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Panel: Challenges in Satisfying the Need and Promotion of Modeling & Simulation Workforce

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ABSTRACT

The foundational role of simulation is to enable understanding, discovery, development, and operations of dynamical systems. As such, modeling and simulation professionals intrinsically encounter problems that have non-trivial complexity and scale traits. Inevitably the systems they encounter must be modeled, simulated, and evaluated. This panel presents some challenges in attracting talented individuals to pursue education and professional careers, continuing education to satisfy the current and future knowledge and practices while advancing basic and applied research and development in modeling and simulation. To highlight modeling and simulation workforce development, panelists share thoughts borne out of extensive professional and academic experiences at Intel®, Oak Ridge National Lab, MathWorks®, and ASU.

1 INTRODUCTION

It has been challenging for modeling and simulation as a (trans-)disciplinary knowledge enterprise to achieve independent standing in academia, industry, and government. Instead, it is commonly viewed and treated as a collection of many things without a core. This situation is undesirable and dangerous in view of understanding, building, and operating existing and future systems that can, should, or may interact in complex ways. In contrast, modeling & simulation gained modest attraction early on in the last couple of decades despite the recognition of its necessity (National Science Foundation. 2006). Some evidence suggests steps and concerted efforts are needed to meet the crucial workforce needed for autonomous transportation systems, preventive healthcare and on-demand delivery, precision pharmacology, and sustainable use of natural and artificial resources, among many other complex systems.

2 PERSPECTIVES

Modeling and simulation as a way of addressing the scientific, engineering, and practice needs should be promoted across private and governmental organizations. Next, views rooted in real-world experiences, the development of cutting-edge frameworks/tools, and science and engineering education are briefly described.

Hessam Sarjoughian: Simulations for autonomous vehicles and precision medicine, for example, require developing computable dynamical models that interact with physical processes. Fundamental to building and operating such simulations are spatiotemporal parallel/distributed abstractions for time-

sensitive, safety-critical, and multi-platform heterogeneous systems. Undergraduate and graduate courses (e.g., computer science, software, and system engineering) barely account for the M&S core knowledge. A salient consequence is fewer students pursuing foundational research in M&S science and engineering important for understanding and creating future heterogeneous computational and physical systems. Students should be as attracted to pursue education and careers in modeling and simulation as those fascinated with topics (e.g., IoT, machine learning, and robotics). Toward this objective, agencies such as the US NSF can place M&S as a core area in specific directorates and cross-cutting programs. Such steps will provide the impetus for (non-)academic entities to invest in education and basic research (Fujimoto et al. 2017).

Edward Yellig: At Intel, discrete event simulation modeling is used in all phases from designing to running the factory. The lead-time, cost, and reentrant nature of semiconductor manufacturing all favor the use of discrete event simulation to analyze such a large-scale system. As the size and complexity of the problems continue to grow, the need for more highly complex modeling is being outpaced by the candidates graduating with the interest in modeling and simulation as a career path. Additionally, the size and complexity of the problems stretch the discrete event compute nodes. There is a need to advertise, educate, expose, and motivate more talent to become the next generation of modeling and simulation engineers. Collaboration between academic research and industry is necessary to promote modeling and research into the development of computational efficient modeling techniques. Superior model development combined with engineering analytical problem-solving skills and quantitative analysis are powerful tools to guide management to the appropriate solutions in our ever more complex environment.

James Nutaro: I began my professional career in the defense industry, where M&S is prolific, and the modeling methods and simulation technologies employed are among the most advanced available. Consequently, upon joining the national laboratory system, I was surprised to discover its uneven practice. Modeling and simulation is advanced in areas where it is unquestionably indispensable: climate systems are interdisciplinary and models are key to scientific progress. In other areas, M&S knowledge is confined to specific tools without a grasp of fundamentals. At best, M&S is not exploited to its potential, and at worst, it leads us astray (e.g., produce questionable results and tools). The decline in the M&S workforce has exacerbated these issues, as noted above. To counter declining interest, it is necessary to reengage the popular imagination. My interest was spurred at a young age when, at a Sperry company picnic, the children were invited to fly a full cockpit simulation of a passenger jet. Later, articles in Wired magazine introduced me to Simnet, and models in the movie Wargames taught us that the only way to win was not to play. Perhaps, a renewed effort in public engagement will help to inspire pursuing M&S careers.

Akshay Rajhans: As the scale and complexity of today's engineered systems continue to grow, simulation plays an ever-increasing role in system design and analysis. M&S platform developers need an understanding of heterogeneous first-principles (e.g., state-space equations and acausal equations) and data-driven (e.g., neural networks) models of computation as well as fundamentals from numerical methods and automatic code generation. They are tasked with developing flexible turnkey functionality that leverages diverse compute architectures yet provides intuitive access to users, including M&S engineers and subject matter experts, to derive intended value. Of late, simulation environments are also serving as a playground for training new machine learning algorithms. At the same time, new research advances are looking to push the envelope of automating model construction (e.g., DARPA's symbiotic design for cyber-physical systems program (Neema. 2021)) and simulation (e.g., neural ODEs). To meet these changing demands, traditional M&S curricula for education and workforce training need to be rearchitected.

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