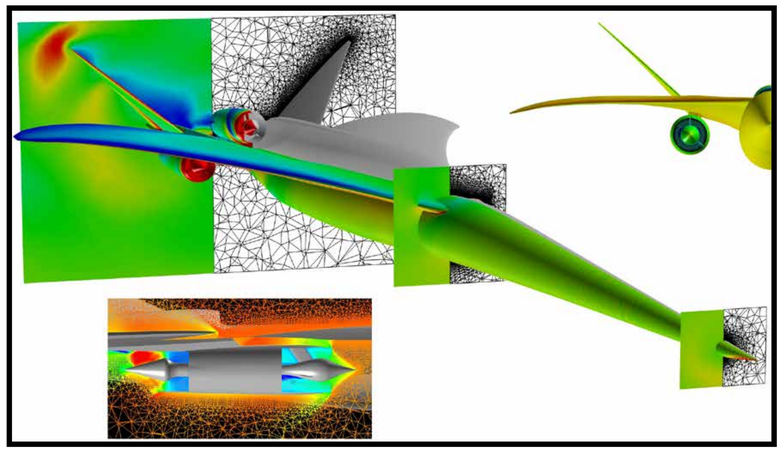
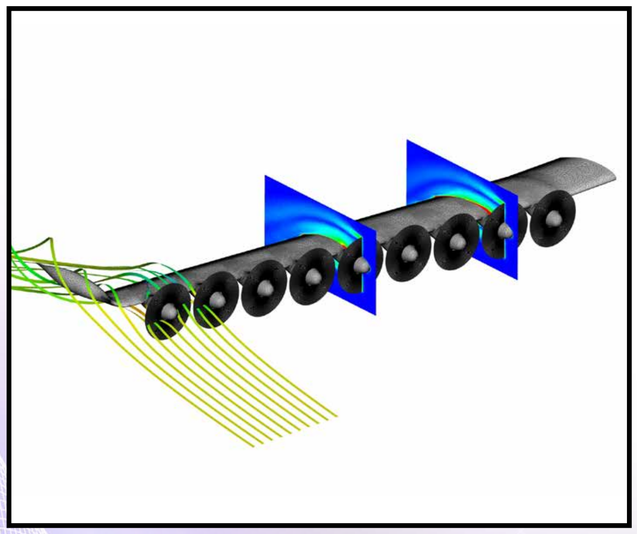
High-Fidelity Physics-Based Analysis and Design of Complex Configurations



Simulation of the Lockheed Martin N+2 low-boom supersonic configuration with direct coupling of aerodynamics, engine cycles, and structural effects. Pressure is shown on several cutting planes through the domain. Center: Left half-planes show solution contours at three fuselage stations; right half-planes show cross-sections of unstructured grid. Top right: Front view of aircraft with view into engine inlet. Bottom: Cutting plane through centerline of engine geometry. *Jan-Renee Carlson, NASA/Langley; Joseph Connolly, NASA/Glenn*



Simulation of a distributed electric propulsion concept. The simulation uses source terms based on actuator disk theory. Vorticity magnitude is indicated on cutting planes and stream ribbons colored by pressure are shown at the wingtip. *Karen Deere, Sally Viken, NASA/Langley*

NASA missions require a wide range of modeling tools to design and analyze next-generation flight vehicles. FUN3D is an unstructured-grid computational fluid dynamics suite of codes that includes high-fidelity modeling, as well as a range of models for structural effects, acoustics, radiation, ablation, and chemistry. A leader in the development of simulation-based design tools, FUN3D provides a very powerful adjoint-based capability for accommodating large numbers of design variables. This technology has also been instrumental in developing adjoint-based methods for mesh adaptation and error estimation, which significantly reduces the uncertainties in accuracy typically present in numerical simulations.

FUN3D is widely used by numerous NASA programs, industry, and the U.S. Department of Defense, and has been used by over 100 academic institutions for conducting research projects. Because of its unique capabilities and performance on large-scale computing platforms, the code is widely used throughout the aerospace industry. Several recent and ongoing applications of FUN3D include:

- Support for NASA programs including fixed-wing and rotary wing vehicles, supersonic boom mitigation, and the development of the new Space Launch System.
- Development of commercial crew spacecraft at companies such as SpaceX.
- Development of efficient green energy concepts, such as distributed electric propulsion, wind turbine design, and drag reduction for long-haul trucking.

Results from a previous collaboration with researchers at the Department of Energy were recognized with the Gordon Bell Prize, a prestigious award for outstanding achievements in high-performance computing. FUN3D has been scaled to 80,000 cores on meshes comprised of several billion elements. This capability is instrumental for the analysis and design capabilities required to complete many NASA missions.

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