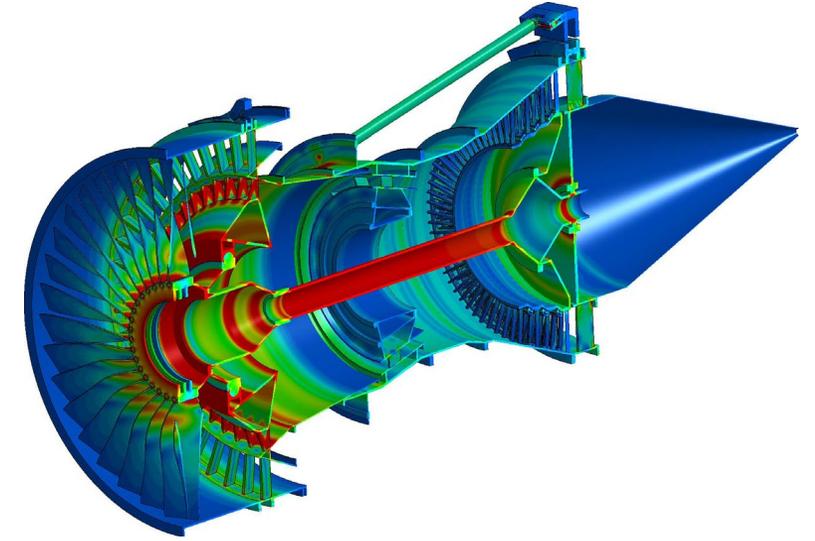




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A cross-section of the jet engine model.

## IMPROVING VIRTUALLY GUIDED PRODUCT CERTIFICATION WITH IMPLICIT FINITE ELEMENT ANALYSIS AT SCALE

### Research Challenge

Modeling and simulation have become increasingly important in both product design and support. Model complexity and size have increased accordingly, leading to longer runtimes for simulation software. The increase in runtime is not linear but, rather, exponential. Research and development of modeling and simulation software are needed to improve its parallel scalability so that larger, more sophisticated models can be run with faster time-to-solution, informing and shortening the design cycle.

### Methods & Codes

LS-DYNA is an finite element analysis (FEA) software package used by a wide range of industries. It is used to analyze a diverse set of manufacturing problems such as the simulation of automotive collisions, explosions, and problems with large deformations. These codes provide important features, such as a rich library of elements, contact capabilities, nonlinear material constitutive models, mesh adaptivity, and flexible coupling.

### Why Blue Waters

Sparse direct solver algorithms in implicit FEM analysis are both computation- and memory-bound, as well as being communication-bound at large scales. Processing and memory bottlenecks revealed themselves as the number of processors increased by an order of magnitude beyond that familiar to today's developers and users. Many other scientific and engineering codes intended to run on high-performance computing platforms will have similar challenges. Blue Waters is an enabling platform where massively parallel sparse solver technology can be tested and advanced.

### Results & Impact

The research has shown that the implicit finite element method can perform exceedingly well on a petascale high-performance computing platform, thus opening the door for high-fidelity multiphysics modeling in real scale and promoting safer and more energy-efficient cars, airplanes, and other advanced industrial products.