U.S. Air Force
Scientific Advisory Board

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Fidelity of Modeling, Simulation, and Analysis to Support Air Force Decision Making

Abstract

The Air Force corporate process to make acquisition and investment decisions uses the Air Force Warfighting Integration Capability (AFWIC) to help identify and evaluate options. AFWIC in turn makes extensive use of modeling, simulation, and analysis (MS&A) to support its understanding of potential characteristics, effectiveness, and value of candidate systems. The Secretary of the Air Force tasked the U.S. Air Force Scientific Advisory Board (SAB) to conduct a study on the Fidelity of Modeling, Simulation, and Analysis to Support Air Force Decision Making in order to review and characterize current state-of-the-art for MS&A applied to complex systems and systems-of-systems. The study sought to identify best-of-breed models and integration frameworks that are relevant to mission- and campaign-level decision making and to assess whether modern approaches to uncertainty quantification can be extended to higher-level (integrated systems and subsystems level and above) MS&A. Finally, the panel was tasked to recommend Science and Technology (S&T) that should be pursued to enable improved fidelity and quantification of uncertainty in campaign-level MS&A.

The SAB Study Panel found that the challenges of assessing integrated, all-domain, force-on-force conflicts are surpassing the ability to rely on intuition and professional military judgment to make comprehensive, well-informed decisions. Challenges associated with rapid technology advances and rapidly-evolving near-peer adversaries demand well-informed analyses providing information to decision-makers on a nearly continuous basis. MS&A that captures the complexities of modern conflict and fully represent all domains—including cyber and space—are essential for integrated force structure design and system evaluation. Models and simulations alone will not solve this need for rapid decision-quality analyses. The analysis process is reliant on the ready accessibility of fully-informed data and well-trained multi-domain analysts.

The SAB Study Panel recommends the Air Force create, manage, and maintain a central, authoritative, accessible repository for MS&A-relevant data. These fully-informed data will facilitate analyses at all levels of resolution and increase the speed and fidelity of campaign-level MS&A. The Air Force should also implement models for red, blue, and gray offensive and defensive operations in space and cyber domains, in order to provide campaign-level analyses with the appropriate fidelity. To efficiently achieve improved campaign-level MS&A, the study panel recommends development or adaptation of an open architecture framework amenable to straightforward representation of all domains at the appropriate level of fidelity. To better leverage the breadth of the analysis community, this framework, incorporating tools, and data, need to be readily available to industry as a government-owned and freely distributed managed capability with a crowd-sourcing development paradigm. Additionally, the study panel recommends the Air Force initiate substantive science and technology development efforts to enhance multi-domain model representation, aggregation uncertainty estimation, and machine-based (Artificial Intelligence/Machine Learning) strategy discovery. Finally, the Air Force must move to a continuous analysis process to keep pace with the rapidly evolving warfighting landscape.

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