

# Accelerant™ Finite Element Solver Technology

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The Accelerant™ solver technology in CFdesign is made up of several highly advanced, intelligent components, each optimized to produce highly accurate, reliable results--efficiently and with blazing speed.

## Finite Element Approach

*CFdesign uses the finite element method primarily because of its flexibility in modeling any geometric shape.*

CFdesign uses the finite element method to reduce the governing partial differential equations (PDEs) to a set of algebraic equations. The dependent variables are represented by polynomial shape functions over a small area or volume (also known as an element). These representations are substituted into the governing PDEs.

Galerkin's method of weighted residuals is used to integrate the governing partial differential equations over an element or volume after multiplying by a weight function. The dependent variables are represented on the element by a shape function, which is the same form as the weight function. The shape function may take any of several forms. The application of finite elements on any geometric shape is the same.

The primary advantages of the Finite Element method are:

- More mathematically rigorous approach than Finite Volume or Finite Difference
- Natural boundary conditions are used for fluxes
- A master element formulation
- The flexibility it provides in modeling complex geometry

## Results Quantities and Outputs

*After the iterations are complete and the scenarios converged, results must be reviewed and questions answered. CFdesign provides a wide range of results quantities to give you the information you need to make informed design decisions:*

- Velocity
- Pressure
- Temperature
- Density
- Viscosity
- Conductivity
- Specific Heat
- Turbulent Kinetic Energy
- Turbulent Energy Dissipation
- Effective Viscosity
- Effective Conductivity
- Wall Model Y+
- Wall Shear Stress
- Turbulent Intensity
- Wall Forces
- Absolute Velocity
- Absolute Static Pressure
- Vorticity
- Strain Rate
- Pressure Coefficient
- Shear Stress
- Temperature Gradient
- Nodal aspect ratio
- Local mean age (LMA)
- Wall Heat Flux
- Wall Film Coefficient
- Thermal Comfort
- Component thermal summary
- Pop-up windows showing thermal device results
- Export to Tecplot-, Fieldview-, and nodal-based output files
- Pressure and temperature export to Nastran, Ansys, Abaqus, Ideas and Cosmos FEA models
- Temperature export to Mechanica

## Accelerant™ Solver

The Accelerant™ solver is a Krylov sparse matrix solver which employs a two level pre-conditioner. Each pre-conditioner level is controlled by a cut-off tolerance, and is constructed during a factorization process. After completing the factorization, it is used within the iterative convergence loop.

- For symmetric matrices, the iterative loops employ a conjugate gradient minimization.
- For non-symmetric matrices, a Lanczos minimization is used.

A CPU minimization optimizer determines the cut-off tolerances

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## Intelligent Solution Control

Intelligent Solution Control is essential to the robustness of the CFdesign solution. By using control theory to evaluate the trends of each degree of freedom, CFdesign automatically adjusts the convergence controls and the time step size to attain a solution.

- If Intelligent Solution Control detects that a solution is approaching numerical instability, it automatically slows the solution progression.
- Alternatively, if it detects that a solution is stable and should progress faster, it adjusts the numerics to evolve faster, which reduces the overall simulation time.

Whatever the situation, Intelligent Solution Control monitors the simulation numerics and constantly adjusts the progress to ensure a robust, efficient design study simulation.

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## Automatic Convergence Assessment

Automatic Convergence Assessment removes the guess-work from knowing when a solution is complete by carefully monitoring the solution field, and automatically stopping the simulation when numerical convergence has been attained.

Small and large frequency changes are monitored throughout the solution field, and the local and global fluctuations of each degree of freedom are evaluated. Multiple parameters are evaluated, and the threshold criteria levels can be customized to suit the particular analysis type.