Orbital's X-34 Gets Boost From SDRC

SITUATION

The X-34 is a low-cost, hypersonic rocket plane being developed by Orbital Sciences Corp. for NASA's Reusable Launch Vehicle program. Unlike the Space Shuttle, which requires a special launch site, an expendable fuel tank, and large booster rockets, the X-34 is dropped from a flying airplane. A single stage propels the vehicle to mach 8 and an altitude of 250,000 feet. Orbital outfitted a Lockheed L-1011 commercial airplane to carry the X-34 to its launch altitude. Because the company had made substantial changes to the plane, its FAA certification was no longer valid. Orbital was required to demonstrate that the modified L-1011 was flight-worthy, and that the L-1011/X-34 combination was flight-worthy as well. This required ground vibration testing (GVT), flutter simulation, and a test flight, and the program schedule was already in jeopardy. Orbital needed expert help to assist them with these tasks.

OBJECTIVES

✔ Meet FAA requirements for certifying the L-1011 in mated and unmated configurations.

✔ Avoid the risk, as well as the cost and delays, of a special flutter test flight.

✔ Keep the X-34 project on schedule to meet a planned "captive carry" flight date.

"We contracted with SDRC's Aerospace Center because we knew they had the state-of-the-art tools and procedures for this kind of work. They proved that in spades. Their performance allowed our test to come in on schedule in spite of a late start."

- Craig Huber
L-1011/X-34 Interface
Lead Engineer
Orbital Sciences Corp.

PROCESS VISION

Augment Orbital's team with aerospace experts who could:

✔ Perform the GVT to detect primary structural modes of the aircraft up to 40 Hz.

✔ Determine whether the modal response caused by adding the X-34 to the commercial plane excited any of the known flutter frequencies identified in the L-1011.

✔ Use computer simulation to avoid a flutter test flight, which costs approximately $250,000 and risks damaging the aircraft.

✔ Accelerate the required vibration testing and flutter simulation to help Orbital meet the overall program schedule.

ACTIONS

✔ Orbital contracted with SDRC's Aerospace Center of Excellence to support the X-34 project. Orbital and SDRC have worked together on a variety of projects for more than 10 years, and Orbital was confident

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SDRC had the expertise, as well as the state-of-the-art tools and procedures for this kind of work.

✔ Orbital used I-DEAS® to create a highly accurate model of the complete X-34 vehicle, including all subsystems. As the airframe was being designed, SDRC aerospace experts worked with Orbital engineers to create the finite element models of the X-34 that would be used for structural analysis of the L-1011 and the L-1011/X-34 combination.

✔ SDRC provided all instrumentation and data acquisition equipment for the GVT and set up a mobile office under the plane from which they conducted the test. SDRC engineers performed a pretest analysis to determine optimal accelerometer placement. Then they performed the GVT, shaking the plane through a range of frequencies, under multiple weight conditions, as well as with the unmated and mated configurations of the two aircraft.

✔ The results of the GVT indicated that the addition of the X-34 to the L-1011 caused a number of frequencies that were close to known flutter modes of the L-1011. Because the Aerospace Center had all the GVT results and SDRC engineers were familiar with the project, Orbital contracted with them to perform a flutter simulation as well.

✔ The engineers took the modes they had obtained from the GVT, added them to the known flutter modes for the L-1011, and measured the coupled response.

RESULTS

✔ By performing a pretest analysis prior to the GVT, SDRC engineers were able to minimize the number of accelerometers needed and reduce the time and cost associated with the test.

✔ By performing a flutter simulation on a finite element analysis-verified test model, SDRC engineers provided Orbital with results that were submitted to the FAA in lieu of a flutter flight, sparing the cost of the flight and the delay to the schedule that it would have caused.

✔ The Aerospace Center's timely work and FAA-acceptable simulation results played a big role in keeping the X-34 test program on schedule.

✔ The first series of captive-carry flight test results increased confidence that the flutter simulation results were accurate.

PLANS

Orbital is already planning its next space vehicle program and has indicated SDRC will be part of the team, including I-DEAS for design and simulation, and SDRC services for the advanced testing and analysis that Orbital relies upon for validating its design.

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