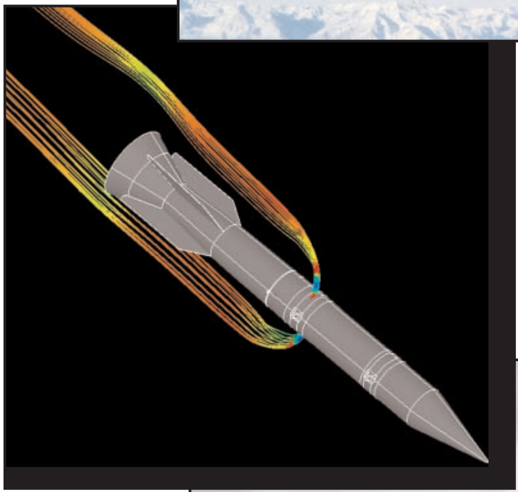
Computational Aerodynamics

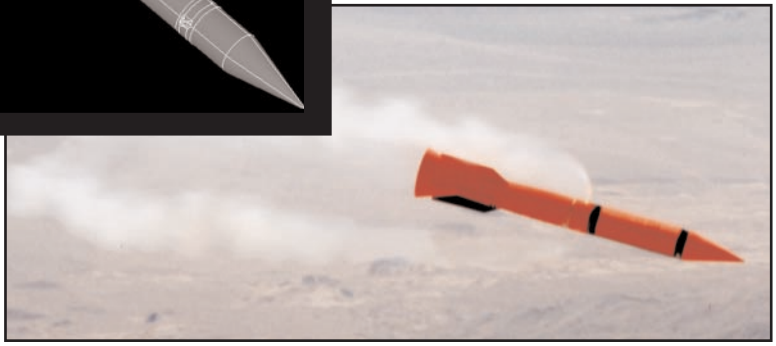
Computational aerodynamics at Sandia National Laboratories is at the cutting edge of research, development, and application of numerical simulation methodologies in support of advanced flight systems for the Department of Energy (DOE) as well as other Department of Defense, NASA, and industry programs. The computational fluid dynamics (CFD) codes at Sandia span the Mach number regime from subsonic through hypersonic flight. Computer codes are developed and utilized for design, analysis, and certification of ground transportation systems, gravity bombs, missiles, and reentry vehicles. Computational support of associated flight and test programs ranges from maintenance and evaluation of the current stockpile to the design and analysis of advanced and exploratory vehicles.

The computational codes applied to these problems are chosen based on the desired physical fidelity and the design or analysis cycle time. Included in this suite of tools are simple correlation-based approaches; inviscid/boundary layer codes; Parabolized, Thin-Layer, and Full Navier-Stokes codes; and Direct-Simulation Monte-Carlo (DSMC) codes. Physical model complexity ranges from laminar flow with an ideal gas equation-of-state to turbulent flows with equilibrium and thermo-chemical nonequilibrium gas chemistry. The Full Navier-Stokes code, SACCARA, and the DSMC code, ICARUS, include the most relevant physical phenomena and operate efficiently on DOE's collection of massively parallel computer architectures.

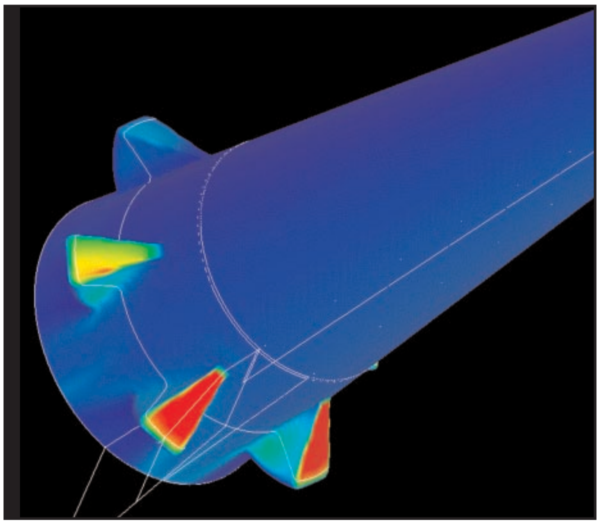
A new code that will eventually replace SACCARA, called Premo, is under development within Sandia's SIERRA framework to take advantage of the latest in numerical algorithms in an object-oriented code design. Premo's unstructured grid design will lead to improvements in overall analysis turnaround time and allow for efficient coupling with other mechanics (e.g., thermal, structural, trajectory) in a massively parallel computing environment.



The B61-11 in flight with spin rockets firing. Code predictions using Full Navier-Stokes calculations are used in concert with flight and ground testing to understand interactions between the spin rocket plumes and the fins.



Fundamental research conducted at Sandia is strongly driven by customer applications for eventual inclusion in the computational aerodynamics tools. Current areas of interest include laminar-to-turbulent transition on high-speed flight vehicles, highly unsteady turbulent flows (coupling of Reynolds-Averaged Navier-Stokes and Large Eddy Simulation), and fluid-fluid and fluid-structure interactions.



Parabolized and Full Navier-Stokes codes are used to calculate the reentry characteristics of both DOE stockpile systems (right) and advanced and exploratory concepts (left).

For more information contact

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