An integrated approach to efficient aeroelastic analysis

Using integrated test and analysis tools to help qualify the Predator B UAV for flight

Issues:

Verify aeroelastic stability ahead of flight tests

Develop analysis models while design is still maturing

Use of various simulation and test tools required for accurate, efficient analysis

Approach:

Use mix of best available tools in an integrated manner to meet schedule and technical requirements

Seamlessly share data between test and analysis to allow correlation of analysis models with test data

Use validated models to carry out advanced analysis with confidence

Results:

Complex all-composite structure quickly modeled in entirely graphical environment

Efficiently updated analysis models to correlate accurately with test data

Verified stability of UAV structure in time for flight testing

GENERAL ATOMICS AERONAUTICAL SYSTEMS, INC.

A tight schedule and a complex all-composite design required a fresh approach to modeling and analysis to verify the stability of the Predator B UAV in time for flight tests.

Expanding the capabilities of the Predator UAV

The Predator B represents a significant expansion of the mission performance and capability of the highly successful Predator, a long endurance unmanned aircraft used by the U.S. Air Force for surveillance and reconnaissance missions. Predator B has 50 percent more payload capacity, an endurance of up to 30 hours and significantly increased speed and operating altitude. Higher speeds and a longer wing span both increase the potential susceptibility for the aircraft to experience flutter. ATA Engineering, Inc. (ATA) was asked to determine if Predator B would experience flutter within the prescribed flight envelope. With flight tests approaching, and the design proceeding concurrently with the analysis, ATA needed a set of tools that would allow rapid model development, continual updating of models as the design matured, and powerful dynamics analysis capabilities.

Comprehensive tools, comprehensive solutions

To meet an aggressive schedule for the completion of the aeroelastic analysis, it was not possible to be constrained by the limitations of a single solution or simulation code. Instead, a mix of the best available tools was used in a highly integrated manner to allow both the schedule and technical requirements to be met. These tools included the I-deas® NX Series suite of simulation tools for finite element mesh generation, MTS I-deas Pro for test and correlation, and Nastran for dynamic analysis. The use of fully-associated geometry, finite element modeling, and laminates tool sets allowed efficient modeling of the complex composite structure and greatly reduced the time required to incorporate design changes. Analysis models were rapidly updated to correlate accurately with test data through the seamless sharing of data between test and analysis codes. Validated analysis models were then used to perform the advanced aeroelastic analyses, and the stability of the final design was verified in time for flight testing.

NX

Solutions/Services

I-deas® NX Series

MTS I-deas® Pro test

Nastran

Client's primary business

General Atomics Aeronautical Systems, Inc. of San Diego, California is focused on the design and production of unmanned aircraft systems. These state-of-the-art reconnaissance systems are in extensive use by the U.S. government including the U.S. Air Force, NASA, Department of Energy and the U.S. Navy as well as by several overseas customers.
www.ga.com/asi/aero.html
www.ata-e.com.

About ATA

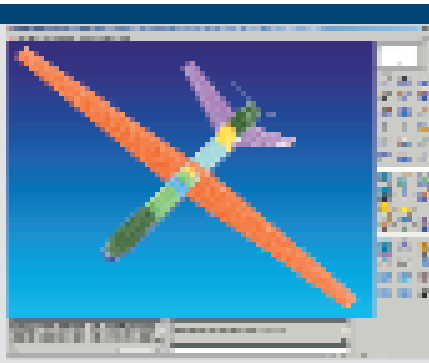
ATA Engineering, Inc. (ATA) is a high-value provider of analysis-driven and test-driven design solutions for structural, mechanical, electro-mechanical and aerospace products.
www.ata-e.com.

"The ability to use multiple tools in a tightly integrated fashion lets the engineers focus their efforts on the design issues, resulting in faster, better solutions."

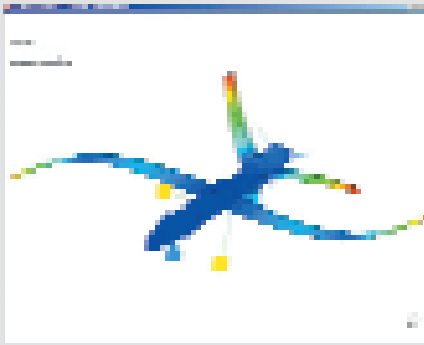
David Alexander
V.P. of Engineering
General Atomics Aeronautical Systems, Inc.

I-deas integrated tool set + Nastran's analysis strength = best solution

The Predator B is an all-composite aircraft with a multitude of different materials and lay-ups throughout, suggesting a difficult and time-consuming modeling task. The suite of direct translators available with I-deas allowed trouble-free interaction with a variety of other CAD and CAE codes, while its design associative system-level finite element modeling capabilities greatly reduced pre-processing time.



The advanced "section meshing" capabilities of NX MasterFEM (within I-deas) were used to remove unwanted features from the detailed solid geometry provided by the manufacturer. This allowed the rapid generation of a less complex geometry that was used in the development of a mesh suitable for modal and aeroelastic analysis.



Associativity with the solid geometry allowed automatic updating of the meshes to incorporate design modifications. The assembly-level FE modeling functionality of NX MasterFEM allowed the modification of meshes of individual components without the need to edit other parts of the assembly, while the NX Laminate Composites module's graphical interface provided easy verification of lay-up design.

The finite element model was exported to Nastran for modal analysis. Mode shape results were imported back into NX MasterFEM and reviewed using the advanced CAE results post-processing and visualization capabilities. Modal test data for the aircraft was measured using MTS I-deas Pro. Design sensitivities, model updating, and correlation with modal test data were performed using a combination of Nastran, MTS I-deas Pro test and CORDS, all using the same data sets. Modes from the validated model, and a panel model of the vehicle, were then exported directly to ZONA ZAERO for aeroelastic analysis. Aeroelastic analysis technology from ZONA is now also available in NX Nastran.

Eliminating the boundaries between tools

The flexibility provided by the ability to import and export models and data seamlessly to and from a variety of codes allowed ATA to focus on the engineering issues and utilize the best tools, regardless of vendor, to get this specific job done. By working in a highly integrated design, analysis, and test environment, ATA was able to meet all of the schedule and technical needs and provide critical flight qualification information to General Atomics Aeronautical Systems, Inc.

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