SUPPORT STRUCTURES

A Sandia National Laboratories partnership contributes to the success of the Joint Strike Fighter program

In 1993, the Department of Defense (DoD) established the Joint Strike Fighter (JSF) program initiative to design and develop a fifth-generation fighter jet. The DoD was interested in an aircraft that would combine air-to-air, strike, and ground attack capabilities, for use by multiple branches of the U.S. military and NATO allies.

After an eight-year concept, design, and development competition between several companies, in 2001 the DoD chose the Lockheed F-35 JSF. The most costly and ambitious project in DoD's history, the JSF program will exceed $400 billion over several decades to develop 2,457 F-35s. The F-35 will eventually replace legacy aircraft currently in Air Force, Navy, Marine Corps, and allied military inventories.

For the program to be successful, however, the complexities of international manufacturing and logistics support needed to be sustainable for the U.S. and partners, including Australia, Canada, Denmark, Italy, Netherlands, Norway, Turkey, and the U.K. Complex supply chains across hundreds of facilities around the globe would supply thousands of parts on an ongoing basis. To save time and money, all of these logistics elements needed to smoothly mesh within a comprehensive management solution.

In 2000, Lockheed was in the process of bidding for the JSF contract. As a key requirement for the contract, the JSF needed an international sustainment and logistics component. Lockheed partnered with Sandia National Laboratories (Sandia) to develop its JSF logistics and sustainment program. Through Lockheed's Shared Vision program under Cooperative Research and Development Agreements (CRADAs), Sandia and Lockheed successfully developed the Support Enterprise Model (SEM), a discrete event simulation tool used to model and simulate operation and support activities in a sustainment environment.

Sandia's Bruce Thompson partnered with Lockheed's Devon Smith to lead the Sandia/Lockheed team that developed the SEM tool. According to Thompson, SEM allowed analysts to define an operational/support environment and determine the most efficient solution scenarios even while responding to changes in the support system, procedures, and business objectives. It also tracked aircraft reliability and maintenance options. Mr. Thompson said, "The SEM CRADA gave Sandia the opportunity to use and build upon its expertise in simulation and optimization. We're continuing to use the capabilities developed under the CRADA to benefit the DoD, Sandia's logistics operations, and the DOE/NNSA weapons sustainment enterprise."

F-35

In addition to enterprise-scale simulation capabilities, SEM includes a global optimization capability for support resources (e.g., spare parts inventory,

personnel, and support equipment). This flexible capability works with the SEM simulation to identify, at each location in the global sustainment system, the optimal combination of support resources required to meet specified performance objectives at the lowest cost. Alternatively, the optimization can determine how best to use a given support resource budget to maximize performance.

According to Sandia, SEM is a discrete event simulation tool designed to model and simulate operation and support activities of a worldwide sustainment system. The general objective of SEM is to help characterize the sustainment system performance including supply, repair, and manufacturing activities over the entire life of the enterprise. To accomplish this objective, the user defines and executes SEM simulations to generate statistical results characterizing the enterprise operations using different notional support and sustainment options. Results of those simulations are analyzed to make recommendations for best-case logistics system configurations that support required mission capabilities at the lowest possible cost. SEM is applicable in industries as diverse as defense, energy, aviation, and healthcare, enabling:

Bruce Thompson

- Integrated modeling of supply chain and repair chain activities for a worldwide support system
- Logistics modeling, analysis, optimization, and decision support of global operations
- Calculation of system and support structure performance and cost metrics while accounting for uncertainty
- Spares inventory and resource optimization on a global scale

The remarkable modeling and simulation capability of SEM has proven critical in the design of the JSF logistics support systems. It has led to billions of dollars in savings, by responding to changes and achieving performance metrics at the lowest cost, a capability critical to successful execution of the JSF initiative.

Neither government nor private sector enterprises can afford the risks of untested decisions on the battlefield, in the supply chain, on the factory floor, or even in customer relationships. Management enterprises must understand, up front, the impacts, risks, and robustness of critical operational decisions. SEM provides the ability to test drive new enterprise strategies, policies, practices, and application logic before committing to their execution. Once in place, SEM provides the ongoing support necessary to maintain the enterprise at its highest functional level, at the most economical cost.

Thanks to Sandia and the empowering CRADA, the SEM tool was used by Lockheed Martin Aero, the JSF Program Office, and the JSF International Partners (U.K., Canada, Netherlands, Norway, Italy, Australia, and Turkey) to help design and optimize a global JSF sustainment system. In fact, SEM was so critical to Lockheed Martin's plans that they continue to use it as JSF aircraft are deployed. SEM can be used both as a design tool, which can demonstrate a proposed design's sustainment solutions and provide acceptable operational performance with significant reductions in costs, as well as an operations tool with autonomic logistics functionality that can sense and respond to changes in JSF fleet operations. In addition, two other Lockheed Martin companies have started to use SEM to support multi-billion dollar Performance-Based Logistics programs and to help win additional programs.

SEM also attracted the attention of Lockheed Martin's new Net-Centric Integration Center and was the first Sandia-Lockheed Martin tool deployed in this showcase facility. Sandia continues to use capabilities developed under the SEM CRADA for Department of Defense applications and for modeling and simulation to support the nation's Nuclear Weapons Enterprise.