of hitting a target in water without ricocheting as well as the collateral damage that can be inflicted by ricocheting projectiles. To better understand the conditions that cause ricochet, Murali and Naik developed a model to predict ricochet and validated the model using empirical data. The result of this research could be used to extend the range of some projectiles under certain conditions.

The articles in this issue truly reflect the novel ways that M&S can help in solving some of the most complex problems that we face. M&S can help find optimal solutions without the significant expense of a "build-test-build" mentality. These capabilities can also help increase human performance and understanding as learning and exploration tools. We are extremely grateful to the authors who shared their research through this venue, as well as to the reviewers and referees who made possible the publication of this special issue.