Special Issue: Foundations and Model Quality Assessment

Bernard P. Zeigler
Editor-in-Chief
University of Arizona
zeigler@ece.arizona.edu

David C. Gross
Special Issue Editor
Boeing
david.c.gross@boeing.com

This issue focuses on assessing how well models agree with their referent real systems or with others in a federation. The first three articles originated as papers presented at the Foundations '04 Workshop held at Arizona State University, Tempe, October 13–15, 2004. Drs. David Gross and Dennis (Steve) Stevenson conducted the review process to transition the papers from workshop to archival form suitable for JDMS publication. To these articles, we have appended a fourth that, although not originating at the workshop, nevertheless well-fits the theme of foundations and model quality assessment.

The first article offers a defense perspective on verification and validation (V&V) of models. In "A Proposed Model for Simulation Validation Process Maturity," Harmon and Youngblood consider both the completeness and correctness of information as well as one's confidence that the information is sufficiently complete and correct for a particular purpose. The authors divide the process into six levels defined by the quality of the input information, the quality of its information products, and the objectivity of the process components. Ranging from uncritical acceptance to formal validation, the objectivity and quality of the validation evidence increases as the process maturity level increases.

An energy perspective is expressed by Logan, Nitta, and Chidester of Lawrence Livermore National Laboratory. In "Risk Reduction as the Product of Model Assessed Reliability, Confidence, and Consequence," the authors link V&V of simulation to risk reduction in investment decisions. They employ a simple measure of risk as the product of reliability, confidence level, and the actuarial consequence, providing a process for obtaining quantified values for each of these terms. Using explosives impact as an example, the authors trace the quantified risk reduction value from simulation results to its impact on the investment trade-off decision process. Since the V&V process is costly, time consuming, and risky, their motivation is to be able to justify the benefits of investment in V&V.

In "The Use of M&S VV&A as a Risk Mitigation Strategy in Defense Acquisition," Kilikauskas and Hall continue to examine V&V as it relates to risk assessment and risk mitigation, now in the context of defense systems acquisition process. The authors review the application of risk assessment techniques and their use in planning and executing V&V activities to reduce the risks. The techniques are largely subjective and depend on the expertise and judgment of the program manager. However, the guidelines developed by the Joint Accreditation Support Activity have proven to be a practical help in planning and conducting a cost-effective effort.

In the final paper, "On the Complexity of Parameter Calibration in Simulation Models," Hofmann introduces a formal approach to model calibration and shows that the problem is computationally complex as measured by accepted computer science metrics. Calibration is akin to validation in that both involve comparing a model's behavior with that of a given behavior. In validation, typically, the comparable behavior is that of a real system referent, and the model is considered a fixed, unadjustable entity. In calibration, comparable behaviors can involve other models, and typically there is a tuning process in which model parameters can be adjusted in an attempt to achieve better agreement. The motivation for the formal approach was an attempt to understand the difficulties encountered in an army study to assess whether different high-resolution combat simulation models could be calibrated for consistency with each other. The author provides an in-depth discussion of the significance of the theoretical results and concludes that the insight they provide is especially applicable to multicomponent federations, where the difficulties in achieving consistency at the model level appear to be underappreciated.

Ranging from practical to theoretical in approach, the articles all agree that the processes of assessing model quality—whether through validation, verification, or calibration—are intrinsically problematic in nature. They cannot be left to intuition or ad hoc approaches that perhaps were acceptable in the past but will most certainly fail when applied in the complex modeling and simulation environments of the future. This issue of *JDMS* offers some initial attempts to come to grips with the difficulties and to lay the foundations for future development. We thank Drs. Gross and Stevenson as well as all the authors for their dedication in these efforts.