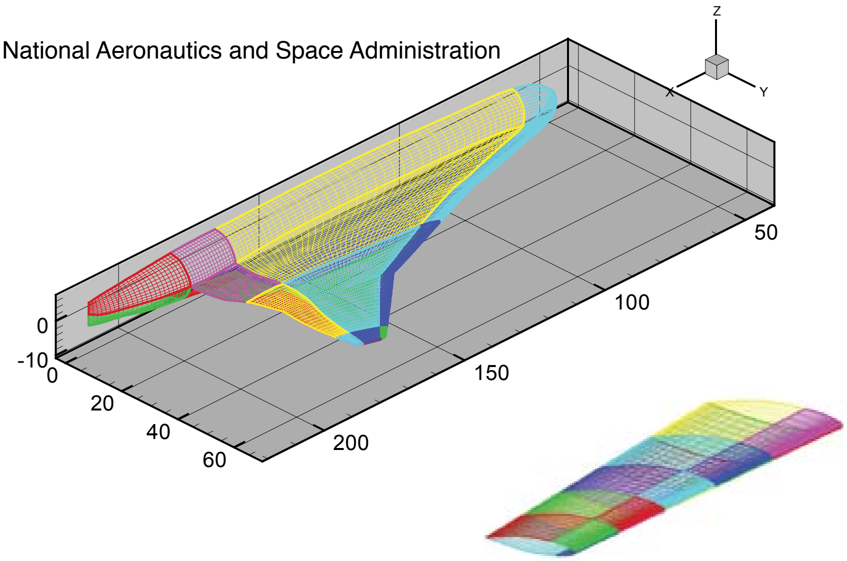
National Aeronautics and Space Administration



NASA Langley's

Reduced-Order Models for Efficient Computational Analysis of Complex Systems

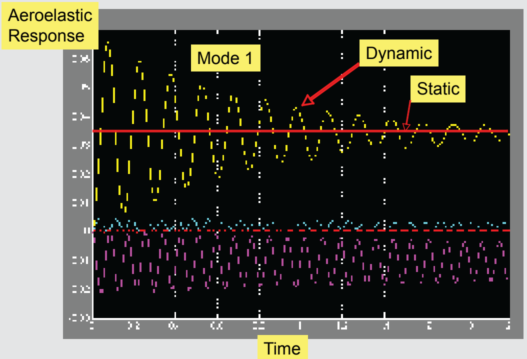
Innovative software for aeroelastic analysis at a fraction of the time and cost of traditional CFD methods

NASA Langley has developed unsteady aerodynamic Reduced-Order Models (ROMs) that significantly improve the computational efficiency compared to traditional analyses of aeroelastic and other complex and unsteady systems. Traditional methods rely on the repetitive use of aeroelastic computational fluid dynamics (CFD) codes and the iteration between the structural and nonlinear aerodynamic models of the aeroelastic CFD code for predicting the aeroelastic response of flight vehicles—very time consuming and computationally expensive. The new ROMs are quite different from the traditional aeroelastic analysis tools and enable the computational aeroelastic analysis of flight vehicles at a fraction of the time and cost.

Benefits

- Reduced computational costs through the ability to:
  - Calculate both the dynamic and static aeroelastic responses using the same ROM
  - Analyze all of the structural modes in one CFD run
- Simplified model in a form shared by other engineering disciplines such as controls and safety

partnership opportunity



Static and dynamic aeroelastic analysis results using ROMs

Applications

The technology offers wide-ranging market applications, including:

- Aerospace – aerodynamic flutter of rotorcraft
- Civil structures – dynamic behavioral models of large buildings and other civil structures such as bridges, dams, and towers

The Technology

As shown in Figure 1, traditional computational aeroelastic analysis using CFD codes requires the coupled interaction of the linear structural model and the nonlinear aerodynamic model (both within the aeroelastic CFD code). The structural model provides displacements due to aerodynamic forces, and the nonlinear aerodynamic model computes the aerodynamic forces induced by the structural displacements. The computed aerodynamic force is passed back to the structural model, and the resource-intensive process is repeated at each time step.

Starting with an aeroelastic model consisting of a CFD grid and structural mode shapes, NASA Langley's new analysis procedure, shown in Figure 2, occurs as follows:

1. The unsteady aerodynamic responses of all of the structural modes are computed by exciting all of the modes simultaneously in just one execution of the CFD code.
2. The responses obtained in Step 1 are processed through a NASA Langley-developed set of algorithms, yielding a simplified mathematical model in state-space form.
3. The state-space forms of the aeroelastic and structural models are combined, and:
   - A new method computes matched-point solutions.
   - Another new method enables simultaneous computation of the static and dynamic responses.

U.S. Patent Application 2008/0243448 A1

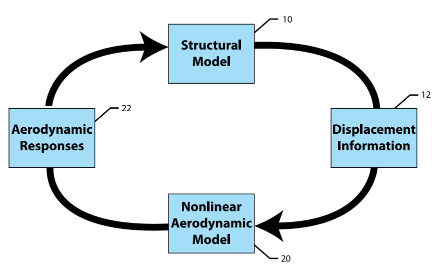


Figure 1: Traditional computational aeroelastic analysis

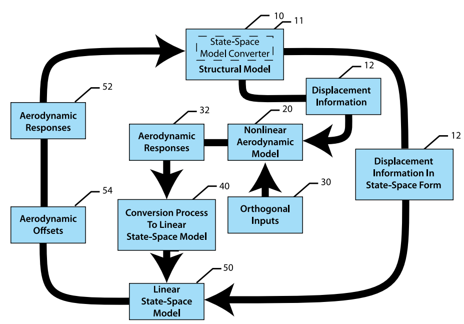


Figure 2: Novel computational aeroelastic analysis using ROMs

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

The Technology Gateway

National Aeronautics and Space Administration

Langley Research Center
Mail Stop 218
Hampton, VA 23681
757.864.1178
LARC-DL-technologygateway@nasa.gov
technologygateway.nasa.gov

www.nasa.gov

LAR-17325-1

TOA 77
NP-2009-09-194-LaRC