VSAERO™

Nonlinear Aerodynamic Software

Desktop CFD in minutes - VSAERO couples integral methods for potential and boundary layer flows for low runtimes - a complete Boeing 727 in 300 seconds. Flowfield properties are computed for off-body velocity surveys and on/off -body streamlines. The ability to calculate internal and external flows, non-uniform inflow and body rotation, makes VSAERO applicable to fluid flow problems in aerospace, automotive and marine engineering.

Special purpose modules FSWAVE, ROTOR, and FLIDYN expand VSAERO's simulation capabilities to nonlinear hydrodynamic waves, helicopter rotor/ fuselage interactions, and rigid-body flight dynamics. Zonal coupling to Navier-Stokes codes is available. Running on a wide variety of computers, from Cray Supercomputers to desktop PCs, VSAERO is used worldwide. VSAERO has been used in the development of Rutan Voyager and Beech Starship aircraft, the Stars and Stripes racing yachts and the Sunraycer solar automobile.

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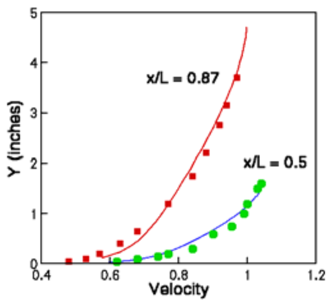
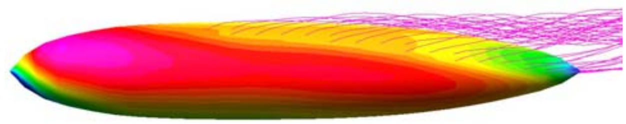
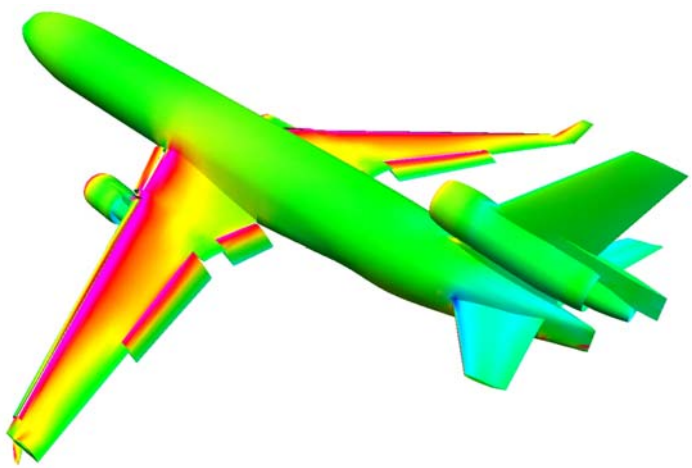


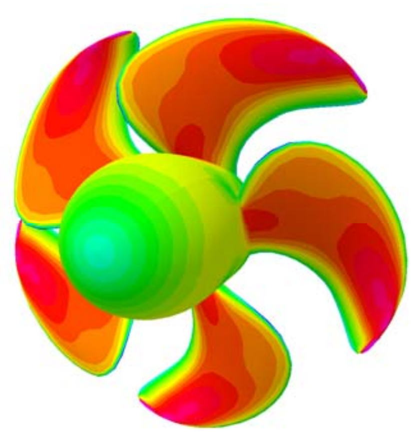


U.S. Airship Akron showing Body Vortex at Angle of Attack and Boundary Layer Velocity Profiles



Panel Model of MD-11 in Ground Effect During Take Off Rotation

Marine Propeller at Advance Ratio of 0.9



Solver

- VSAERO solves the three-dimensional potential flow equations by the boundary integral method (panel method) based on Morino's formulation
- Viscous boundary layer effects calculated by integral methods which include convergence/ divergence terms along streamlines and are coupled to the potential flow solution by surface transpiration
- Non-zero normal velocities model inlets and exhausts. Rotation rates for aircraft maneuvers and propellers. Non-uniform wind profiles for sailboats and cars
- Wake models for wing trailing-edge separation, bluff-body and cross-flow separation
- Matrix solutions are obtained by a variety of user selected methods (user options for residual convergence provided) which include Direct, Blocked Gauss-Seidel, Banded Jacobi and GMRES solvers
- In-core matrix storage reduces scratch disk space

Oscillate

Oscillate is an option to VSAERO to calculate the aerodynamics of a structure oscillating with a prescribed shape, amplitude and frequency. Oscillate calculates the steady and oscillatory pressures including the in-phase (real) and out-of-phase (imaginary) pressures. Linear analysis is used to achieve calculation times equivalent to steady-state calculations. The unsteady pressures can be linearized about the freestream, or for greater accuracy, linearized from the steady-state solution.

ElasticAIC

An oscillatory option to VSAERO has been developed along with AMIDb, a program to generate an external aerodynamic database for Nastran. Aeroelastic calculations of divergence and flutter are possible. ElasticAIC generates the aerodynamic influence coefficients suitable for calculating pressures on a body undergoing arbitrary oscillation.

Input

- Import of mesh geometry produced by POINTWISE® preprocessor
- SPIN(w) GUI for specifying wakes
- VSAERO supports arbitrary three-dimensional bodies but only requires surface geometry definition and meshing
- Accepts grid point input description of surface geometry in various forms: station, buttline or waterline cuts, non-planar sections and unstructured
- Options for surface biquadratic interpolation of surface mesh through section/point data
- User input of reference flow conditions such as velocity, Mach number, angles of attack and yaw, and Reynolds number

Output

- Surface and wake geometry
- Surface and wake flowfield data
- Total, component, patch, and panel-set forces and moments
- On-body streamline trajectories and flow properties including boundary layer transition, separation, and reattachment predictions
- Off-body flowfield data in volume grids and along streamlines
- Added mass calculations during vehicle acceleration
- Restart file data—complete state of solution at user specified break points
- Plot file data—exports OMNI3D plot file data
- Surface mesh data—exports surface meshes to POINTWISE® preprocessor

Documentation

Complete user's manual describing the underlying theory, input variables (defaults, options, suggested values), and 60 example problems with input and output descriptions.

Questions?

For more information about VSAERO, please contact:

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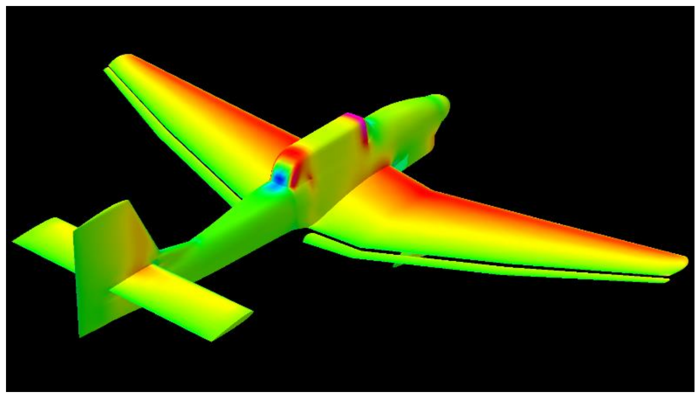
VSAERO Version 8.0 Release Notes

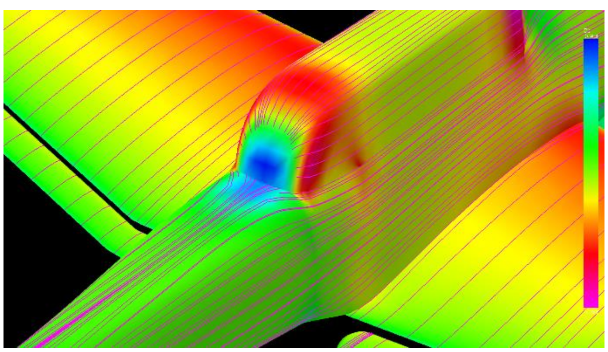
James Nathman

Version 8.0 of VSAERO supersedes Version 7.9. This release consists of the updated code with improvements described below and 169 testcases (two new). Version 8.0 has been tested under the CentOS 7 and Windows 7 operating systems.

Bluff-Body Separation Model

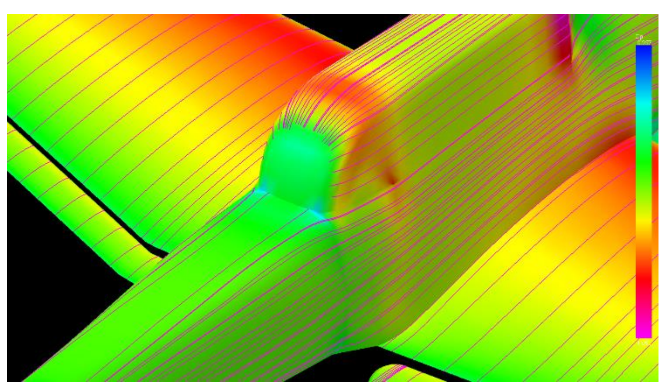
Stagnation behind Bluff Canopy produces no Drag





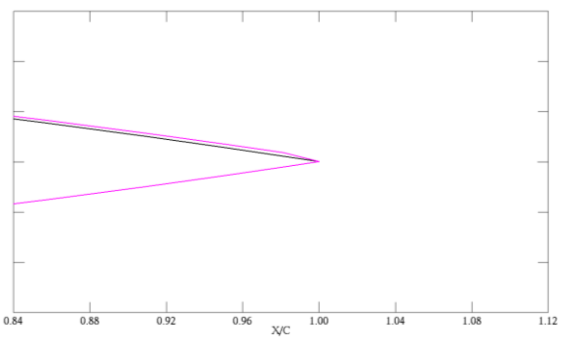
Boundary Layer Identifies Extent of Separation Bubble

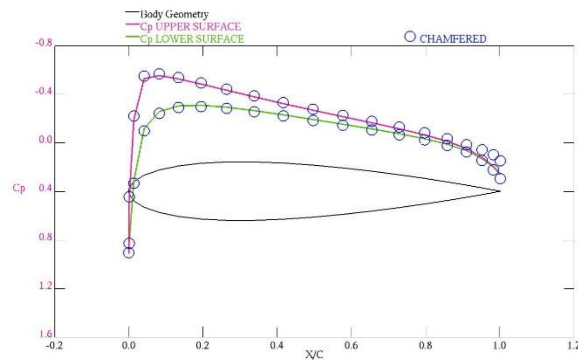
Bluff-body Separation Model reduces Base Pressure and produces realistic Drag



DECHAM

All but a few airfoils have thick trailing edges. At present, trailing-edge thickness degrades the accuracy of VSAERO. This is another example of the rule that a good solution to an approximate geometry is better than an approximate solution to the exact geometry. Some users modify the thick trailing edge by chamfering the last panel on the upper surface. This creates a small, but highly deflected flap. Version 8.0 includes an addition to the SQEEZ utility. DECHAM reduces the chamfer angle to get a more accurate pressure distribution and lift. The figures below compare the trailing edge geometry before (red) and after (black) applying DECHAM. DECHAM can only be applied to structured, folded patches. The improvement in trailing-edge pressure is readily apparent.





Kutta Condition Diagnostic

Version 8.0 now prints a diagnostic for the difference in pressure between the upper and lower shedding panels of all wake columns. Whenever the loading exceeds DCPWRN [0.25] in the print namelist, a warning will be printed to the log file:

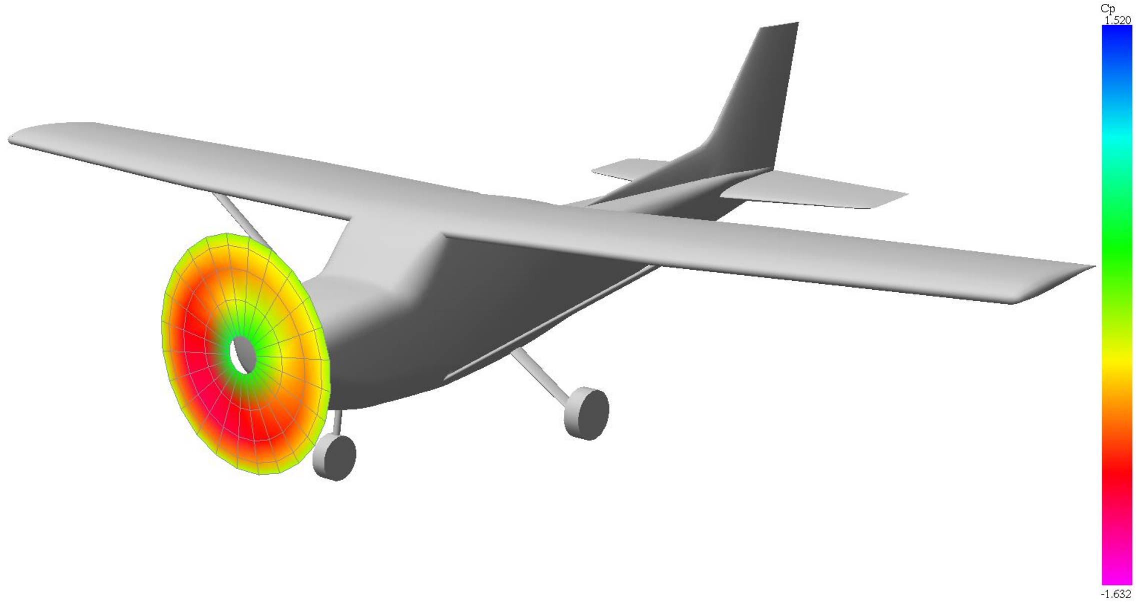
Column 27 of wake 1 has delta CP of -0.93

Many input mistakes cause the Kutta condition to fail: mismatched panels, poor panel spacing, missing neighbors, large trailing-edge camber (often caused by chamfer), wake attached to wrong location. The new diagnostic makes it easier to locate the problem paneling and evaluate model fidelity.

Rotor Module

Rotor calculations now optionally include the effect of slipstream swirl. This is important for propellers with high activity factor.

Also, ROTOR output is now sent to the plot file as an off-body scan. For example, the loading on the propeller disk is shown below. Other data available include: section mach number, angle of attack and inflow angle, cl, cd, chord and pitch. Additional data could be easily added.



Errors Fixed

Unstructured panels that form the base of a jet wake are now correctly identified.

The pressure on unstructured wake-shedding panels is more accurate.

The pressure on unstructured wake-shedding panels is more accurate.

The thrust of a propeller (Type 5 patch) with swirl (ADVRT>0) is now correct.

The boundary layer transpiration just downstream of transition has been improved for the Drela analysis (ISLRST=5).

Simplified BASIC DATA

Many of the basic-data inputs have been moved to the optional namelists. They were rarely specified, and to clarify which inputs are important they were deleted from the basic-data description. Old input files will be interpreted correctly, but are deprecated.

SSPAN replaced by SPAN

Contrary to industry standard, VSAERO previously expected the lateral reference length, SSPAN, to be the semi-span when calculating the rolling moment. The lateral reference length is now expected to be the span. If users must use SSPAN, contact jim@amiaerollc.com.

DBG file

Many warnings and diagnostic messages that were sent to the .OUT or .log file are now sent to a DBG file in addition to more detailed messages. The DBG file should be sent to AMI technical support (jim@amiaerollc.com) when reporting a problem. The .OUT and .log files have less clutter as a result because diagnostic messages that have a low probability of indicating a problem have been deleted.

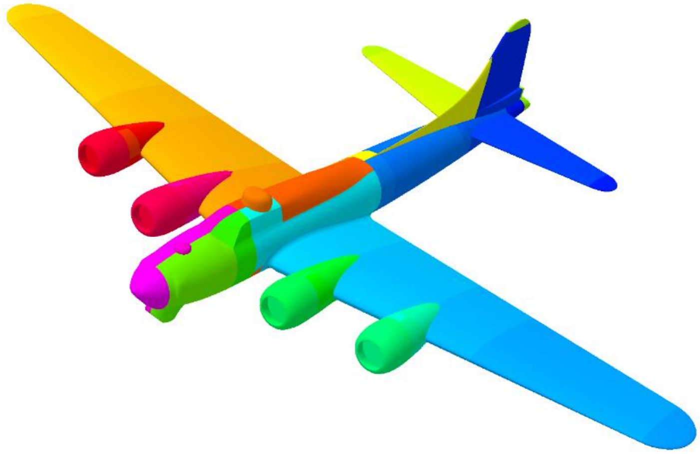
New Testcases

Wing1_decham illustrates airfoil trailing-edge dechamfering.

Sphere1_8t illustrates bluff-body separation.

Spinw Preprocessor

Version 6 of Spinw includes the ability to order selected patches according to x, y, or z. This simplifies the ordering process of complex models. To support this, selecting patches can be done by dragging the cursor across the screen. Typically, for a conventional airplane, the patches on the fuselage ahead of the wing should be ordered in X, the wing ordered in Y and the aft fuselage ordered in X. Below are images of the patch order before and after being reordered. Patch order is significant to the 'LAPACK BGS' solver that is considered the best solver in terms of computer speed and accuracy. Also, the log file now prints the recommended patch order and the reordered body and wake can be output. The automatic blocking is improved in Version 8.0 so that common reasons for lack of convergence (e.g. upper and lower shedding panels in different blocks) no longer occur as long as highly-interacting patches are contiguous. Manual blocking can now be specified by the name of the first patch in each block as well as the first panel number or the block size.



Previous Patch Order

Reordered Patches