

## Aeronautics

# Cart3D

A high-fidelity inviscid analysis package for conceptual and preliminary aerodynamic design

NASA's Cart3D tool allows users to perform automated Computational Fluid Dynamics (CFD) analysis on a complex geometry. The package includes utilities for geometry import, surface modeling and intersection, mesh generation, flow simulation and post-processing of results. The main simulation code, flowCart, runs in parallel both in shared memory (OpenMP) and distributed memory (mpi) with excellent scalability. The package is highly automated so that geometry acquisition and mesh generation can usually be performed within a few minutes on most current desktop computers. Geometry enters into Cart3D in the form of surface triangulations. These may be generated from within Computer-Aided Design (CAD) packages, from legacy surface triangulations, or from structured surface grids. Cart3D uses adaptively refined Cartesian grids to discretize the space surrounding geometry and cuts the geometry out of the set of cut-cells which actually intersect the surface triangulation. The flow solver is parallel and can take full advantage of multi-core and multi-cpu hardware.

## BENEFITS

- Easy reconfiguration that simplifies parametric studies
- High-quality mesh generation at low PC memory requirements
- Excellent scalability
- Significantly reduced simulation time requirements

technology solution



# NASA Technology Transfer Program

Bringing NASA Technology Down to Earth

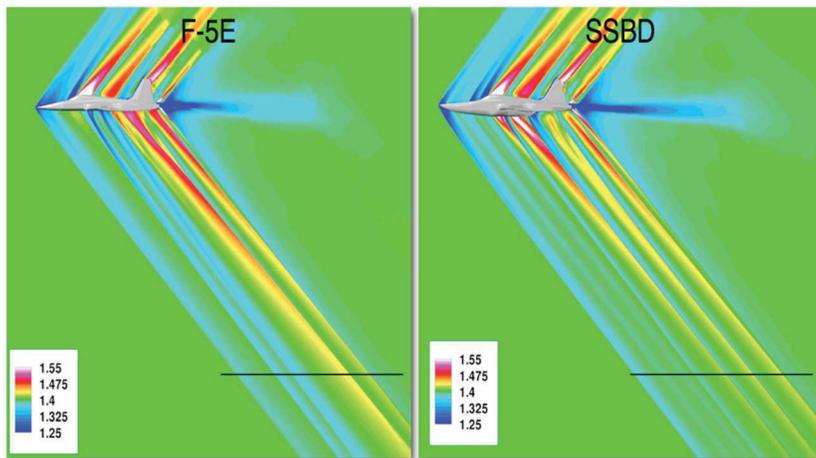
## THE TECHNOLOGY

### Mesh Generation

Cubes is an automated mesh generation tool, which produces Cartesian meshes around arbitrarily complex, watertight geometry. The mesh is adaptively refined based on the local curvature of the geometry. Geometry is input as surface triangulations of individual components. This component-based approach permits easy reconfiguration, greatly simplifying parametric studies. The time to generate a mesh is insensitive to the complexity of the geometry. The highly optimized code generates meshes at over four million cells-per-minute on typical desktop computers and memory requirements are below one gigabyte per million cells.

### Flow Solver

FlowCart is a scalable, multilevel, linearly-exact upwind solver which uses on-the-fly domain-decomposition to achieve excellent scalability on modern multi-core computers. It is among the most scalable, accurate and robust codes in the industry. On most modern desktop machines it can converge well over 2 million cells-per-hourper-core, and is targeted directly at multi-core CPUs. FlowCart is tightly integrated into Cart3D with a suite of automation tools built around it. Since it is a multilevel code, it converges very quickly and includes the latest technical developments on low-dissipation numerics, solid wall boundaries, mesh interfaces and limiters. Both the parallelization and multigrid are completely transparent to the user and can be adjusted at runtime without pre-processing or a special domain partitioning step.



Boom-propagation with running engines and inlets

## APPLICATIONS

The technology has several potential applications:

- Aircraft and spacecraft design
- Aerodynamic and fluid-flow simulations in automotive, turbomachinery, electronics, and process industries
- Military vehicles
- Helicopter design

## PUBLICATIONS

Patent No: 6,445,390

For more information go to:  
[http://people.nas.nasa.gov/~a\\_ftosmis/cart3d](http://people.nas.nasa.gov/~a_ftosmis/cart3d)

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