Boeing JSF Modeling and Simulation Breakthroughs Reduce Program Risk, Cost

Boeing today unveiled details of a comprehensive modeling and simulation architecture that assures new levels of affordability. Demonstrated during the Joint Strike Fighter program's concept demonstration phase, these improvements will make the Department of Defense's long-standing vision of simulation-based acquisition a reality.

Combining benchmarks achieved on its 777 and Next-Generation 737 commercial aircraft, C-17 airlifter, Apache helicopter and other programs, the new Boeing JSF architecture incorporates what previously were separate, stand-alone modeling and simulation tools into an overall integrated system.

"Simulation-based acquisition -- the innovative use of simulation tools to reduce program costs - not only allows us to execute the JSF program in a revolutionary manner, but has a transformational impact on the company's future programs as well," said Frank Statkus, Boeing vice president and JSF general manager.

"On JSF, incorporating a number of simulations from areas such as propulsion systems, vehicle management, avionics, etc., into one 'package' not only gives our One Team members an early, clear picture of the interactions between all elements of the aircraft, but also significantly improves integration and reduces program risk and cost."

From the beginning of the program, Boeing used computer modeling and simulation to design and build its demonstrator aircraft thousands of times before the first airplane part was fabricated. As the design matured, changes and special relationships were reviewed electronically as well. Using the same design, fabrication and assembly approach Boeing plans to use in the engineering, manufacturing and development (EMD) phase of the program, engineers and assembly workers built the two X-32 aircraft in record time, while reducing costs more than 50 percent compared to previous demonstration aircraft.

As JSF requirements evolved, Boeing matured successive versions of its aircraft in a single database used by all 34 One Team partners in the United States, Canada and Europe. From this single database, wind tunnel models, flight simulations and virtual reality models - that allowed rapid and comprehensive testing of emerging configurations - were generated in near-real time. Once the demonstrator aircraft began flying, Boeing proved that its simulation tools predicted actual in-flight performance within 2 percent or better accuracy. In addition, some predictions were made up to two years prior to the actual flight tests, further underscoring the validity of these processes.

"Modeling and simulation contributed significantly to the flight-test program's outstanding efficiency and unprecedented sortie rate of up to five flights a day," said Dennis O'Donoghue, Boeing JSF lead STOVL test pilot. "Pilots flew the planes thousands of hours in a simulated cockpit before we actually climbed into the X-32. When we began flying the real planes, they flew just like the simulator."

"The importance of modeling and simulation in reducing risk can't be emphasized enough," Statkus said. "We were able to eliminate the majority of bugs before we ever built or flew the X-32 aircraft. Excellent software models and revolutionary control law development made the changeover from the lab to flight test incredibly simple.

"The days of lengthy delays in development or living with design flaws far into a production run are gone," he added. "We've proven that our simulation tools are very reliable, which gives us high confidence that we can build aircraft that will meet requirements within both schedule and cost constraints."

Modeling and simulation were used in a number of other areas of Boeing JSF development as well:

- Since supportability accounts for nearly two-thirds of an airplane's life-cycle costs, significant effort has been placed on developing aircraft maintenance through use of virtual reality simulations and maintenance rehearsals during the design phase rather than after the aircraft design is frozen. This effort will not only significantly reduce maintenance man-hours per flight hour but also greatly reduce overall support costs.
- Extensive testing using the company's 737 Avionics Flying Laboratory (AFL) reduced risk in designing the mission systems. During a live-fire demonstration with the integrated system, which included an F-15E, a Joint Direct Attack Munition destroyed a ground target using refined target data provided by the AFL.
- To validate the low-observable characteristics of the JSF, a highly detailed full-scale radar cross-section model was built using the same, single engineering database used to design the actual aircraft.

"What's important about all this is that Boeing has proven it is ready to hit the ground running on day one of the EMD phase and not get behind schedule," Statkus said. "We're delivering the DoD vision of simulation-based acquisition today, and both the warfighter and the taxpayer will benefit from what we've accomplished. This is truly a revolutionary way of doing business.

"You can't go where the JSF program needs to go -- build an affordable 21st century fighter aircraft for all services -- by doing business as usual," Statkus added.

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