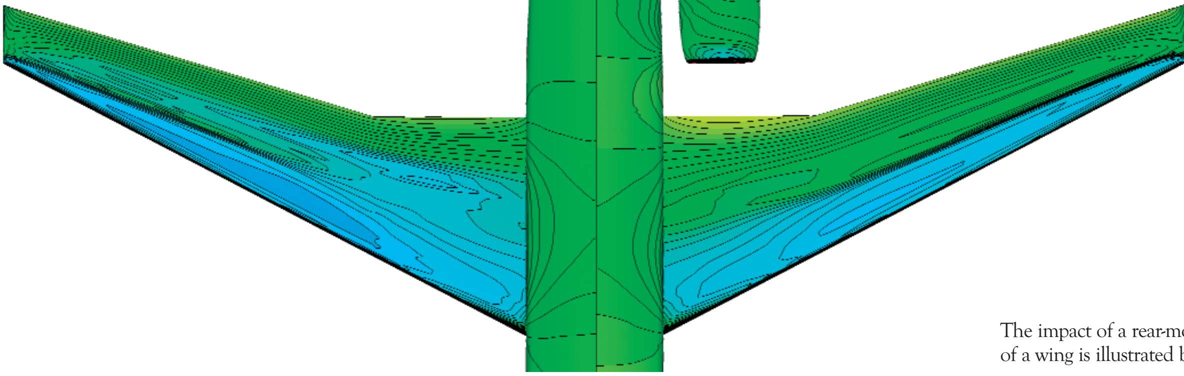

The impact of a rear-mounted nacelle on the top surface of a wing is illustrated by static pressure contours

Nacelle Impact on Aircraft Wing & Fuselage

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THE GENERAL CONFIGURATION and aerodynamic design integration of the nacelle on a commercial aircraft have an important influence on economy, safety, comfort, and performance. It is a complex yet important task to study the aerodynamic interference between the wing/body and engine nacelle and develop techniques for integrating these components during the design phase. These considerations have played a role in the development of the advanced regional jet ARJ21 from China's AVIC 1 Commercial Aircraft Company (ACAC). At ACAC, FLUENT was introduced during the pre-development phase, and it continues to play a major role in design, engine selection, and to save time spent on wind tunnel tests.

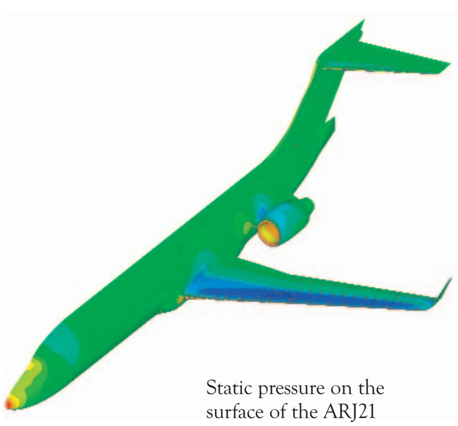
Before applying the turbulent Navier-Stokes equations to the complete aircraft, validations were performed on a simplified geometry. Using a 3D wing-body model, predictions of pressure and lift coefficient were compared to experimental data, and very good agreement was obtained. These results gave the engineers confidence in CFD, and its use has expanded to include many components and aspects of the full-scale aircraft.

As an example, the flow above the joint that is formed between the wing and body of an aircraft has been examined. The flow in this region can separate, and if it is possible to reduce or eliminate the size of the separation region by design modifications, the flight performance of the plane can be improved. Engineers at ACAC have used FLUENT to study this phenomenon and improve the flow characteristics.

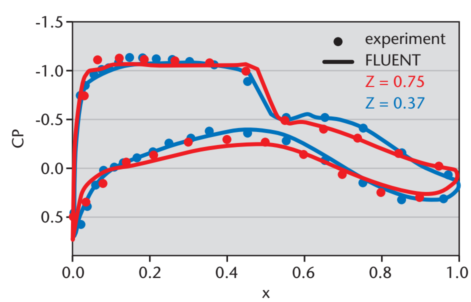
As another example, a rear-mounted nacelle configuration has been studied, in which the aircraft's engines are installed behind the wings. In this configuration, the position of the nacelle or the design of the wing can cause the wake of the wing to be entrained by the engine, compromising its performance. Using FLUENT, the pressure distribution on the wing for several different rear-mounted nacelle positions has been computed for a flight Mach number of 0.78 at an altitude of 35,000 feet. The results showed that the lift coefficient of the wing with this configuration is lower than that of a clean wing (without the interference of the nacelle). The drag coefficient is also lower, however, so that the lift/drag ratio is increased. Furthermore, the interference caused by rear-mounted nacelles makes the nose-down pitching moment decrease and it can reduce the trim drag produced by the elevators. The overall analysis of drag indicates that the existence of a rear-mounted nacelle will have little influence on friction drag, but can have the advantage of reducing the pressure drag. ■

	Pressure (Form) Drag	Friction Drag	Total Drag
Clean wing	0.01547	0.00412	0.01959
Wing with a rear-mounted nacelle	0.01367	0.00397	0.01764

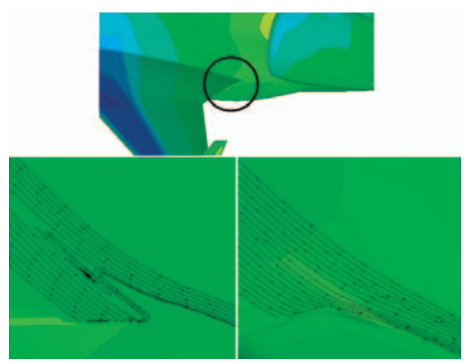
The influence of a rear-mounted engine nacelle on components of drag for a case with a wing lift coefficient of 0.46



Static pressure on the surface of the ARJ21



A comparison of the pressure coefficient computed by FLUENT and measured in the wind tunnel for two wing span locations for the simplified wing-body geometry



Flow separation near the wing-body joint (lower left) was improved by using CFD to alter the design (lower right)