Engineering, Consulting, and Software

ASD/CLAS Customer Success Story

Shuttle/Payloads Nonlinear Transient Coupled Loads Analysis Reduces Mission Risk

Customer: Lockheed-Martin

Software: ASD/CLAS

Summary:

The engineering analysis team at Lockheed Martin (Houston) has just completed what can only be described as one of the most complex Shuttle/payloads nonlinear liftoff/abort landing transient coupled loads analysis (CLA) simulations ever conducted for NASA. Per S. Bhatia, the Senior Structural Dynamics Engineer in charge: “The nonlinear CLA involved more than 20 component dynamic math models, system damping synthesis, and over 190 joint deadbands including deadbands at both the top and bottom surfaces of FSE plates carrying orbital replacement units for the Space Station. For most components, every single attach degree of freedom had a deadband, making it an extremely challenging computational problem. One particular component, the MT-TUS, had deadbands at four separate interfaces including component internal deadbands. ASD/CLAS' nonlinear solver crunched through the nonlinear equations without any problems. The system performed well, the results make physical sense. This is an amazing capability.”

S. Vidyasagar, the Engineering Analysis Manager, adds: “We had tried other commercially available tools in the past to solve this type of nonlinear CLA problem. Even with just a few deadbands, the solution time-histories were riddled with numerical noise, rendering the results useless for our purposes. ASD/CLAS solved this very difficult problem with no issues producing very rational response time-histories. In addition, ASD/CLAS' results viewer allowed us to quickly go through all component and OTM time-histories and its custom report generator allowed us to quickly generate the required comparison tables for our customers. All this was done in ASD/CLAS' user friendly, configuration managed environment.”

Bhatia reports that the execution times for the liftoff transient simulation, involving 24 cases, was just under an 1 hour per case on a 3.3 GHz quad-core workstation.

Dynamic tests conducted by NASA have demonstrated that joint tolerances can have a major impact on the joint forces and therefore the component responses. Tests with joint deadbands as small as 2.5 mils were shown to increase the maximum joint forces by over a factor of 2 relative to the zero deadband case.

Nonlinear CLAs accounting for the impact of joint tolerances have become a major NASA risk-mitigation analysis for Shuttle/payloads since 2006.

Key words: Nonlinear Coupled Loads Analysis, Risk-Mitigation, Component-Mode Synthesis, Dynamic Math Models, Configuration Management, Configuration Control

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