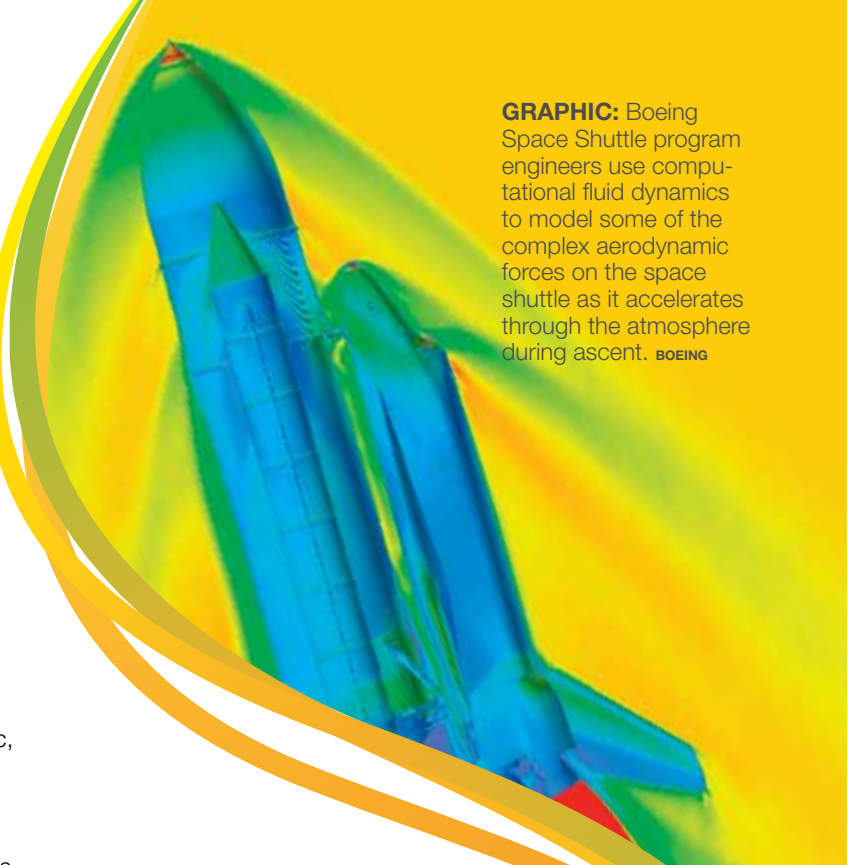
Knowledge *flow*

Boeing team expands aero-modeling skills to help keep shuttle crews safer—and better share its expertise companywide

by Ed Memi



GRAPHIC: Boeing Space Shuttle program engineers use computational fluid dynamics to model some of the complex aerodynamic forces on the space shuttle as it accelerates through the atmosphere during ascent. BOEING

Few flying machines can match the aerodynamic complexity of the space shuttle. It travels at subsonic, supersonic and hypersonic speeds, rocketing into space at around 17,500 miles per hour (28,000 kilometers per hour), withstands aeroheating temperatures soaring to 3,000 degrees Fahrenheit (1,650 Celsius) as it re-enters Earth's atmosphere at Mach 25, and then slows to land like a glider.

Key to understanding the diverse environments and risks encountered by the space shuttle—and one of its biggest engineering challenges—is a tool called computational fluid dynamics (CFD). Boeing engineers use CFD extensively on the Space Shuttle program and continue to refine and expand this expertise to reduce risks to shuttle crews—and help Boeing better design and engineer future aerospace vehicles.

CFD is one of the branches of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the billions of calculations that are required to simulate the interaction of liquids and gases, such as airflow, over surfaces.

The main shuttle CFD application is to determine airloads and aeroheating loads on the vehicle as it crosses the atmosphere. The most critical analyses are aeroheating loads upon the shuttle thermal protection system during atmospheric re-entry, as the shuttle reduces its speed from Mach 25 to Mach 5, according to Georgi Ushev, integrated team manager for the orbiter aero and aeroheating group for the space shuttle.

CFD also is used to analyze critical atmospheric flow and heating applications inside the shuttle. "We might monitor the rate at which the astronauts generate heat in the cabin or the rate at which oxygen is being depleted," Ushev said. "We could be asked to eliminate spots where the air does not circulate properly. If there is a fuel leak somewhere, we can analyze how quickly the gases may spread through the orbiter and whether they are flammable."

The team already has applied its expertise on NASA's Orion Crew Exploration Vehicle Launch Abort System; Ushev said the team's CFD skill and knowledge could be valuable to other programs across and outside Boeing as well.

"Our CFD expertise—in aerodynamics, aeroheating and thermal gas dynamics—is applicable to any new platform required to travel through the atmosphere of Earth, or any other planet," Ushev said. ■

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PHOTO: Georgi Ushev (left), integrated team manager for Boeing's orbiter aero and aeroheating group, analyzes computational fluid dynamics data with teammates Peter McCloud (center) and Peter Jang. BOB FERGUSON/BOEING