



Design Tool

Under a Small Business Innovation Research (SBIR) contract with Lewis Research Center, Fluent Inc., Lebanon, New Hampshire developed a CFD (Computational Fluid Dynamics) software package for computing the flow around very complex shapes, such as aircraft contours.

Developed by Fluent's Dr. Wayne A. Smith, the CFD

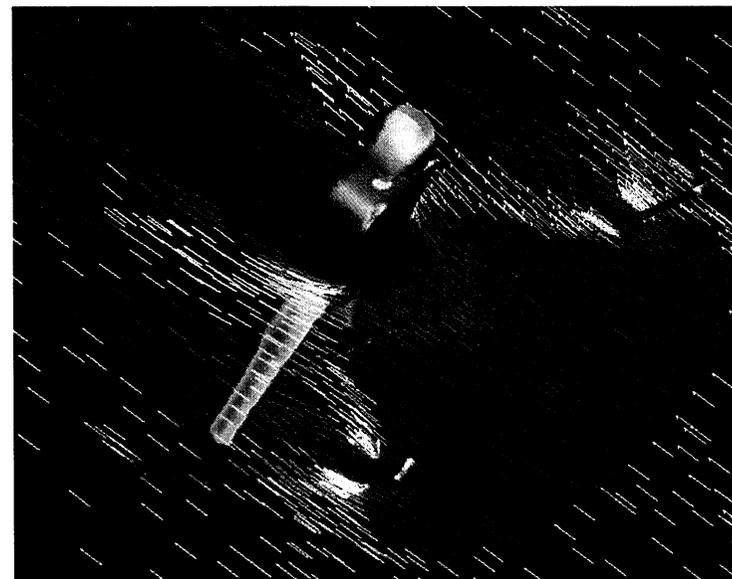
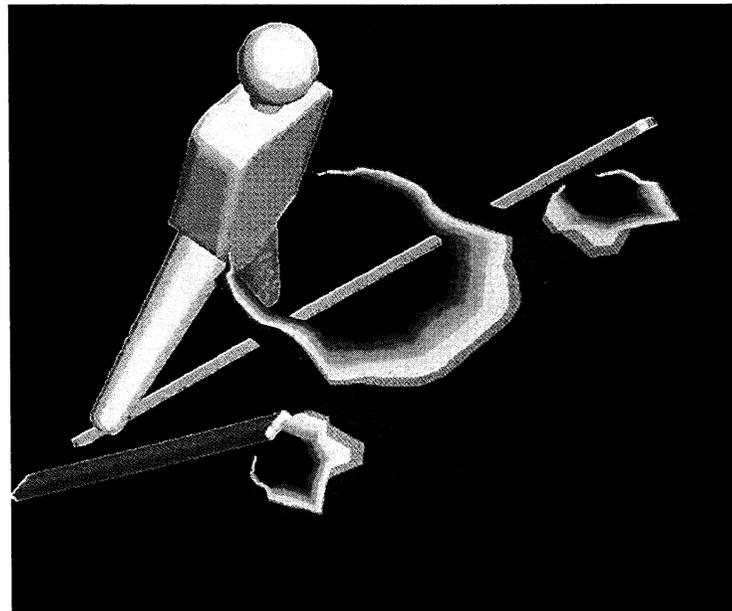
code has evolved into a commercial product known as RAMPANT™, which is available on an annual lease basis.

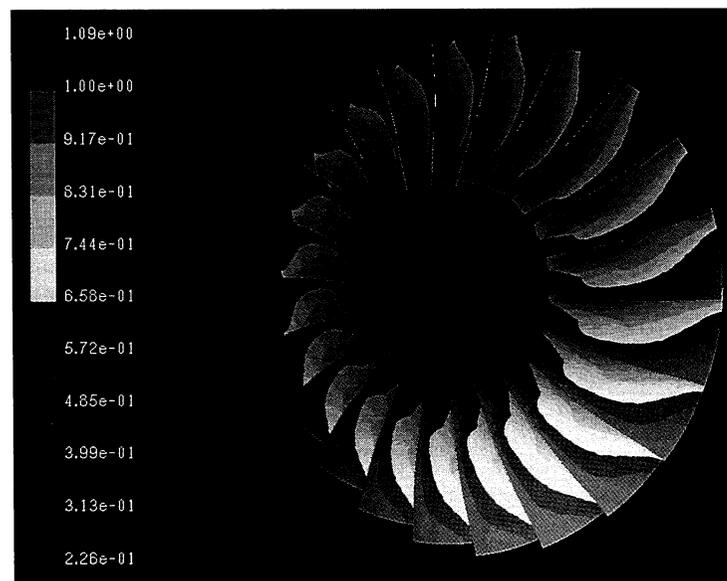
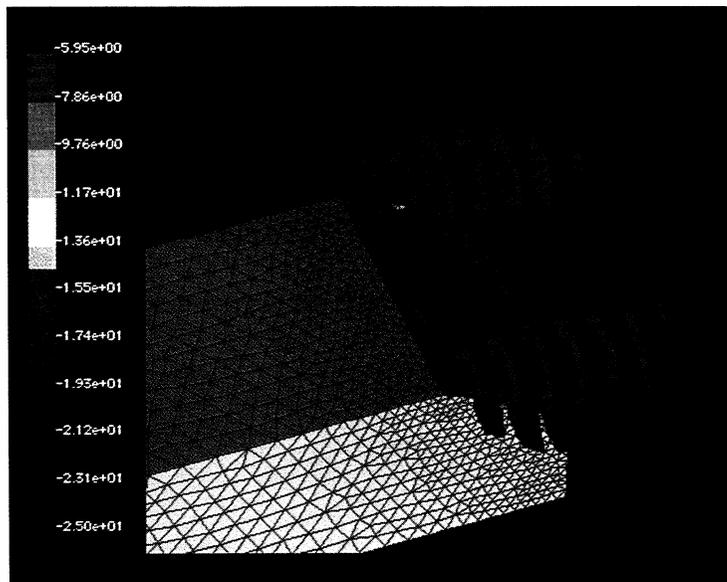
Dr. Smith started work on the SBIR project in 1987 with the goal of producing a CFD code that was flexible, fast and easy to use. To get flexibility, he used an innovative unstructured grid approach. RAMPANT uses tetrahedral

(four-sided) cells to divide the flow field into discrete pieces instead of the six-sided cells used in more traditional CFD codes. This approach provides greater flexibility than the structured grid approach because it does not impose a fixed order on the layout of computational cells. RAMPANT also offers reduced cost of using CFD through a multigrid technique for getting flow solutions in minimal computer time.

RAMPANT, says Dr. Smith, "is well suited for any problem that involves fluid flow and heat transfer around or inside complex geometries." The code's versatility was demonstrated in 1992 when it was employed to compute the flow of air around a Nordic ski jumper. Many of the jumpers in a competition had switched to a new jumping technique called "V-style", a term that describes the shape the skis form while flying through the air with the ski tips spread far apart. Fluent made a comparison of the flow over a V-style jumper (*upper left*) and a traditional jumper with parallel skis (*lower left*). RAMPANT's results showed that the longer distances V-style jumpers were getting was due to differences in aerodynamics caused by the change in ski positions.

A SOFTWARE PACKAGE
FOR FLOW COMPUTA-
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RANGE OF INDUSTRIAL
APPLICATIONS





RAMPANT, Smith adds, “is especially applicable to fluid flow problems in the aerospace, automotive and turbomachinery industries.”

An example of an aerospace application that is easily handled by RAMPANT but would be difficult to compute under the traditional structured grid approach is prediction of the flow over an airfoil with leading edge and trailing

edge flaps. Knowledge of the characteristics of this flow is essential to designing wings with greater lift, which allow lower (hence safer) speeds for aircraft landings and take-offs. RAMPANT is able to predict accurately the maximum lift produced by airfoils with multiple flaps.

In the automotive industry, RAMPANT can compute the external aerodynamics of cars,

trucks, motorcycles, underhood and passenger compartment flows, and the flow through various engine components. *At left* is a RAMPANT computation of the vortices (air whirlpools) shed behind a moving auto of simple shape.

In the turbomachinery industry, RAMPANT can predict the flow through axial and centrifugal turbines, inlet and exhaust ducts, and auxiliary cooling passages. The image *below left* shows the pressure contours on the surface of an axial flow compressor that was tested at Lewis Research Center. ●

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