Editorial Introduction, SCS Simulation Special Issue on Grand Challenges for Modeling and Simulation

Ernest H. Page
The MITRE Corporation

Wendell H. (Dell) Lunceford
U.S. Army Model and Simulation Office

> "One of the better aspects of human nature is our drive to seek out and conquer challenges. We seem imbued with a desire to formulate problems of the highest degree of difficulty and then to relentlessly pursue their solution. The identification and pursuit of Grand Challenges has been a hallmark of the high-performance computing arena for over a decade. In recent years, many other technical communities have defined Grand Challenge problems for their disciplines. While Grand Challenges themselves provide a useful focal point for research and development activities within a discipline, perhaps more important is the community dialogue that surrounds the formulation of Grand Challenge problems."

The preceding quote appears on the Grand Challenges for M&S website (http://www.grandchallenges.org) to address the question, "Why Grand Challenges?" The quote was authored during the formulation of a special forum on Grand Challenges within the Simulation Interoperability Workshop (SIW) during the Fall of 2000. It appeared again in the Call for Papers for the First International Conference on Grand Challenges for Modeling and Simulation (ICGCMS), which was held as part of the SCS Western Multiconference, 27-31 January 2001 in San Antonio, Texas, U.S.A. And for a third time, it appeared in the organizational material for the Dagstuhl Seminar for Grand Challenges in Modeling and Simulation, held 26-30 August 2002 in Dagstuhl, Germany (a summary article from the workshop appears in: SCS Modeling and Simulation, 1(4)). We use the text again here, not due to our lack of utility with the English language (although we admit to our shortcomings with our native tongue) but, rather, because we still believe that it best captures the motivation for attempting to establish a conversation within the M&S community about its strategic objectives.

The intent of framing the discussion of strategic objectives for M&S around the notion of Grand Challenges was not to suggest that some problems were more important than other problems-all problems warrant solution-but rather to identify, hopefully, a few demonstrably-hard-but-not-impossible problems. The spirit of the discussion at SIW, ICGCMS and Dagstuhl has been creative and enjoyable. The understandable fear, for any researcher, that their colleagues would ascribe to them a certain degree of hubris if they were to have the audacity to suggest a problem as a "Grand Challenge" has, happily, not stifled the initiative. Those engaged within the Grand Challenges discussion have been thoughtful, insightful, and not prone to regard themselves too seriously. We are thankful to the community for their collegial participation.

In this Special Issue, we present four articles that are well-representative of the Grand Challenges discussion.

Fishwick suggests that the very nature of model representation presents a Grand Challenge. He asks the question: if you were standing in Star Trek's Holodeck, how would you go about constructing a model? Fishwick argues that it is unlikely you would choose to develop a model through the use of equations written on paper. He describes the emerging discipline of aesthetic computing, and discusses how results in this field may lead to a revolution in the way simulation models are conceived and represented.

Mosterman and Vangheluwe describe the area of Computer Automated Multi-Paradigm Modeling (CAMPaM). They suggest that as systems become increasingly complex, subsystems models will necessarily become increasingly divergent in their individual dialects and representative formalisms. Holistic systems models, that combine these individual subsystems models, will require methods to bridge these dialects and formalisms. The authors describe an approach based on meta-models (models of individual formalisms) to develop both formalism and abstraction bridging mechanisms.

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Eeckhout and De Bosschere describe the problem of designing microprocessors. They assert that the total design time of a complex microprocessor can be seven years. They describe and consider the complexities of: (1) design space, (2) workload space, (3) program run length, and (4) simulator capacity (speed). They suggest and evaluate optimizations in each dimension.

Fowler and Rose assert a family of Grand Challenge problems in the manufacturing systems domain. First and foremost, they discuss the problems attendant with achieving orders-of-magnitude reductions in problem solving cycles. A second challenge is suggested in the area of real-time simulation support. A third challenge involves interoperability of manufacturing simulations, and their fourth challenge relates to engendering a greater acceptance of simulation and simulation results by decision makers in the manufacturing industry.

Eight articles were received in response to the Call for Papers for this Special Issue. After rigorous peer-review, the four articles presented here were accepted for publication. We are grateful to all of the authors for their efforts in preparing articles for consideration and for responding to the reviewers' comments. We are also grateful to the reviewers for their time, and thoughtful, constructive reviews. Our thanks also to Simulation Editors, Adelinde Uhrmacher and Richard Fujimoto for inviting this Special Issue, and thanks to Sharon Odegaard at SCS for arranging its publication.

This Special Issue is the capstone of 4 years of our participation in the Grand Challenges for M&S arena, and we commend it to you highly.