Precision Assemblies | Detailed Dynamic Stress Analysis of Complex Assemblies

CASE STUDY

CUSTOMER:
BAE SYSTEMS

INDUSTRY:
Defense Electronics

PROJECT NAME:
Stress Analysis of THAAD Seeker IGA

CUSTOMER LOCATION:
Nashua, New Hampshire

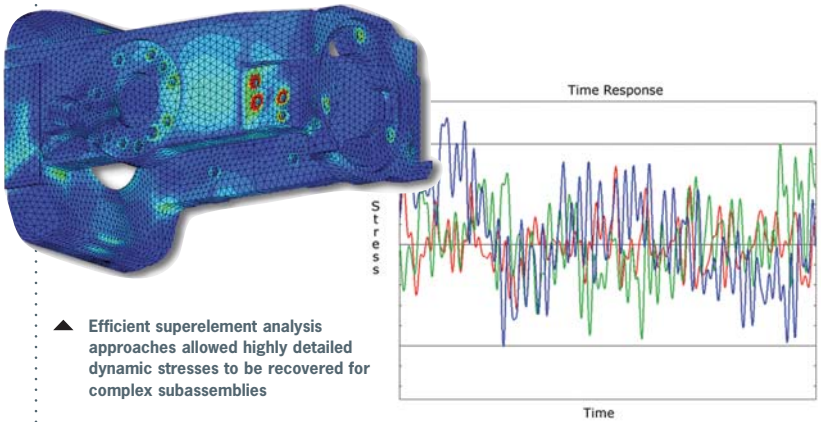
OVERVIEW

The Theater High Altitude Area Defense (THAAD) missile system is a transportable defensive weapon that uses precision targeting imagery to protect against hostile incoming threats such as tactical and theater ballistic missiles. BAE SYSTEMS is responsible for providing the infrared (IR) seeker subsystem containing an infrared detector, stabilized on a two-axis integrated gimbal assembly (IGA). During operation and transportation, the seeker is subjected to severe static, random vibration, shock and thermal loads. With no margin for failure in the qualification test program, BAE SYSTEMS asked ATA Engineering, Inc. (ATA) to analytically qualify the IGA structural design for all load cases and identify any required design modifications before manufacturing.

To balance the need for accurate stress predictions and reduced solution time, a superelement analysis approach was used. A system dynamic model of the entire assembly was created that included detailed finite element models of all the components. An efficient modal solution of the assembly was achieved by representing individual subassemblies as superelements in the solution. The system modal response was then used in a forced response analysis to predict the dynamic stresses on the components under the various random vibration and shock loads. The modularity and efficiency of the solution allowed design issues to be identified sufficiently early to implement improvements in a cost effective manner.

ATA SUPPORT INCLUDED:

- Imported detailed Solid Works™ geometry of individual IGA parts into I-deas, removed structurally insignificant details, and created detailed finite element models for stress analysis.
- Created NASTRAN superelement models of IGA subassemblies and predicted the natural frequencies of the total system for the frequency range of interest.
- Predicted stress response and fatigue life for individual parts under shock input and random vibration.
- Developed a custom algorithm within MATLAB that generates envelope functions in an automated way to define the vibration environment at various critical interfaces to the IGA.
- Performed detailed bolt analysis of all fastener interfaces.
- Assisted BAE with redesign of components in order to reduce predicted stress response.



▲ **Efficient superelement analysis approaches allowed highly detailed dynamic stresses to be recovered for complex subassemblies**

"The data integration of the digital simulation tools enabled this design to be completed under a very tight schedule. (ATA's) analysis processes provided an unprecedented fidelity to the results, allowing the design to pass the Critical Design Review with flying colors."

Sean McAllister
Principal Mechanical Engineer
BAE Systems, IEWS

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