

# USAERO™

## *Unsteady Aerodynamic Software*

Challenged by relative motion aerodynamic or hydrodynamic simulations? Multi-store release from a complex aircraft? Trains passing in a tunnel? Ships with rotating propellers operating near the free-surface?

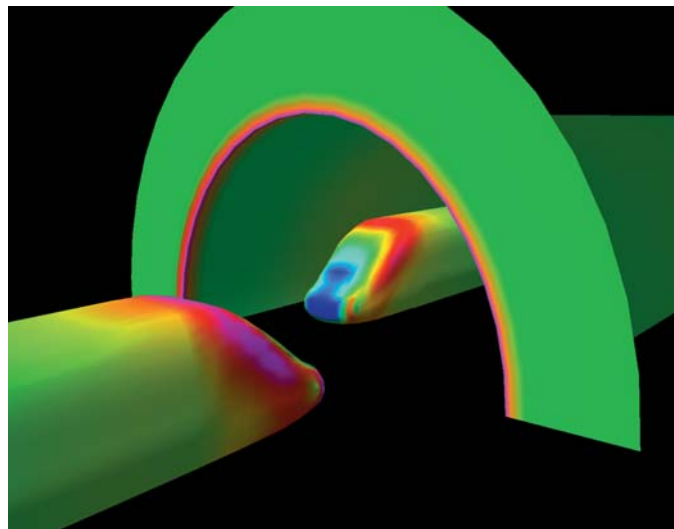
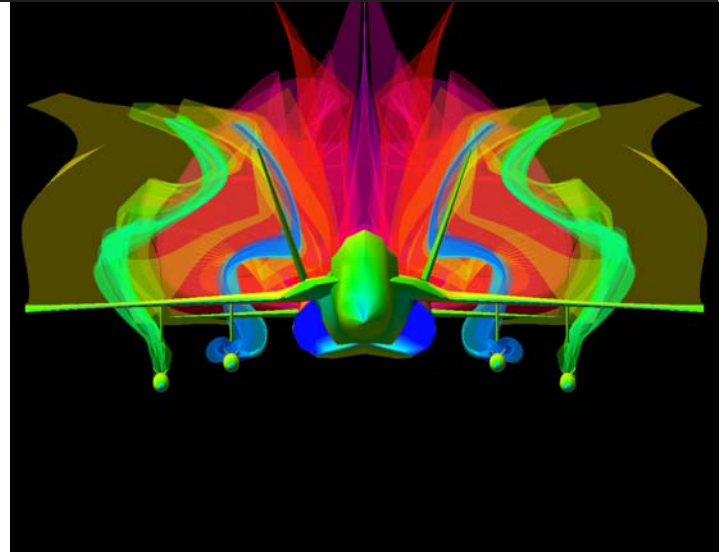
USAERO is the engineer's choice for these and other transient calculations. USAERO's unique coupling of potential flow and boundary layer methods with a time-stepping procedure for arbitrary motions assures timely and cost effective assessments of unsteady surface pressures and loads.

So, beat the challenge! Get USAERO, a really fast CFD tool for transient simulations.



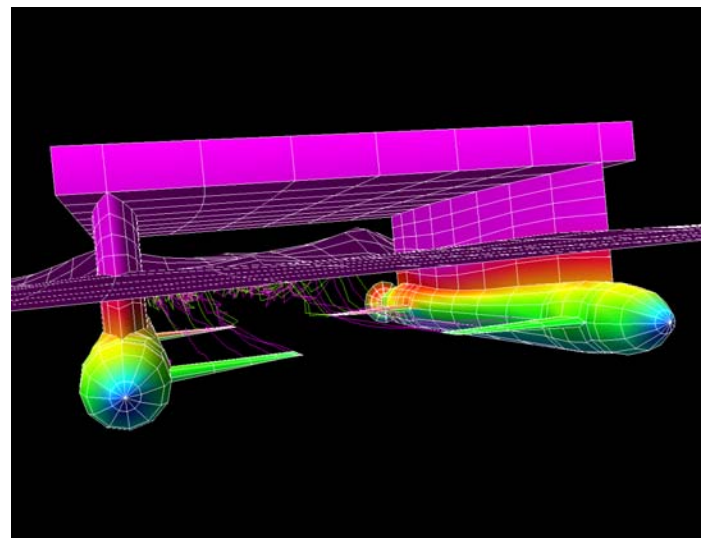
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Multi-Store  
Release  
Simulation



Trains Passing  
In A Tunnel

Ship Motions  
Near The  
Free-Surface



USAERO calculates the transient aerodynamic characteristics of complex configurations in arbitrary motion. It is based on a time-stepping procedure, which allows relative motions of configuration components. As integral potential flow and boundary layer methods are the basis of this CFD software, the aerodynamics solution is only required on the boundary surfaces for each time step and requires only surface meshing. Furthermore, while components or bodies may involve relative motions, no regridding is required by the solution scheme. Because of these features, USAERO supports practical engineering solutions for such problems as maneuvering aircraft, formation flying, aircraft stores carriage, gust response, rotor/body interactions, and train passing and tunnel entry. Special application modules, FLIDYN and FSP, couple with USAERO to provide, respectively, flight-path integration calculations with six degrees of freedom and ship nonlinear free-surface simulations.

### **Solver**

- USAERO solves the instantaneous three-dimensional potential flow equations by the boundary integral method (panel method) based on Morino's formulation.
- Numerical time-stepping accommodates arbitrary motions of multiple bodies and components
- Matrix solutions are obtained by a variety of user selected methods (user options for residual convergence provided), which include the BM Jacobi and GMRES solvers
- Viscous boundary layer effects are calculated by an integral method that includes convergence/divergence terms along instantaneous streamlines and are coupled to the potential flow solution by surface transpiration
- Unsteady wake effects are included by thin shear-layer models convected by local flow conditions.

### **Input**

- USAERO supports arbitrary three-dimensional bodies but only requires surface geometry definition and meshing
- Accepts simple section/point data input descriptions of surface geometry.
- Simple user input options for surface biquadratic interpolation through section/point data

- Simple user input options for surface mesh generation
- Import of mesh geometry produced by Surfgen and Gridgen preprocessors is supported by SPIN(w)
- Wake preprocessing by SPIN(w)
- User input of reference flow conditions such as velocity ( $V_{ref}$ ), Mach number ( $M$ ), onset flow angles ( $\alpha$ ,  $\psi$ ), and Reynold's number ( $Re$ )
- User prescribed frame motion schedules for each body, component, and/or control surface

### **Output**

- Surface and wake geometry
- Surface and wake flowfield data
- Total and component force and moment histories
- On-body streamline trajectories and instantaneous flow properties including boundary layer transition and separation predictions
- Off-body instantaneous flowfield data in volume grids and along streamlines
- Restart file data – complete state of solution at user specified time steps
- Plot file data – exports OMNI3D plot file data
- Surface mesh data – exports surface meshes to SPIN(g) preprocessor

### **Optional Modules**

- Coupling with FLIDYN predicts body motions. For example, multiple store releases from aircraft are computed with USAERO supplying instantaneous forces and moments to FLIDYN and FLIDYN supplying the instantaneous positions, velocities, accelerations, and orientations to USAERO
- Simultaneous coupling with FSP solves the nonlinear ship free-surface problem. Additional coupling with FLIDYN completes the simulation of unsteady ship motions in sea state.

### **Questions?**

For more information about USAERO, please contact:

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