Director's Forum

Modeling and Simulation in Today's DoD

When I remodeled my kitchen, I made a scale drawing of the room and paper cutouts of the various cabinets and appliances—then moved them around to see what would fit where and what the "flow" would be while working at the counter, stove, and sink and retrieving things from cabinets and the refrigerator. In my woodworking shop, I often make a scale model or a prototype of something before committing to the full-scale version or the one made from walnut or ebony. These are examples of modeling in a very simplified form. At much more complex scales, computer-based models and simulations are used every day by DoD and industry to help simplify and try out complicated ideas.

Models are generally used to simplify complex concepts, products, and processes to make them easier to understand; therefore, they are often used to aid complex decision making. There are many types of models, each suited for a subset of applications, ranging from conceptual to detailed, from physical to behavioral, from deterministic to stochastic, and from simple to complex. A model implemented over time is a simulation. Simulations are often classified as live (real people operating real systems), virtual (real people operating simulated systems), or constructive (simulated people operating simulated systems).

Modeling and simulation, like standardization, plays a significant but unseen role in our daily lives, and that is especially true in the military. Today, modeling and simulation applications comprise a critical tool set for the design, engineering, test, and evaluation of defense systems, for operational concept development and wargaming, for training and mission rehearsal, and for real-time situational awareness and analysis tools.

Defense engineers, warfighters, and decision makers use models and simulations in the engineering and operation of defense systems, as well as the training and execution of strategic, operational, and tactical decision making and operations. For example, engineers use 3-D digital models to design and assemble aircraft carriers, production managers use 3-D models and discrete event simulations to plan and manage assembly lines for aircraft and vehicle parts and systems, and maintenance workers use models and augmented reality to plan and conduct maintenance. Furthermore, the system-centric practices of design and engineering increasingly use high-fidelity, physics-based models to improve system performance and quality.

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In the operational domain, warfighters use live, virtual, and constructive (LVC) simulations to train and operate at the strategic, operational, tactical, and individual skill levels. Large, international LVC exercises are conducted multiple times a year to practice operations with coalition partners and to experiment with new concepts and capabilities. Simulations provide the ability to train and conduct mission rehearsal in a variety of operational environments against a variety of threats, based on the warfighter's mission set. Models and simulations are also present in the warfighters' tactical decision aids and in other tools used to maintain situational awareness during operations.

To support these complex tasks, models, LVC simulations, and supporting hardware, software, and databases are often integrated to produce complex synthetic environments for analysis, experimentation, and training at the strategic, mission, or engagement levels; or they are integrated to conduct high-fidelity, physics-based simulations for design, test, and analysis of components, sub-system, and system performance. In either case, standardization is key to intelligent and accurate exchange of data between models and systems. Standards enable interoperability at the physical interfaces, at the syntactic level for data exchange, and at a deeper "conceptual" or "semantic" level to promote meaningful exchange of information. Though we are quite proficient at the former two, there is still much work remaining to fully achieve interoperability at a deeply reliable and consistent level.

This issue of the *Defense Standardization Program Journal* highlights some of the current capabilities, concepts and needs, and possibilities empowered by standardization of and for models and simulations. This is a domain in which DoD has invested heavily, and one where we have benefited greatly from the efforts and products of non-government standards bodies. In these articles, you will find proven, stable standards that have enabled interoperability and aided engineers and architects for decades. You will also see possibilities and needs for new standards, to make the most of the mobility and ubiquity of computing devices, the rapid growth of virtual and augmented technologies, and the evolution of model-based engineering tools and practices in DoD. Perhaps you are able to apply some of the highlighted standards in your programs, or you would like to get more involved in shaping the future of digital engineering for defense systems, or the integration and interoperability of models and simulations for large-scale LVC exercises.

For more information on modeling and simulation in DoD, visit *https://www.msco.mil/*; for digital engineering, visit *https://www.acq.osd.mil/se/initiatives/init_de.html*.