



Recent Applications of Computational Fluid Dynamics at Boeing

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Douglas N. Ball
Director, Enterprise Technology Strategy

High Performance Computing

This is what it's good for . . .

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787-8



747-8



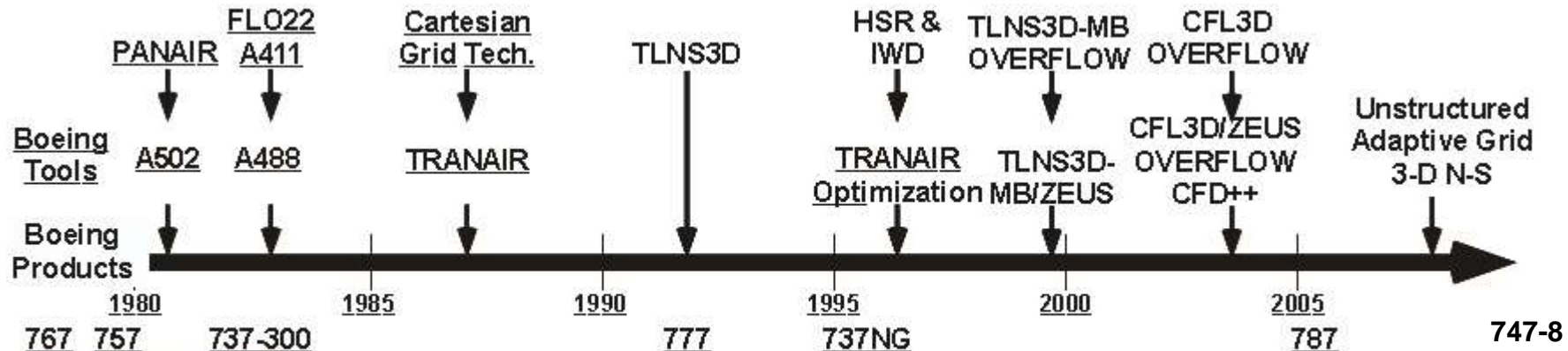
747-8F



737MAX

CFD Contributions to 787

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1980 state of the art

Modern close coupled nacelle installation, 0.02 Mach faster than 737-200

21% thicker faster wing than 757, 767 technology

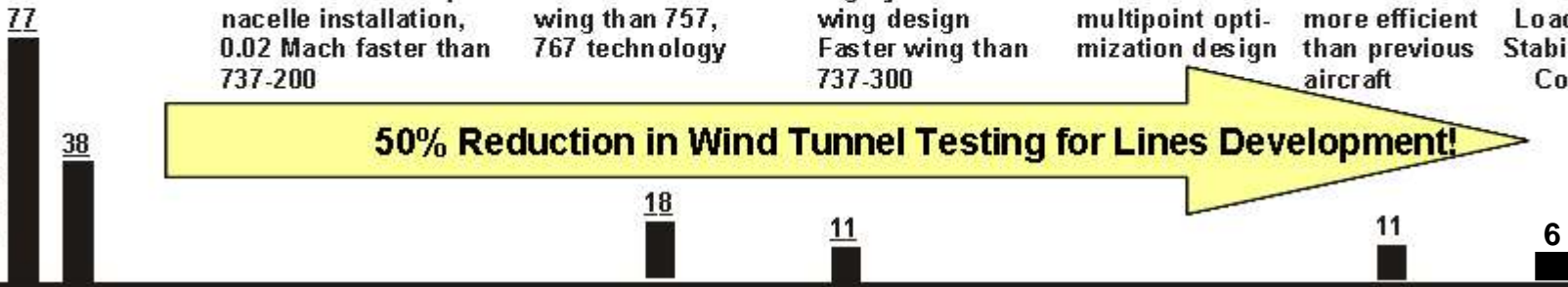
Highly constrained wing design
Faster wing than 737-300

Successful multipoint optimization design

Faster and more efficient than previous aircraft

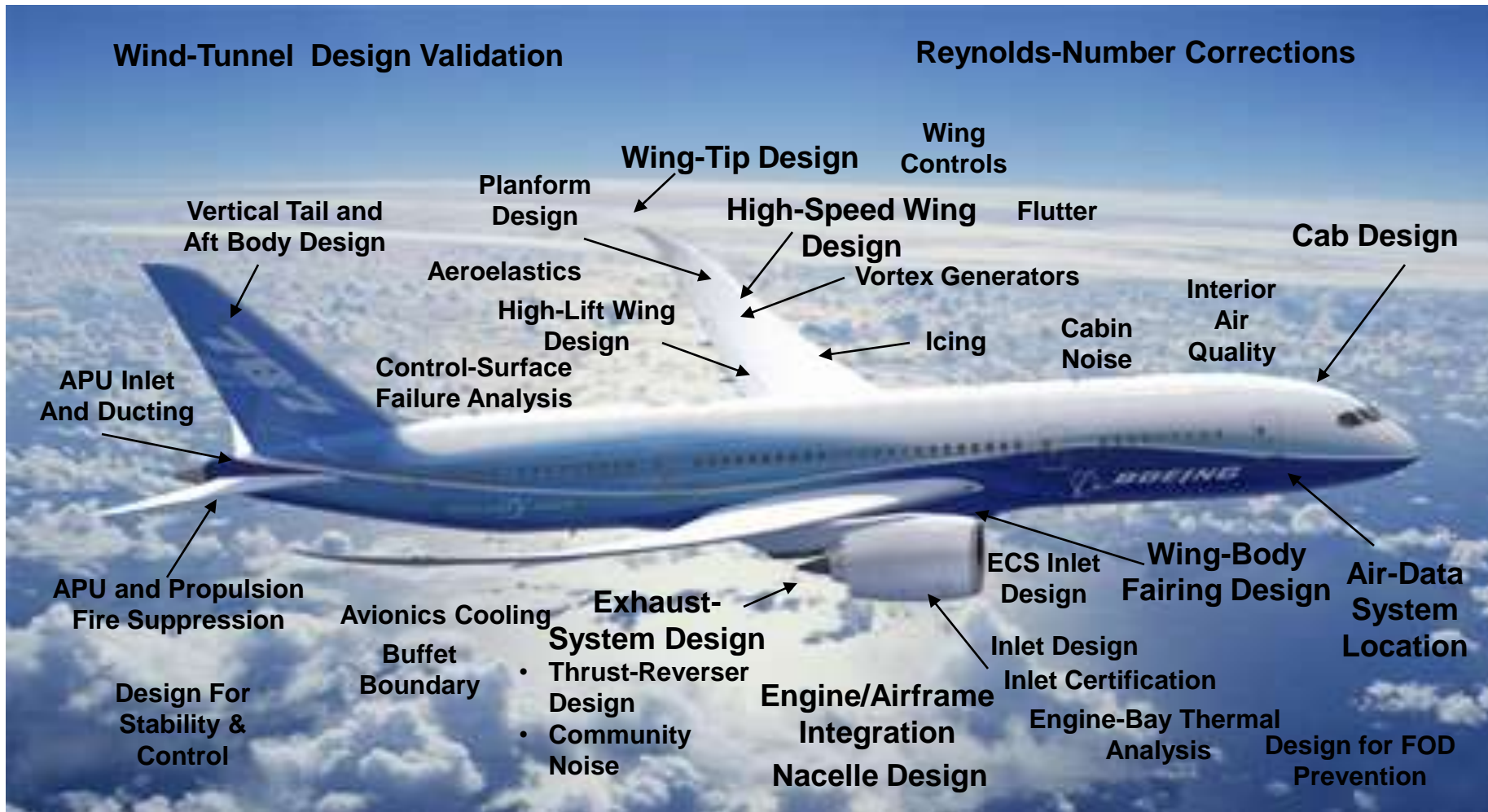
CFD for Loads and Stability and Control

Number of Wings Tested



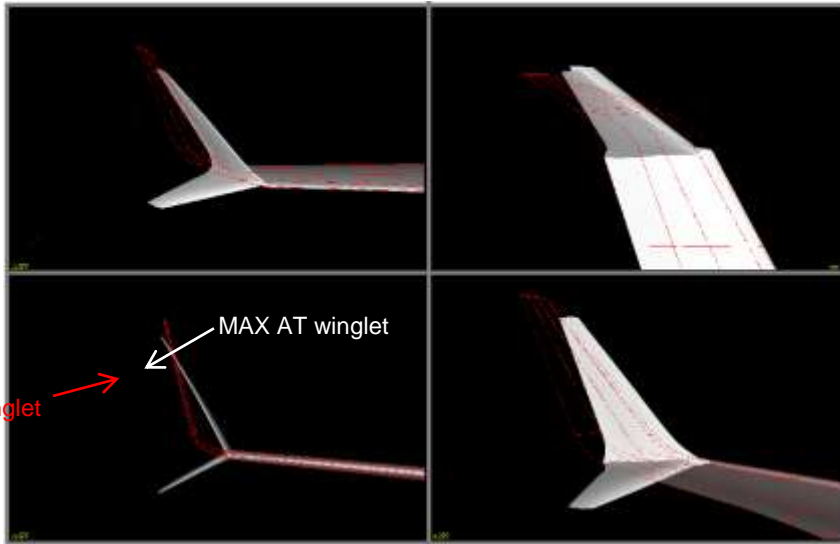
CFD Contributions to 787

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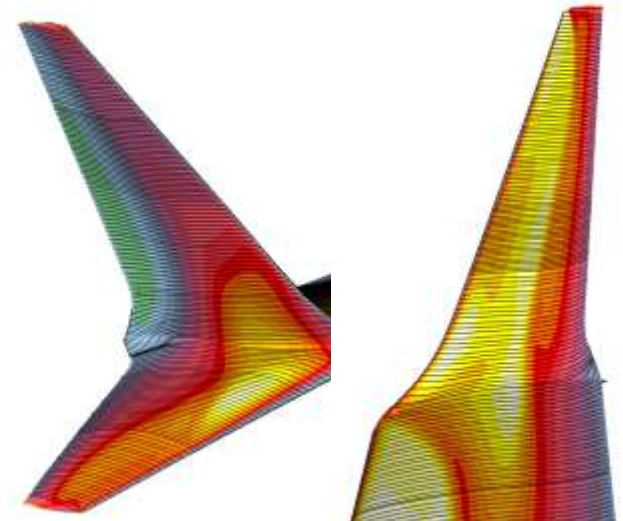
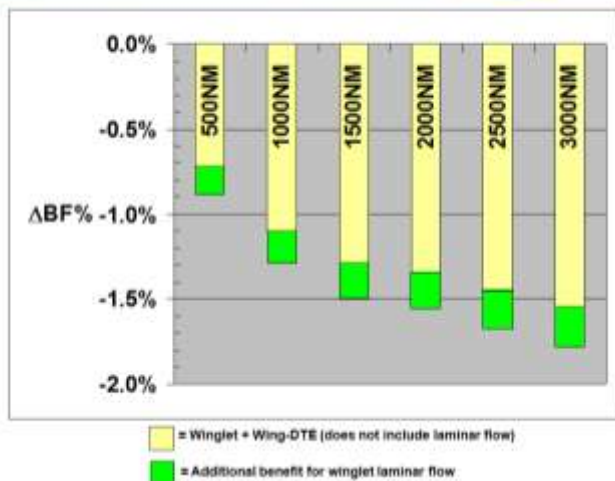


CFD Contributions to 737MAX

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Block Fuel Summary



CFD Contributions to 737MAX

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- Wind tunnel testing completed 2Q 2012
- Drag results near expectations
- Good correlation with CFD predictions



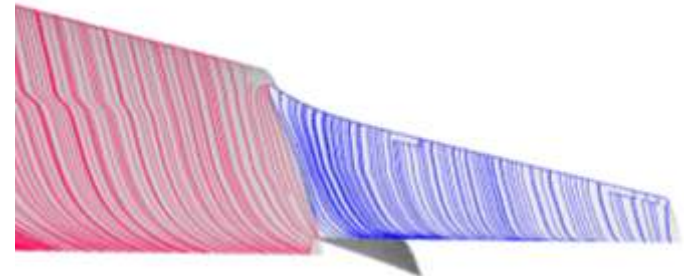
Wind Tunnel Results



CFD Prediction



Wind Tunnel Results

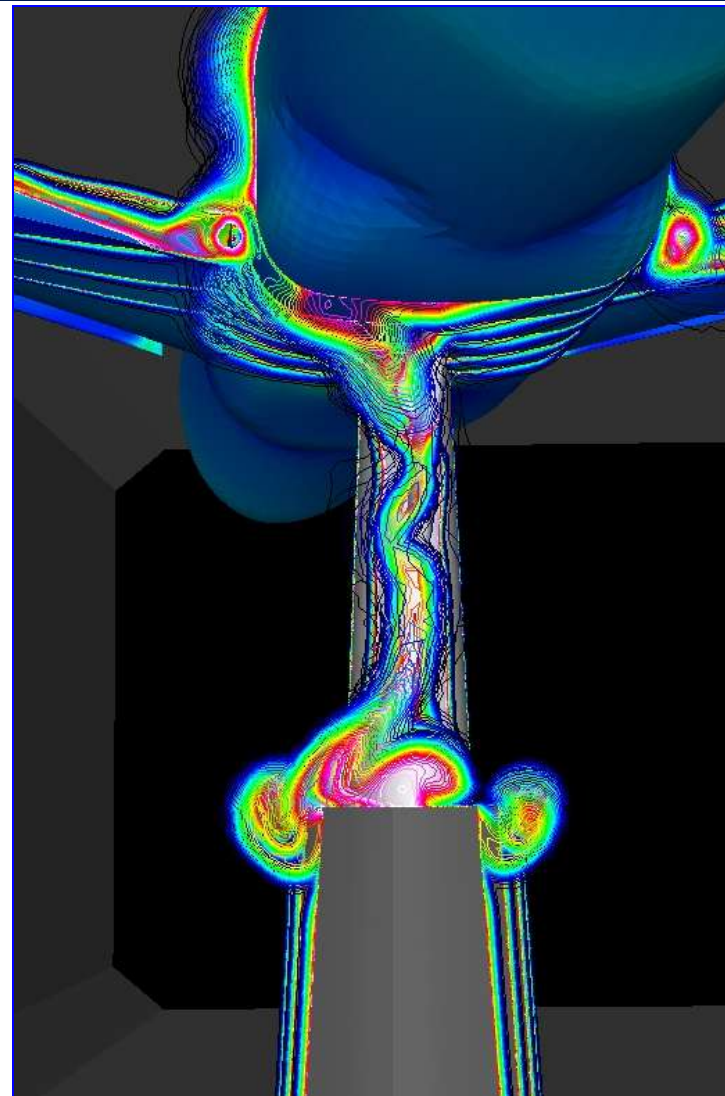
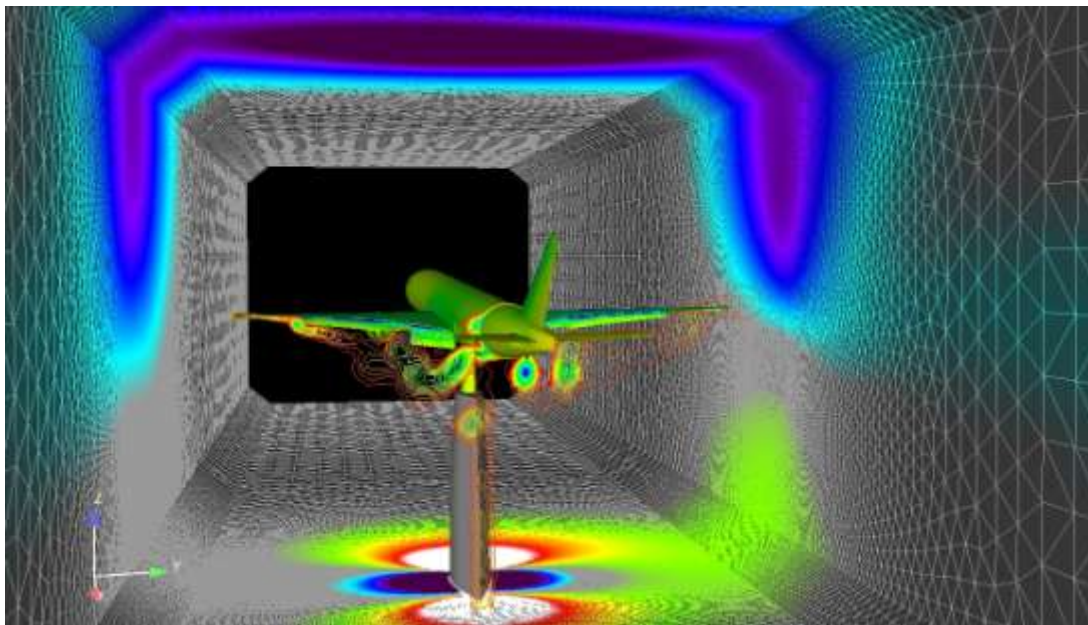


CFD Prediction

Stability & Control Application of CFD

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- Increasing our understanding of mounting system & wall interference effects
- Used for validation and improvement of traditional correction methods
- We've developed automated tools for quickly adding and analyzing wind tunnel geometries to pre-existing models

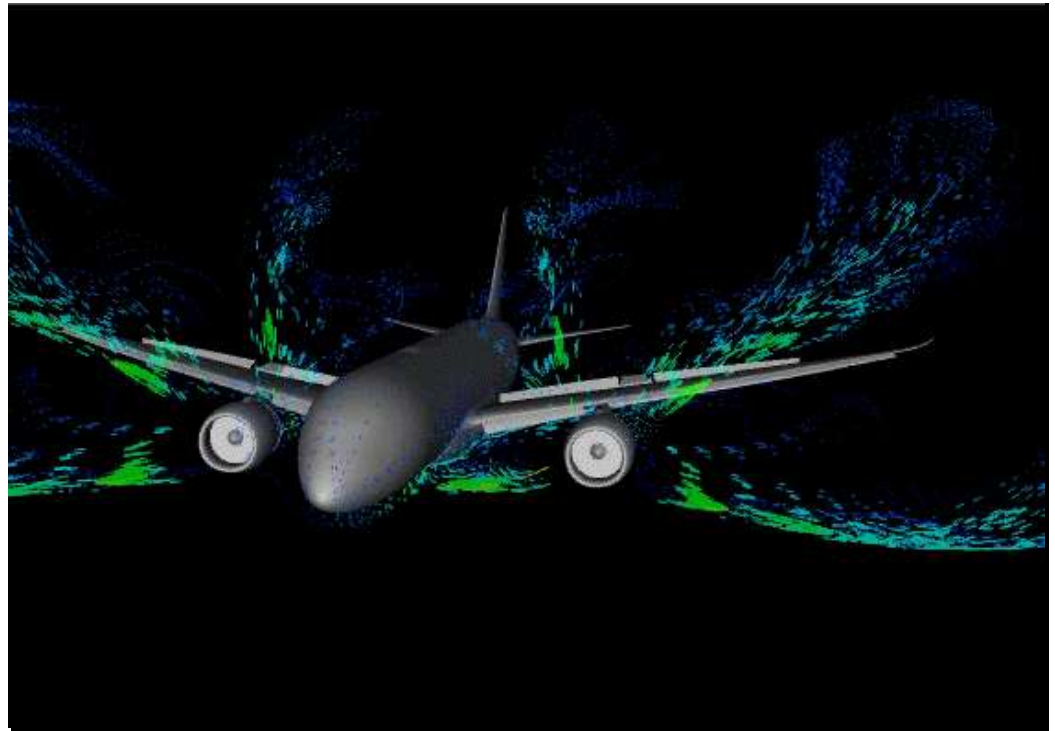
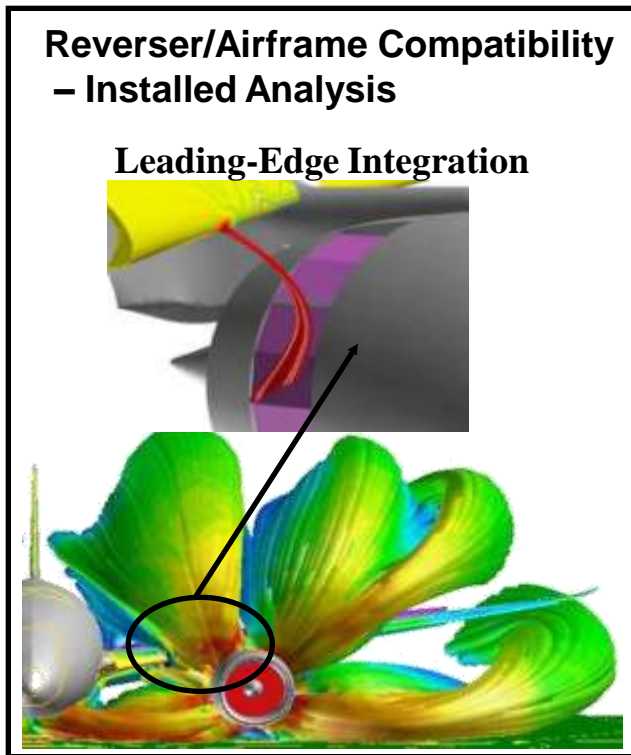


Propulsion Aerodynamics – Thrust Reverser

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What Are We Doing?

- CFD process developed within Boeing utilized ANSYS/ICEM and CFD++ solver in support of T/R external efflux pattern development and related analysis of re-ingestion, impingement, and controllability concerns.

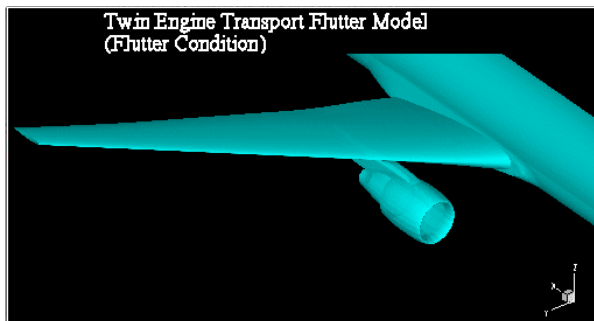
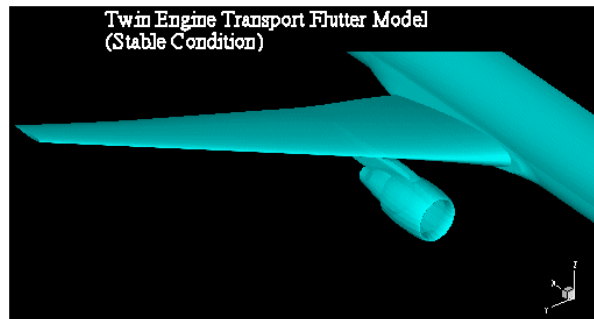


CFD in Flutter Predictions

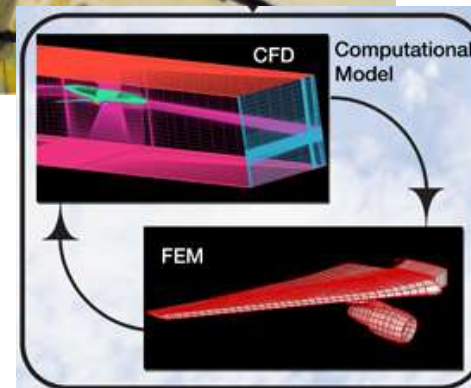
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What Are We Doing

- Create, correlate, and validate both steady and unsteady aeroelastic processes.
- Assure the processes (TRANAIR-based and CFL3D-based) are robust and repeatable.
- Validate process components for each component to assure accurate results:
- Initially validate unsteady code for 'simple' wing and isolated nacelle oscillations
- Apply methodology to compute wind-tunnel static aeroelastic deformations and high speed flutter



Wind Tunnel Model
↓
Computational Model
↓
Analysis of Flutter Conditions



It's Not Just About Airplanes

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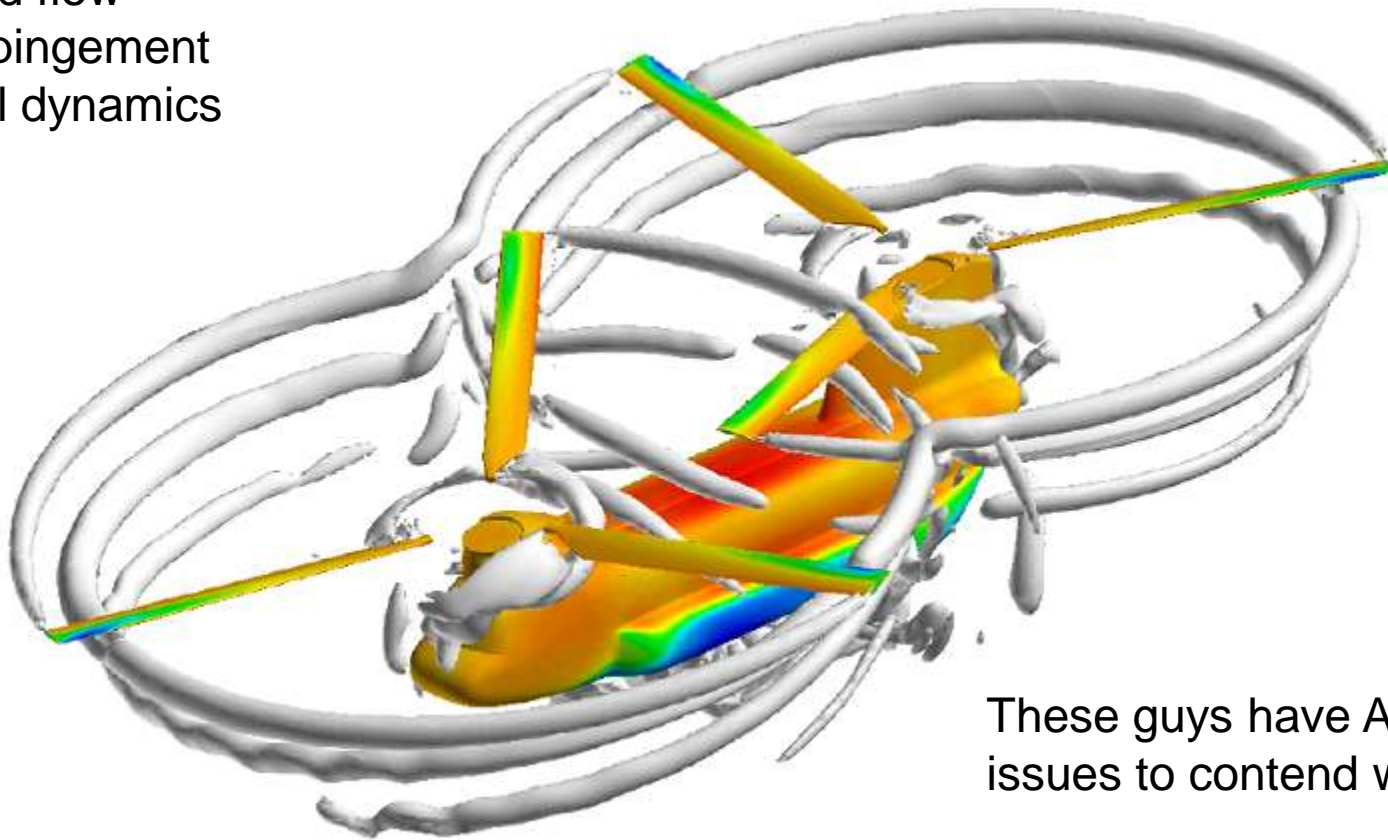
CFD was used to determine a new ignition sequence to reduce the hydrogen fire risk



It's Not Just About Airplanes

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Unsteady flow
Separated flow
Wake impingement
Structural dynamics



These guys have ALL the issues to contend with !

Concluding Remarks

- CFD has contributed greatly to the development of new products
- The need to further reduce development cost and cycle time will drive greater dependence on CFD.
- Improvements are needed in: transition and separation prediction, separated flow modeling and calculation efficiency
- Multi-disciplinary analysis and design will drive further requirements (loose vs tightly coupled)

